Offshore Wind Evidence + Change Programme

# Mapping fishing activities in the UK EEZ: a brief overview of data, methods, and tools

FiSMaDiM Project

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# Executive Summary

The report provides a brief overview of the different types of data available to identify the spatial distribution of fishing activity. This review focuses on vessel location data, rather than catches or landings data. A comprehensive report (MMO, 2022) was commissioned by Defra's Marine Biodiversity Impact Evidence Group (IEG) and prepared by the Marine Management Organisation which investigated data accessible to MMO to enable spatial mapping of <12m fishing vessel activity in England. This review aims to complement the MMO (2022) report, by expanding its spatial coverage to include Scotland, and by including a review of data available for >12 m fishing vessels nationally. A brief overview of methods and tools available to identify the spatial distribution of fishing activities is included. We further illustrate the strengths and limitations of existing data, methods and tools used to identify the spatial distribution of fishing activities and provide recommendations relevant to the application of these data to evaluate potential impacts of offshore wind developments.

# 1. Introduction

Increasing competition for marine space and evolving spatial management regimes, particularly in coastal areas, demands objective spatial and temporal evidence of use and the "value" (economic, social and cultural) derived from such use. These data are critical to informed decision making if fisheries are to be adequately represented in these processes (Campbell et al., 2014; Metcalfe et al., 2018; Tidd et al., 2015) and can bring insights into the potential impacts or displacement that might result from the expansion of maritime activities such as Marine Protected Areas or offshore wind developments (Cabral et al., 2017).

Traditionally, fishing effort data have been collated with low spatial resolution for the purposes of fishery management at fleet level. However, more detailed spatial information about resource distribution and fishing effort at the vessel level is needed for spatial planning (including fisheries management plans). Ideally, to understand the impact of changes in the marine use on the fisheries (e.g. introducing offshore windfarms or closing areas for nature conservation purposes), not only the wider economic impact on the fishery should be considered, but also the importance of the fishing ground on fishers' livelihoods. Recent technological developments have enabled the collection of spatially-detailed fishery-dependent effort data, initially through the use of vessel tracking systems such as Vessel Monitoring Systems (VMS) and Automated Identification Systems (AIS) (Gerritsen and Lordan, 2011; James et al., 2018; Lee et al., 2010; Natale et al., 2015a), and more recently through the deployment of Global Navigational Satellite System receivers coupled to General Packet Radio Service devices (mobile phone Technology, referred to as iVMS in the UK) (Behivoke et al., 2021; Burgos et al., 2013; Navarrete Forero et al., 2017). These systems generally record at least four data streams: latitude, longitude, time stamp, and device id. However, the collection of these data is not enough, as unprocessed geopositional data does not indicate whether a vessel is engaging in a fishing operation, therefore different methodological approaches need to be developed to identify when fishing activities are occurring and by whom to enable the economic and social assessment of spatial measures on the fishing industry.

The Fisheries Sensitivity Mapping and Displacement Modelling project (FiSMaDiM) aims to provide evidence on fisheries activity and the impact potential that offshore windfarms development will have on the activity of the sector.

The project will fill evidence gaps to reduce potential conflict between offshore windfarms and commercial fishing and guide future strategic deployment of new offshore wind developments away from areas of high relevance to the fishing industry and into areas of lower relevance to the fishing industry. For this, and as part of WP2 - Identification of fishing activities in potential OWF areas within the UK EEZ- first it is necessary to review existing data, methods, and tools used to identify the spatial distribution of fishing activities of vessels in the UK EEZ.

The main objectives of this review are:

1) Provide a brief overview of the different types of data available to identify the spatial distribution of fishing.
2) Assess the strengths and limitations of existing data, methods and tools used to identify the spatial distribution of fishing activities.
3) Provide recommendations relevant to the application of these data to evaluate potential impacts of offshore wind developments.

This review focuses on vessel location data, rather than catches or landings data (which is a more integral part of WP3). A comprehensive report (MMO, 2022) was commissioned by Defra's Marine Biodiversity Impact Evidence Group (IEG) and prepared by the Marine Management Organisation which investigated data accessible to MMO to enable spatial mapping of <12m fishing vessel activity in England. For a description of each type of data please refer to this report. This review aims to complement the MMO (2022) report, by expanding its spatial coverage

to include Scotland, and by including a review of data available for >12 m fishing vessels nationally. A brief overview of methods and tools available to identify the spatial distribution of fishing activities is included.

