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Subject:	Document for submission unique ref no 20048237
Date:	02 December 2024 13:33:18
Attachments:	MMO1382_Sensitivity-of-under-12-fleet-east-marine-plan-areas-to-offshore-wind_final-report.pdf

Hi
I did speak about some our concerns over OWFs and this report attached commissioned by MMO endorses it far better than me. Please accept this to be considered by the planning officials.
Regards
Trevor Armstrong
Secretary
Harwich Harbour Fishermens Association

Sent from my iPad

Marine
Management
Organisation

Sensitivity of the under 12m fishing fleet to offshore wind development in the east marine plan areas

Final Report

MMO1382

...ambitious for our seas and coasts

MMO1382: Sensitivity of the under 12m fishing fleet to offshore wind development in the east marine plan areas Final Report, June 2024

Report prepared for:

The Marine Management Organisation

Report produced by:

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When referencing this publication, please cite as:

MMO (2024). Sensitivity of the under 12m fishing fleet to offshore wind development in the east marine plan areas. Final Report. A report produced for the Marine Management Organisation by Poseidon Aquatic Resource Management Ltd and AVS Developments Ltd. MMO Project No: 1382, June 2024, 86 pp + appendices.

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Glossary of terms

Term	Explanation
Active (fishing gear)	Refers to fishing gear that has to be moved, dragged or towed to capture fish. This usually requires engine-propelled boats and often involves additional investment over passive or stationary gear.
Activities	A general term that includes development and uses. Examples of uses might include fishing or recreation.
Coexistence	Where multiple developments, activities or uses occur alongside or in close proximity to each other in the same area or at the same time*.
Co-location	Where multiple developments (often structures), activities or uses co-exist in the same place by sharing the same marine footprint or area, either temporarily or spatially (by using different portions of the water column)*. The footprint can include both the physical location of a development or activity, for example, a built structure, and a wider area associated with the development or activity, for example, a surrounding safety zone.
Displacement	The action of causing the moving of a development, or activity from its current place or position, e.g. fishing activities can no longer occur in an area due to the placement of built infrastructure, either physically, or due to a reduction in the number of a species occurring within or immediately adjacent to an area in which an anthropogenic activity is occurring or has occurred.
Evidence	For the purpose of marine planning, evidence includes policy, data, information, surveys, maps, fisher's anecdotal information and any other relevant material.
Exclusion zone	In this report exclusion zones are areas where fishing gear is requested to be removed temporarily from an area. Unlike safety zones, exclusion zones are not mandatory but are requested by developers to minimise interactions between fishing gear and developer equipment.
Footprint	Can include both the physical location of a development or activity, for example a built structure, and a wider area associated with the development or activity, for example a surrounding safety zone.
Inshore fishing	Fishing activity that takes place within the territorial limit (12nm)
Passive (fishing gear)	Refers to fishing gear that are left in place for a period before being recovered to retrieve the caught fish and shellfish. Includes pots, static nets, driftnets and longlines.
Polyvalent	Vessels using more than one type of fishing gear
Safety zone	A renewable energy safety zone (UK) is a designated area around offshore renewable energy installations as established under section 95 of the Energy Act 2004. Safety zones can be

Term	Explanation
	in place 500m from major works, such as construction and maintenance and/or 50m around an operational installation. Vessel entry into a safety zone is prohibited unless given express permission.
Sensitivity	The resilience capacity a group (e.g. <12m fishing fleet) has to the impacts of a development (e.g. offshore wind).
<	Under.
>	Over.
≥	Over or equal to.

* These are based on the statutory definition as defined within the most recently published marine plans (2021)

Acronyms used

AIS	automatic identification system
DESNZ	Department for Energy Security and Net Zero
EIA	environmental impact assessment
EMF	electromagnetic fields
FLO	fisheries liaison officer
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables (Group)
GDPR	General Data Protection Regulation
GW	gigawatt
IBTS	international demersal trawl survey
ICES	International Centre of the Exploration of the Sea
IFCA	Inshore Fisheries Conservation Authority
iVMS	inshore VMS
MMO	Marine Management Organisation
MPA	marine protected area
MSPri	Marine Spatial Prioritisation
NFFO	National Federation of Fishermen Organisations
nm	nautical mile
NSIP	Nationally Significant Infrastructure Projects
NUTFA	New Under Ten Fisherman’s Association
O&M	operation and maintenance
OP	offshore platform
OWF	offshore wind farm
RDE	Research, Development and Evidence
ROV	remote operated vehicle
VMS	vessel monitoring system