# 2. Fishing activity data

There are four main categories of data available to identify the distribution of fishing activities. These are: electronic reporting, sightings, landings, and fishers' data. In each of these categories, several types or sources of data are available. The following sections summarise each type of data, including fleet segment coverage, temporal coverage, temporal resolution, and discusses the strengths and limitations of the data, methods and tools which are available to map fishing activities.

## 2.1 Electronic reporting data

Electronic reporting devices transmit geopositional data either through satellite, radio or mobile phone communication (GPRS). The main devices used in UK fisheries to collect spatial data are Vessel Monitoring Systems (VMS), Automatic Identification Systems (AIS), and inshore Vessel Monitoring Systems (iVMS), other tracking devices are also sometimes used (e.g. GNSS trackers, Remote Electronic Monitoring (REM), (Table 1).

**Table 1. Overview of data collected via electronic reporting devices**

| | Fleet Coverage | Temporal coverage and resolution | Strengths | Limitations |
|---|---|---|---|---|
| **VMS** | English and Scottish vessels > 12 metre length | Since 2009/2012 depending on vessel size<br><br>Frequency 1-2 hours | ➢ Covers all English and Scottish vessels.<br>➢ Standardised methods to pre-process data and link with landings (logbook data).<br>➢ Standardised methods for analysis developed (Hintzen et al., 2012; Russo et al., 2014).<br>➢ VMS is tamper-resistant and tamper-alarmed, plus monitored 24/7 by UK Fisheries Monitoring Centre. | ➢ These data do not differentiate between vessels that are fishing or stationary / steaming. Low temporal resolution, issues properly identifying fishing operations, especially for vessels using static gears (Muench et al., 2018).<br>➢ Rectangles with < 5 transmissions are not included within the dataset.<br>➢ Vessels < 12 metre length are not well represented in the dataset.<br>➢ There is generally two or more years delay in data being published. |
| **iVMS** | English vessels < 12 metre length.<br><br>Devon and Severn IFCA trialled iVMS with 25 vessels using demersal trawl. | Since 2022 Frequency 3 minutes<br><br>Since 2019 Frequency of at least 10 minutes | ➢ Will be mandatory for all English vessels < 12 metre length from 2024.<br>➢ Highly resolved data.<br>➢ Trials starting in Scotland. | ➢ Collected from 2022 – will not be available for use until 2024 (MMO, 2022).<br>➢ Method development needed to infer fishing trips and fishing operations.<br>➢ These data do not differentiate between vessels that are fishing or stationary / steaming.<br>➢ No standardised method for analysis (MMO, 2022). |
| **AIS** | English and Scottish vessels > 15 metre length | Since 2015 for vessels with length between 15- | ➢ Mandatory for Scottish and English vessels > 15 metre length.<br>➢ Highly resolved data . | ➢ These data do not differentiate between vessels that are fishing or stationary / steaming. |

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|---|---|---|---|---|
| | | 18 metre, and since 2013 for vessels with length between 18-24 metre (EC, 2009) Frequency 2-10 seconds | ➢ Methods being developed to infer fishing effort in static gears such as pots and gillnets (Mendo et al, in prep). | ➢ Vessels < 15 metre length may not be well represented in the dataset.<br>➢ Common identifier between AIS data and UK fleet register (PLN or RSS) is not readily available.<br>➢ Some areas will not have reception therefore some gaps in coverage (James et al., 2018).<br>➢ AIS devices can be turned off by skippers and false information can be entered (e.g. vessel ID, location).<br>➢ Designed for anti-collision, use for enforcement might increase turning device off.<br>➢ No standardised method for analysis – only ad-hoc. |
| **REM** | Multiple trials in England and Scotland, e.g., Scottish scallop dredging, English otter trawling | Since 2009/10 Frequency as high as 1 sec | ➢ Includes video streams and sensors to validate which different fishing operations are being conducted.<br>➢ Highly resolved data.<br>➢ Standardised method for analysis available. | ➢ REM systems are more expensive.<br>➢ Currently only few vessels/fleets are covered in trials and discrete projects (although see 2023 Defra consultation on expanding the use of REM). |
| **Other tracking devices** | Outer Hebrides, Scotland (regional trial, Teltonika trackers) | Since 2020 Frequency 30 seconds | ➢ Highly resolved data.<br>➢ Standardised method developed (Mendo et al, in prep). | ➢ Only 40 vessels currently tracked.<br>➢ These data do not differentiate between vessels that are fishing or stationary / steaming but methods have been developed to infer fishing activities. |

*Tools and maps available from electronic reporting data*

There are currently a range of electronic reporting-based maps or visualisation tools available that provide insight into fisheries activity. The most prominent ones are:

- **Global Fishing Watch**: Provides generic AIS data aggregated into grid cells (0.01x0.01°degrees) of estimated hours spent fishing. As fishing is inferred without including logbook data or similar, no catch or gear specific effort data available.