Executive summary

The development of offshore wind farms (OWF) is an important element in the UK’s strategy for energy security and net zero. Around half of England’s OWF capacity is currently located in the east marine plan areas and is expected to see an almost five-fold increase over the next decade. The plan areas are also home to around 263 commercial fishing vessels under 12 metres (<12m) spread across a large number of small coastal communities along this part of the southern North Sea coast. Given the projected expansion of OWF, it is important to understand the spatial and fishery-specific sensitivity of the <12m fleet to all stages of OWF development, to minimise detrimental impacts and ensure opportunities for coexistence are evidenced. The Marine Management Organisation (MMO) commissioned this project, which involved fisher-led participatory mapping to identify and validate fishing grounds in the east marine plan areas (which were grouped into three regions: (i) East Yorkshire and north Lincolnshire; (ii) the Wash and north Norfolk; and (iii) south Norfolk, Suffolk and Essex coasts) and to undertake sensitivity analyses for <12m fishing to OWF development. By drawing on fisher knowledge, MMO data on the spatial distribution of the <12m fleet has been enhanced in the east marine plan areas, providing evidence that can be used in impact analyses across the two sectors.

The project spanned November 2023 – June 2024, with eight workshops held across the coast from Bridlington in the north to West Mersea in the south. In total 54 vessel owners and operators were interviewed (of which 51 were individual vessel skippers / crew of <12m fishing vessels and three were larger (>10m) fleet operators with a good knowledge of their vessel’s activities), representing over 20% of the 263 vessels in the east marine plan areas. A range of gear types were captured in this engagement, covering potters (comprising 55% of vessels included), demersal trawls (18%), fixed gillnets (8%) and longlines (6%) as well as other gear types. The majority (c. 90%) of the <8m fishers interviewed (n=12) and around half of both the 8-9.99 m (n=35) and 10-11.99 m (n=4) were polyvalent.

Two different analyses were carried out; i) participatory mapping of <12m fishing grounds and ii) a qualitative assessment of the sensitivity of different fisheries to OWF.

Participatory mapping involved interviewees identifying fishing grounds applicable to <12m vessel activities and outlining their sensitivity to OWF. This produced a series of maps representing the spatial distribution of fishing grounds in the east marine plan areas. Results showed differences in the levels of sensitivity among fishers in the three regions analysed.

- In **East Yorkshire and north Lincolnshire**, the majority of participants are potting for crab, lobster and whelk. Their major area of sensitivity is from the displacement of offshore fleets from the OWF areas into the inshore fishing area. Participants reported increased concentration of effort in an already heavily fished area.
- In the **Wash and North Norfolk**, there is a wider range of fishing gear including shrimp trawling and cockling. Potters reported similar challenges as potters further north. Trawlers particularly in the Wash reported problems with cable laying including overlying spoil and cables lifting. The loss of historic seed mussel beds to substrate change attributed to OWFs is a concern.

- A high level of contention between fisher and OWFs was described in the **south Norfolk, Essex and Suffolk area**, which has four offshore wind farms within the east marine plan areas, four wind farms in close proximity to the south, as well as pressure from shipping, capital dredging and aggregate extraction. Fishers mapped grounds which are considered no longer productive or viable, despite a perceived long-term decline in fishing pressure. They also provided supporting narrative on unproductive grounds including the recent decline of sole and rays.

The second analysis, conducted during the workshops, was a qualitative assessment of the sensitivity of different fisheries to OWF and explored potential for coexistence between the two sectors. Conducted around different fishing gear types, this showed:

- **Demersal trawls** are particularly sensitive to all aspects of OWF construction and operation. This is mainly because they tend to favour the same type of ground (relatively shallow with an even, non-rocky substrate). Demersal trawling is conducted in reasonably straight lines and is therefore particularly sensitive to sub-sea or surface obstructions. Given the nature of the gear, there are also safety concerns over snagging trawl gear, which is exacerbated by the often single-crewed nature of smaller (8-9.99m) vessels. Other active gears (dredge and mid-water trawls) are less sensitive, as they tend to be lighter gear, but are still impacted by OWF.

- **Pots and traps** in the north of the area are largely outside of survey and construction activities and are therefore currently at low – medium sensitivity. Those further south, e.g. in the Wash and East Anglia seem to be much more sensitive, probably due to the higher density of OWFs, as well as the cumulative spatial squeeze from other marine activities. In all parts of the east marine plan areas, the impact of displaced fishing from OWFs on potting was raised by participants. Impacts identified included increased gear conflict or additional pot fishing pressure as those displaced from OWF areas move into areas traditionally fished by others. Potting pressure was suggested to be exacerbated by new vessels and equipment purchased by potters compensated by OWF operators.

- Those fishing with **other passive gear**, e.g. static gillnets, longlines and drifting gear are mainly found in the congested southern part of the east marine plan areas. Overall, these vessels are found to be highly sensitive to OWF development, both because of the level of exclusion during survey and construction, as well as OWF operation. Fishers also expressed a view that the finfish targeted by these gears are particularly sensitive to the noise produced, increased sedimentation, benthic structure and hydrology changes and electromagnetic forces (EMF) resulting from OWF development. The only exception in this survey is bass handlining, which is facilitated by the aggregating effect of the turbine towers.

In conclusion, spatial squeeze remains a pertinent reality for many <12m fishers. In less congested northern parts of the east marine plan areas impacts tend to be indirect (for example the result of larger vessels traditionally fishing offshore being displaced into inshore areas where the majority of the <12m fishing activity takes place). In southern areas there is a greater number of cable routes and OWFs that directly affect <12m fishing activities, especially those gears targeting finfish. Results further suggest that fisheries are vulnerable to EMF and habitat changes related to OWF operation.

The findings indicate the current coexistence measures that are in effect where fisheries and OWF occur alongside or near each other in the same area or at the same time. It is clear that coexistence policy implementation in regard to the <12m fleet needs to be strengthened. In particular, the careful use of safety zones that minimise their economic impact on <12m fishers; a greater understanding and mitigation of EMF and other environmental change; better consideration of how displacement and associated compensation affects smaller boats that despite their polyvalency, lack the resilience to overcome pressures from larger vessels.

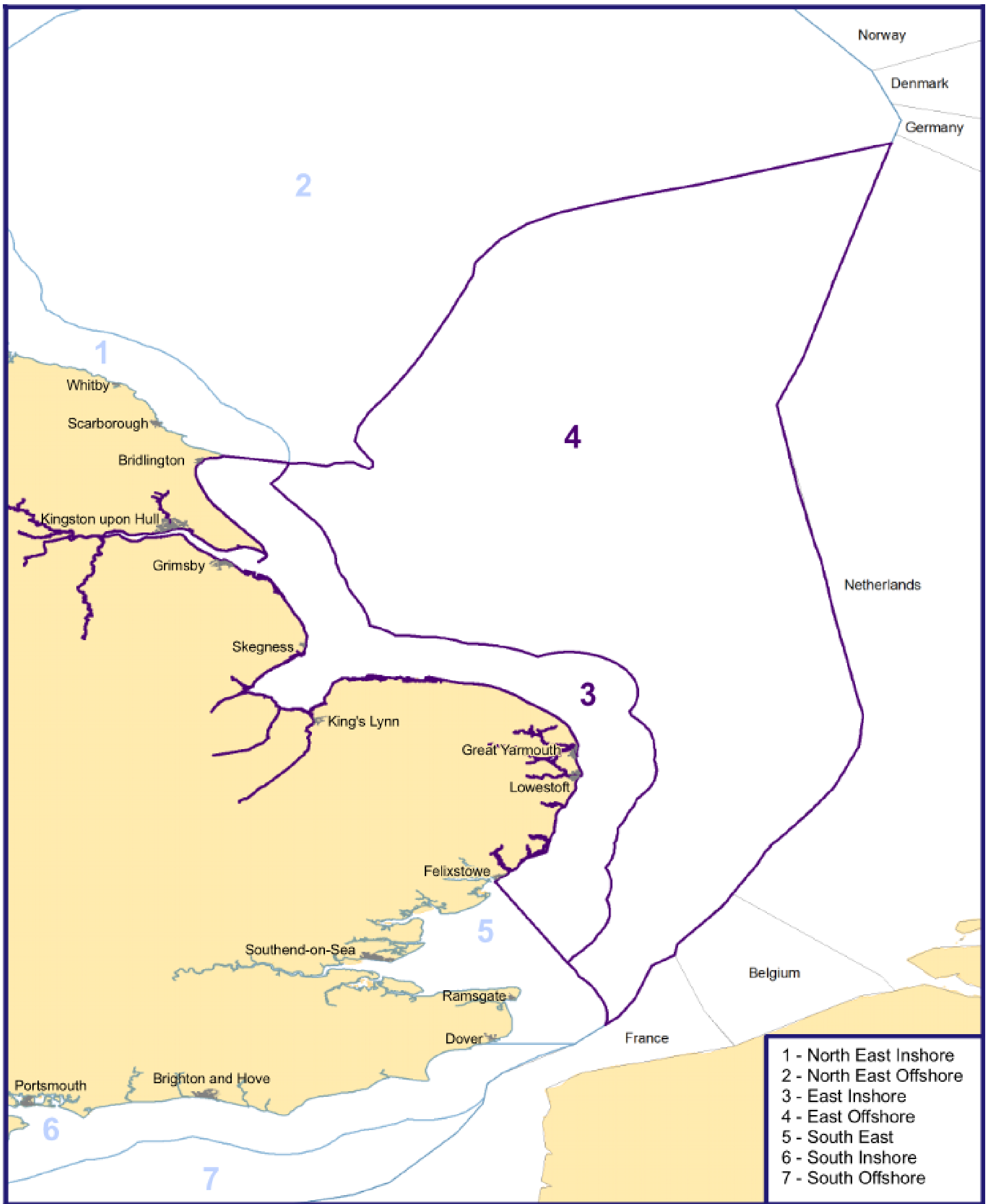
The methods used in this project represent a pilot for gathering data on <12m fishing activity. The report presents possible improvements to the methodology for future adoption in other marine plan areas.