- **EMODnet:** provides several layers:

  - Fishing Intensity Maps (2015-2018) – aggregated VMS data 0.05×0.05° degree grid by gear showing average hours fishing in each grid cell. Datasets provided by ICES.
  - Emsa Route Density Map (2019-2022) – aggregated AIS data 1x1 km showing AIS data converted into route and then counting the number of routes (polylines) crossing each grid cell.
  - Vessel density map (2017-2022) - aggregated AIS data 1x1 km showing AIS data aggregated into time spent (hours) in each grid cell.

- **MMO Fishing Activity Maps**:

- Anonymised AIS Derived Track Lines 2011
- Fishing Activity for ≥ 15m United Kingdom Vessels 2007-2020
- Shipping Vessel Density grid 2011-2019 – aggregated data 2x2 km showing number of vessels in each grid cell (MMO, 2014)

❖ **National Marine Plan Interactive** – Marine Scotland Maps: Provides several layers depicting fishing activity, including VMS fishing activity layers (2010-2020) provided by the International Council for the Exploration of the Sea

❖ **MMO Explore Marine Plans**: Provides several layers depicting fishing activity, including fishing effort (VMS data)

❖ **Geofish – CEFAS/MMO**: Spatial database and tool that produces maps to visualise fishing activity in the UK EEZ. Uses VMS data and logbook data as provided to ICES, grid cell size c-squares. This tool is currently only available to Defra group staff. This is a tool to process and supply our UK contribution to ICES but is being explored for wider utility.

## 2.2 Sightings data

These data refer to observations data sources designed to understand the distribution of fishing activities. This includes sightings from patrols on shore, at sea or from air (Table 2).

**Table 2. Overview of data collected through sightings**

| | Fleet Coverage | Temporal coverage and resolution | Strengths | Limitations |
|---|---|---|---|---|
| **Monitoring Control and Surveillance System** | Stratified sample of sightings of English and Scottish vessels. | Although decades of sightings data is locally (IFCA level) available, data processed into fishing location and effort only for the years 2007-2009 | ➢ Covers English and Scottish waters, long term dataset.<br>➢ Processed into fishing activity maps only for England with focus on the inshore area (i.e. up to 6nm) (Breen et al. (2015) | ➢ Sightings over the last decade at historic lows.<br>➢ Sightings data are highly variable (not all sites covered) around English and Scottish waters. Ships and aircraft are tasked in response to risk. There is sampling bias for sightings.<br>➢ Absence of information on fishing activity does not equate to an absence of fishing |

*Tools and maps available from sightings data:*

**MMO and IFCA sightings**: The inshore fishing activity data following the method outlined in Breen et al. (2015) are freely available from the Marine Environmental Data and Information Network (MEDIN) and Cefas. UK Inshore Fishing Activities Intensity - Geographic Information System Data Layer 2011-2012. Data are presented by gear classes: mobile, static, dredging, trawling, potting, netting and lining & commercial angling. Data from 2010 and 2012 and grided onto a 0.05 deg. in longitude and 0.025 deg. in latitude cells. Data are available in the form of aggregated maps on the following website: https://data.cefas.co.uk/view/3277

## 2.3 Data associated with landings

Landings data are the oldest source of information available to understand the spatial distribution of fishing activities. These are, for example, logbooks, sale notes, FISH1 forms (landings declarations), that fishers are

required to submit to government. The spatial and temporal resolution associated with these data is usually low (ICES square resolution 1.0 x 0.5 degree).