1 Introduction and purpose

1.1 Introduction

This project examined the sensitivity of the under 12m (<12m) fishing fleet to offshore wind development in the east inshore and east offshore marine plan areas[1] in England. The plan areas extend from Flamborough Head in the north to Felixstowe in the south and out to UK territorial limits (see **Figure 1**).

Figure 1: East marine plan areas boundaries (3=Inshore and 4=Offshore)



Source: Defra, 2014.

[1] Here after combined to the east marine plan areas

Development of offshore wind farms (OWF) is an important element in the UK’s strategy for energy security and net zero, with plans to rapidly increase installed capacity from the current (early 2024) 13GW to 50GW by 2030 (HM Government, 2022). Half of England’s OWF capacity is currently located in the east marine plan areas and is expected to see an almost fivefold increase in the east plan areas over the next decade. There are currently (January 2024) 14 operational wind farms (7.24GW) in the east plan areas with a further three in construction (3.8GW) and nine consented, but not yet in construction (13.91GW).

Offshore wind farms (OWF) <100MW are designated as Nationally Significant Infrastructure Projects (NSIP) and therefore require a Development Consent Order (DCO) that is accompanied by an Environmental Statement prepared through the environmental impact assessment (EIA) process. Environmental Statements include a ‘commercial fisheries’ section assessing predicted impacts on the sector from the construction, operation and maintenance (O&M) and decommissioning of the project, alone and cumulatively. When conducting an EIA, key sources of information include landings statistics, automatic identification system (AIS) and vessel monitoring system (VMS) data. These quantitative datasets capture commercial fisheries activity at varying spatial resolutions. For instance, higher resolution VMS is currently only required for fishing vessels ≥12m and AIS is only required for fishing vessels ≥15m in length[2]. For <12m fishing activity, only low resolution landings/sales notes data are available which is usually supported qualitatively through consultations with the Inshore Fisheries Conservation Authorities (IFCAs) and industry participants. As such, the impact on <12m fishing may be under-estimated or misunderstood.

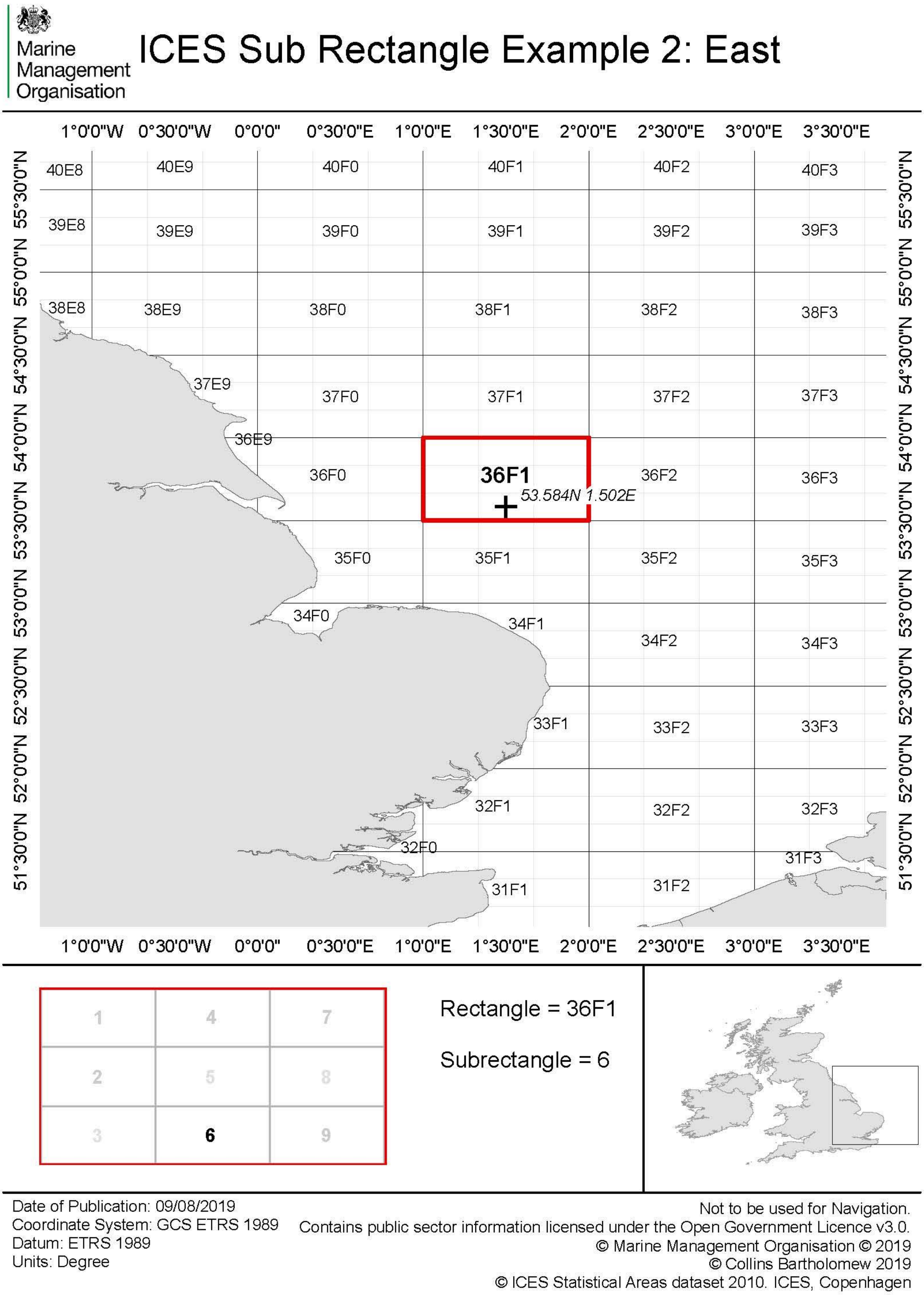
1.2 Aims of the project

MMO identified the need to fill the <12m fishing activity data gap and through multiple projects, including Defra’s Marine Spatial Prioritisation (MSPri) programme, and has developed methods to describe the spatial distribution of fishing. The spatial resolution at which fishing activity can be determined is limited by differing reporting requirements for different sized vessels. At present, commercial fishing vessels ≥12m in length are required to have on-board VMS which reports the Global Positioning System (GPS) location of the vessel, and to submit electronic logbooks. As a result, activity is mapped to 0.05-degree latitude and longitude cells (approximately 3 nm x 1.9 nm in English waters). Vessels 10m to <12m in length are required only to submit paper logbooks which must include a catch location corresponding to International Council for the Exploration of the Sea (ICES) rectangles (approximately 30 nm^2). Until 2022 vessels <10m length had no obligation to submit catch data but sales note records reported catch per ICES rectangle. Since 2022 however, <10m vessels have been required to submit catch records at ICES ‘sub-rectangles’ resolution (ICES rectangle sub-divided into nine).

Figure 2 illustrates the allocation of ICES statistical rectangles within the Southern North Sea. The sub-rectangle numbers are shown in the caption in the bottom left corner of the image.

[2] Inshore VMS (iVMS) is being rolled out across the fleet for fishing vessels <12m in length but data from the system are not yet readily available.