**Table 3. Overview of data associated to landings**

| | Fleet Coverage | Temporal coverage and resolution | Strengths | Limitations |
|---|---|---|---|---|
| **e-logbooks and landing declarations** | Mandatory for English and Scottish vessels >= 12 metre length. | Since 2012 for vessels > 15 metre length. Since 2014 for vessels > 12 metre length. Reports submitted every 24hr. | ➢ Covers all English and Scottish fishing vessels > 12 metre length.<br>➢ There is an established method for analysis and reporting based on the Data Collection Framework - Fisheries Dependent Information (FDI) data call (Castro Ribeiro et al., 2016). | ➢ Spatial resolution at ICES rectangle (1.0 x 0.5 degree).<br>➢ There is no independent validation of the skippers' spatial data. |
| **Paper logbooks** | Mandatory for English and Scottish vessels 10 - < 12 metre length and for vessels < 10 metre length that are members of a Producer organisation. | Since the 90's. Reports completed every 24hr | ➢ Covers all English and Scottish fishing vessels 10 -< 12 metre length.<br>➢ There is an established method for analysis and reporting based on the Data Collection Framework - Fisheries Dependent Information (FDI) data call. | ➢ Although, fishers provide latitude and longitude where most of their catch was taken, fishing location is published at spatial resolution at ICES rectangle (1.0 x 0.5 degree).<br>➢ Different reporting requirements in England and Scotland and over the years, changes in data might be due to changes in reporting requirements.<br>➢ There is no independent validation of the skippers' spatial data. |
| **Catch recording App** | Mandatory for English vessels < 10 metre length. | Expected to be available from 2023 onwards (MMO expects to produce standardised anonymised data product). Trip-level | ➢ All English vessels < 10 metre length.<br>➢ Spatial resolution at statistical sub-rectangle (~6x6 km).<br>➢ MMO expects to have a method developed by 2023. | ➢ Catch data allocated to sub-rectangle where majority of catch was taken. No information of other locations recorded.<br>➢ There is no independent validation of the skippers' spatial data. |
| **Sales notes** | Mandatory English and Scottish vessels < 10 metre length. | 1993 - Common Fisheries Policy Trip-level | ➢ Covers all English and Scottish fishing vessels < 10 metre length.<br>➢ There is an established method for analysis and reporting based on the Data Collection Framework - Fisheries Dependent Information (FDI) data call. | ➢ Data might be aggregated to week, depending on frequency of buyer's visit.<br>➢ Spatial resolution at ICES rectangle (1.0 x 0.5 degree)<br>➢ Data quality variable. Location often filled in by MMO expert knowledge.<br>➢ Not all landings have to be reported (England: only >30kg for intended market sales to be recorded, Scotland: Each member of |

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|---|---|---|---|---|
| | | | | the public is permitted to purchase up to 30kg for personal consumption without sale note required).<br>➢ There is no independent validation of the skippers' spatial data. |
| **Shellfish returns** | English vessels < 10 metre length | From 2004 until 2020, replaced by CatchApp<br>Trip-level | ➢ Mandatory for all English vessels < 10 metre length.<br>➢ MMO expert developed a method for analysis and reporting the data to meet the requirements of the Data Collection Framework - Fisheries Dependent Information (FDI) data call. | ➢ Only specifies main ICES rectangle (1.0 x 0.5 degree) fished during the month.<br>➢ Data quality is variable.<br>➢ There is no independent validation of the skippers' spatial data. |
| **FISH1 forms** | Scottish vessels < 10 metre length | Since 2017<br>Trip-level | ➢ Mandatory for all Scottish vessels < 10 metre length. Includes self-declared latitude and longitude where majority of catch was taken.<br>➢ There is an established method for analysis and reporting based on the Data Collection Framework - Fisheries Dependent Information (FDI) data call. | ➢ Data quality is variable, data might be aggregated to week.<br>➢ Any landings for commercial markets need to be reported.<br>➢ There is no independent validation of the skippers' spatial data. |

*Tools and maps available from landings data:*

- **STEFC-FDI data:** provided by EU Member States, responding to the annual Fisheries Dependent Information data call, these data are analysed by the Scientific, Technical and Economic Committee for Fisheries (STECF) Expert Working Group. Data on days at sea, fishing days, landed value and landed weight are aggregated into ICES rectangles. UK data was submitted up until 2021 (2020 data). An equivalent UK FDI data collation initiative is under development.

- **MMO1264 data viewer:** user-friendly visualisation tool (MMO, 2022). The tool shows fishing effort (days), live weight (tonnes) and live value (£) at ICES rectangle level from 2014-2020, for each gear type, country in the UK, and vessel length class.

## 2.4 Fisher's reporting (voluntary)

This category primarily includes data collected from surveys and interviews with fishers to understand the distribution of their activities. These activities have been generally used to understand the distribution of vessels < 15 metre length.