Figure 2: Identification of ICES statistical rectangles within the Southern North Sea



The differing reporting requirements for UK fishing vessels means that fishing activity data for the ≥12m fishing fleet has a greater spatial resolution than that of the <12m fleet. <12m fishing vessels represent 80% of the fishing fleet with a home port registered in the east marine plan areas. This means that the fishing activity for a large majority of the fleet are mapped at low resolution. Although in time this evidence gap will likely be closed with the introduction of inshore VMS (i-VMS) it will likely be a number of years before data can be used in decision making.

With the upcoming replacement of the east marine plans, the continued development of OWF in the east marine plan areas, and the desire for the best available evidence for consenting and decision making, the MMO commissioned this evidence project. It aims to increase the spatial resolution and understanding of the <12m fishing fleet's activity in the east marine plan areas and their sensitivity to OWF.

This project responds to the evidence gap described through primary research conducted with <12m fishers in the east marine plan areas.

The objectives were to:

1. Run participatory mapping workshops with <12m fishers to produce a series of maps to represent the spatial distribution of <12m fishing effort in relation to OWF development in the east marine plan areas.
2. Develop a qualitative assessment containing appropriate representation of the sensitivity of different fishing gears to OWF and their coexistence potential.
3. Develop a repeatable methodology for other marine plan areas.
4. Produce a final report to discuss and summarise findings with a focus on how the evidence can inform coexistence policies in decision making.

This work was undertaken by Poseidon Aquatic Resource Management Ltd and AVS Developments Ltd under Defra's Research, Development and Evidence (RDE) Framework 1.

1.3 Scope

This project covers the below fishing activities.

1. <u>Fishing activity type</u>: commercial fishing vessels with a UK domestic fishing license to fish within the UK exclusive economic zone (EEZ) for sea fish that will be sold i.e. recreational vessels or exempt vessels are excluded.
2. <u>Vessel size</u>: vessels that are registered and licensed on the MMO vessel lists up to October 2023 that are up to 11.99 m in length (MMO, 2023).
3. <u>Home ports</u>: the home ports, as noted in the relevant vessel list, are within or on the boundary of the east marine plan areas, with the addition of West Mersea to the South.[3]

[3] Although the port of West Mersea is outside the scope of the east marine plan areas, the boundary of the study was extended to include this location as fishers regularly access the southern end of the east marine plan areas. During the workshop, spatial information was collected for areas beyond the study area limits in order to give a fuller picture of their concerns in a very crowded and pressured environment.

2 Background

2.1 Commercial fishing and interactions with OWFs

Fishing vessels and their gears are potentially impacted by OWFs (Poseidon, 2021). The specifics of how fishing vessels are impacted is nuanced, with different fisheries, gears and sized vessels being sensitive to varying elements of OWF development.

This background review establishes a baseline of the interactions between OWFs and the fisheries sector. It summarises the main features of OWFs in terms of their ‘activities’ and ‘infrastructure’ (see Table 1) and how fishing gears are sensitive to these two elements, with a particular focus on smaller (e.g. <12m) commercial fishing vessels. It also assesses the current evidence gaps that might be explored by this evidence-gathering exercise.

This review is not exhaustive and is intended to provide the reader with a basic understanding of how OWF construction and operation might affect the nature of fishing activities (e.g. spatial access and the ability to use different types of fishing gears).

2.1.1 General UK OWF development

The British Energy Security Strategy 2022 outlines the Government of the United Kingdom’s (UK) ambition that ‘*by 2030 over half our renewable generation capacity will be wind*[4]*’* achieved through reducing consent times, strengthening renewable policy statements, and implementing new measures and packages (UK Government, 2022). The increase in OWF development is set to be implemented in areas around the UK coastline which are best suited for OWFs, including already investigated and developed regions like the North Sea (Chirosca *et al.* 2022). The implementation of OWF around UK coastlines can conflict with industries already utilising the area, including fisheries (Poseidon, 2021).