**Table 4. Overview of data collected through fisher's interviews**

| | Fleet Coverage | Temporal coverage and resolution | Strengths | Limitations |
|---|---|---|---|---|
| **FisherMap** | English fishers operating vessels < 15 metre length. | 2005-2010<br><br>Snapshot | ➢ Represents fishing activity for English vessels < 15 metre length. | ➢ Prepared as preparation for MCZ introduction in England. Has not been updated since 2010.<br>➢ There are perceptions in industry that only limited numbers of fishers were involved therefore trust in the results is low (MMO, 2022).<br>➢ Only publicly available for East Marine Plans (Explore Marine Plans). |
| **Scotmap** | Scottish fleet<15 m vessels. | 2007 – 2011<br><br>Snapshot | ➢ Represents fishing activity for Scottish vessels < 15 metre length (except Shetland).<br>➢ Standardised method for analysis available (Kafas et al., 2017). | ➢ Has not been updated since 2011. |

*Tools and maps available from fisher's reporting:*

- **Explore Marine Plans:** FisherMap part of the East Marine Plan, can be accessed by user-friendly webtool.

- **National Marine Plan Interactive**– Marine Scotland Maps: User-friendly tool that provides several layers depicting fishing activity, including:
  - Scotmap data: The data were collected during face-to-face interviews with individual vessel owners and operators and relate to fishing activity for the period 2007 to 2011. The data are aggregated and analysed to provide information on the monetary value, relative importance (relative value) and the usage (number of fishing vessels and crew) of seas around Scotland.
  - Creel fishing effort study: This survey interviewed 198 creel vessel skippers from four regions, two on the west and two on the east coast of Scotland. Effort in this case is defined as number of creels hauled per day per 4 $km^2$.

# 3. Methods to infer fishing operations and effort

Standardised approaches to identify the distribution of fishing activities in the UK have been developed for sightings, landings and fisher reported data. In the case of electronic reporting, there are still limitations and gaps.

Electronic reporting data, with the exception of Remote Electronic Monitoring (where fishing operations can be validated through video observations or sensor data) do not differentiate whether a vessel is engaging in fishing or other activities. Several methods have been developed to infer fishing activity based on some descriptor of the vessel movement profile. For example, the simplest criterion is a speed rule, where records above and below a certain speed threshold are assumed to be associated with fishing operations (Lee et al., 2010; Palmer and Wigley, 2009). This method is mainly used to classify VMS data into fishing or non-fishing activities. This approach, however, has several critiques, mainly associated with the low frequency of data acquisition in VMS.

Muench et al (2018), for example, showed that using speed thresholds resulted in misrepresentation of fishing grounds for fisheries other than bottom otter trawling. Katara and Silva (2017), showed that for the Portuguese purse seine fishery, an increase of the time interval used to record positional data from 10 minutes to 2 hours resulted in a loss of 42% of the trips conducted by the fleet. For inshore fishing vessels (< 12 metre length), Mendo et al. (2019a) showed that to identify all hauling events and the total area fished, the optimal frequency of positional data acquisition was 60 seconds.

The limitations associated with VMS data, especially for smaller vessels and fisheries that display more complicated fishing patterns, have motivated attempts to complement VMS data with other sources of positional data, such as AIS. For example, Russo et al. (2016) showed that joining both data sources significantly improved spatial representation of distribution of fishing activities in Italy. A similar attempt to merge AIS and VMS data was conducted in England, which concluded that integrating AIS and VMS data would improve the spatial representation of fishing effort (Martinez et al., 2022). This integration, however, was done only for one day of fishing activities in southern England, because to date, there is no vessel identifier common to both VMS and AIS data sources, which makes the integration process challenging (Martinez et al., 2022).

Due to the limitations associated with a speed rule method, other methods have been developed and trialled in different fisheries that have higher a higher frequency of positional data acquisition. These include Gaussian mixture models (GMM) fitter using an expectation-maximisation algorithm (Mendo et al., 2019b; Natale et al., 2015b); Hidden Markov Models (Joo et al., 2013; Peel and Good, 2011; Vermard et al., 2010); probability models (Muench et al., 2018), and more recently, machine learning models, such as Random Forests (Behivoke et al., 2021; Mendo et al., 2022). If the data is of sufficient resolution, these methods generally perform very well in correctly identifying fishing activities but require expert knowledge about each fishery to be analysed. Once fishing activities are identified, landings data can be linked to provide a clearer picture of what is being caught where, and the economic importance of the area.