[4] See https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

Table 1: Classification of OWF activities and infrastructure types

OWF element		Description
Activities	Survey	Geotechnical surveys e.g. surveys from a moving vessel. Acoustic surveys e.g. surveys using a percussive sound such as an airgun array, either from a static or moving vessel. Benthic habitat surveys: surveys of the demersal substrate using a grab, remote operated vehicle (ROV) etc. from a static or slow-moving vessel. Fisheries survey e.g. surveys assessing the state and nature of fish / shellfish populations, such as the international demersal trawl survey (IBTS).
	Construction	Installation of turbines, substations / platforms, inter-array cables and export cables.
	On-going maintenance	On-going maintenance and repair of offshore infrastructure.
	Decommissioning	Most or all offshore structures above the seabed level, together with all subsea cables, will be completely removed.
Infrastructure	Wind turbine towers	Rotor blades / generators will be supported by foundation structures permanently attached to the seabed. These are typically fabricated from steel or concrete.
	Substation / platform	Including offshore substation platforms which collect the power generated through the inter-array cables and connect the transmission export cables to shore. They also may include accommodation platforms to host personnel during the lifetime of the wind farm.
	Inter-array cables	Buried subsea cables that will connect the generators to one of the OPs, typically in branched strings.
	Cable protection	In order to protect the seabed around foundation structures from scour and cables in the event that full or adequate burial cannot be achieved (or where other seabed assets are crossed), protection materials may be placed on the seabed.
	Offshore export cables	Cables connecting the OPs to the cable landfall at the adjacent coastline (includes inter-link cables).

Source: Compiled by the authors from various OWF ‘Commercial fisheries’ chapters in EIA scoping documents

2.1.2 OWF activities impacting fishing operations

There are four major OWF activities that affect fishing, outlined below.

Surveying

Surveying can include geotechnical, acoustic, benthic habitat and fisheries surveys (OWPB 2015, Poseidon 2021). Surveying occurs throughout the life of the project including during pre-development (Zero Carbon Analytics, 2022); during this time temporary exclusion of fishers from fishing grounds can occur (Poseidon, 2021) to enable some surveys. Surveying, particularly seismic and sonar surveys, can lead to disturbance and impacts on fish behaviour as fish's auditory senses are interfered with and / or damaged, impacting reproduction, predator-prey interactions, migration, and habitat selection (Carroll et al*.* 2017, Kok et al*.* 2021). Such survey based impacts vary from environmental to physical to socio-economic, all of which can detriment the fishing activities to varying degrees.

Construction

Activities related to OWF construction such as the installation of turbines, offshore platforms, inter-array cables and export cables can result in numerous impacts (Poseidon 2021). Impacts include increases in vessel traffic in the surrounding area (Gray et al. 2016, Poseidon, 2021, Anatec Ltd., 2022); increasing navigation risks (Macjan & Kotkowska 2023) and vessel strikes with marine animals (Bennun et al. 2021). Furthermore, noise from additional vessels as well as foundation construction and cable laying, impact marine organisms, both targeted and non-targeted, resulting in environmental and socio-economic repercussions (Farr et al. 2021, Poseidon, 2021). Construction can lead to temporary mandatory exclusion from fishing grounds (Poseidon, 2021) (through safety zones), causing socio-economic repercussions to the nearby fishing fleet; this might include greater steaming times to fishing grounds causing fuel costs increases and decreases in earnings with less fishing time per day (Mackinson et al. 2006). During the foundation construction and cable laying, a rise in sedimentation and turbidity can be noted (Mackinson et al. (2006), Gray et al. (2016), Poseidon (2021)), leading to organism smothering and short-term changes to ecosystem productivity. Construction could also cause chemical pollution as some construction breakages and sediment disruptions can release contaminants which detrimentally impacts the local ecosystem (Mackinson et al. (2006) and Bennun et al. (2021)).

On-going maintenance and repair of offshore infrastructure

As with other activities described, the on-going maintenance of OWF can result in overall increased vessel traffic (Gray et al. 2016, Poseidon, 2021, Anatec Ltd., 2022), with associated navigation risks (Macjan & Kotkowska, 2023), vessel-marine life strikes (Bennun et al. 2021), and noise. Temporary safety zones around infrastructure undergoing large-scale maintenance can result in vessel route disruption / increased steaming times to fishing grounds (Mackinson et al*.* 2006, Gray et al. 2016, Poseidon, 2021).