These methods have tended to focus on large fishing vessels (> 15 m length), using mainly active gears (dredges, trawlers). For static gears (e.g. pots, gillnets), inferring the time that a vessel spent fishing, usually describes the time associated with retrieving (hauling) the gear, not actually the amount of gear used or the time the gear was submerged underwater. To estimate appropriate descriptors of effort for these gears new methods need to be developed that can estimate the amount (quantity, length) of gear deployed, and the gear soak time. Research to better quantify the amount of gear and its soak time are underway in Scotland for the creel fishery. In the UK, while approximately 90% of fish landed in 2021 was captured using active gears, approximately 82% of vessels were using static gears (Moran-Quintana et al., 2020).

# 4. Conclusions and recommendations

Several different data sources have been identified in this review to describe the distribution of fishing activities in the UK. These data fall into four categories: electronic reporting, sightings, landings and fisher's reporting data. Different strengths and limitations characterise these data, with regards to spatial and temporal resolution and long-time series availability. For example, while electronic reporting data, specifically VMS data covers all of the vessels > 12 metre length, the temporal resolution is low (2-hour interval between positions), which can result in loss of trips reported and making it very difficult to infer fishing activities. Landings data include vessels < 12 metre length and comprise a long-time series, however the spatial resolution is the ICES statistical rectangles (1.0 x 0.5 degree). These results highlight the need to combine several sources of data to best depict fishing activities in the UK.

While positional data are available for all vessels > 12 metre length (VMS) and > 15 metre length (AIS), high resolution data for the inshore fishing sector (< 12 metre length) is lacking. In England, where iVMS will be mandatory for < 12 metre, these data are expected to improve knowledge on the distribution of this sector by 2023 (MMO, 2022). In Scotland, to date, there is no mandatory tracking of this sector, although a pilot is being

conducted in the Outer Hebrides. Currently, the most comprehensive data set including all fishing activities is the STEFC FDI data, which depict aggregated information on the distribution of fishing at ICES rectangle level (1.0 x 0.5 degree) in a way that assures that the identification of individual fishing vessels is not possible. This data is provided by the national institutions responsible for the collection of fisheries dependent data. In the case of the UK, MMO provided effort and landings data for the UK, and CEFAS and Marine Scotland added the biological parameters (e.g. age structure of landings and discards) and submitted these to the EU in the past. This data is still compiled currently in the same format and made nationally available.

Therewith, economic and social impact assessments of policy on fisheries are restricted by the data, limiting the robustness of assessments of the potential economic and social impact of offshore windfarm developments on this sector. Moreover, widely accepted indicators to measure the social and economic impact on fisheries are currently not available. In discussion with the fishing industry and offshore windfarm developers, it was pointed out, however, that most of the larger offshore windfarm developments are expected to be located in areas fished mainly by vessels > 12 metre vessel length. Inshore fishing activity is more likely to be impacted by cables or support infrastructure for the offshore windfarms. Hence, the impact might be manifold and differ between different fleet segments. Although the data for vessels > 12 metre length is more readily available, there are still limitations when considering the spatial resolution needed to assess the social and economic impact of offshore windfarm on fisheries.

The limitations associated with the spatio-temporal resolution of the data (for example, sightings, landings, fisher's, VMS data) can reduce confidence in decision making for offshore developments. For example, Stelzenmueller et al. (2022) showed that even resolutions of 0.05 degrees of gridded fishing effort tend to overestimate the actual overlap between fishing activities and offshore windfarms. They suggest that to appropriately represent fishing activities, fine scale depictions of effort (0.01 x 0.01 degrees, roughly 1 x 1 km) are needed, as some offshore wind sites can cover areas of only few squared kilometres (Stelzenmüller et al., 2022).

High resolution positional data would allow for better model inference of fishing operations, specifically for fishing vessels that display more complicated fishing patterns and use static gears. Increasing the ping frequency required by VMS would improve the identification of fishing trips and model inference of fishing operations. In the meantime, and for the purposes and timeframe of the FiSMaDiM Project, the integration of VMS with AIS data could provide an improvement to represent fishing activities in the UK. However, first a common identifier to the vessel needs to be established. An automated method to link data from these two devices and a new standardised method to infer effort for these new data needs to be developed. In addition, to appropriately represent effort in space for static gears, new methods need to be developed that estimate the amount of gear deployed, and the time the gear was underwater.

This work is focused on improving the spatial resolution of documented fishing effort. There is more work to be done to link the fishing location to fishing landings and other metrics important for fisheries management as well as social and economic impact assessments if to be integrated into marine management.

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