Decommissioning

OWF must be decommissioned at the end of their lifespan, this is commonly after around 25 years of operation (Zero Carbon Analytics 2022). OWF projects can be considered for decommissioning, which involves most or all of the offshore structures above seabed level, together with all subsea cables, being either completely removed, partially removed, or left in place (Gill et al*.* 2020, Poseidon, 2021). Due to the variation in options, there is uncertainty on how much space lost to OWF may be returned after decommissioning. These options for decommissioning will have their own unique effects on both the corresponding ecosystem and the fishing fleet operating in the area (Fowler et al*.* 2018). Potential impacts include a temporary increase in noise and vibration resulting in adverse impacts to fish and in consequence, fisheries (Poseidon, 2021). Decommissioning can also result in potential collision risks from lost, dropped, or forgotten infrastructure and tools, causing danger to both fishers and wildlife (Poseidon 2021). Decommissioning involves the implementation of 500m temporary safety zones surrounding decommissioned infrastructure, leading to route disruption and increased steaming times to fishing grounds (Gray et al*.* 2016, Poseidon, 2021, Anatec Ltd., 2022). Similar to all stages of OWF development, decommissioning leads to increased vessel traffic resulting in navigation risks (Macjan & Kotkowska, 2023) and increased ecological interactions (Bennun et al*.* 2021). Furthermore, the removal of below-water infrastructure can increase sedimentation and turbidity impacting fish behaviour, and chemical pollution can damage sensitive species, similar to construction impacts (Fowler et al*.* 2018, Hall et al*.* 2020).

2.1.3 OWF infrastructure impacting fishing operations

Further to four OWF activities discussed in Section 2.1.2, there are five major infrastructure elements which can affect fishing activity. Infrastructure impacts vary development by development; therefore, the discussion below addresses the core and common impacts only.

The key aspect which determines the level of impact on fishing activity from OWF development is linked to whether the gears used are active or passive. In the UK there is no legal restriction to fishing within an OWF outside of explicit safety zones. Active gears however, such as trawls, are unlikely to be deployed in an OWF array due to safety and liability issues (Gill et al*.* 2020). Other factors such as size of vessel and range of operations could also be affected by OWF development as the imposition of temporary safety zones increase steaming times and could limit fishing opportunities.

Wind turbine towers

Rotor blades and generators are supported by foundation structures permanently attached to the seabed which are typically fabricated from steel or concrete (Orsted, 2021). During the construction phase, temporary safety zones imposed to reduce spatial interactions, can potentially impact fishing activity, particularly active gears. The permanent presence of towers also limits the movement of fishing vessels (Gray et al*.* 2016; Farr et al. 2021; Poseidon, 2021), with permanent 50m safety zones normal practice. Machinery noise, associated with tower construction, can detrimentally impact fish behaviour (Farr et al. 2021, Poseidon 2021).

Substation / platform

Offshore substations and platforms collect power generated by OWF through inter-array cables. Substations and platforms are connected via transmission export cables to shore and can include accommodation platforms to host personnel during the lifetime of the wind farm (Orsted, 2021). Platforms can create navigation hazards and gear entanglement, inadvertently resulting in spatial exclusion for fishing activity (Anatec Ltd., 2012, Poseidon, 2021).

Inter-array cables

Inter-array cables are subsea cables that connect generators to a substation / platform, typically in branched strings which can vary dramatically in length (GoBe, 2021). Cables can pose hazards resulting in gear entanglement. EMF emitted from cables may impact elasmobranchs and other marine fish behaviour, however effects would depend on project and site-specific factors (Normandeau et al. 2011, GoBe, 2021). Chemical pollution incidences from disruption of sediment and heat emission from cables could also negatively impact the behaviour of some fish and marine life species and the surrounding habitat (Gray et al. 2016, Clarke, 2020).

Cable protection

To protect infrastructure, particularly in cases where both full or adequate burial cannot be achieved, or where other seabed assets are crossed, protection materials (such as boulders or concrete ‘mattresses’) may be placed on and around cables (GoBe, 2021). Cable protection can result in gear entanglement, particularly for active gears, risking fishing vessel damage and financial consequences (Gray et al. 2016, Poseidon, 2021). Furthermore, spatial exclusion zones for some fishing gears can increase steaming times and loss of fishing time as safer areas to fish are sought, which have socio-economic repercussions for fishers (Poseidon 2021, Macjan & Kotkowska, 2023).

Offshore export cables

Offshore export cables connect the offshore substations / platforms to the cable landfall at the adjacent coastline (GoBe, 2021). Export cables present potential for gear entanglement, particularly for active gear types, resulting in potential vessel damage and financial repercussions (Gray et al. 2016, Poseidon, 2021). Similar to other aspects of OWF infrastructure discussed here, navigational hazards and spatial exclusions for some fishing gears from exposed cables can result in increased steaming times (Poseidon, 2021, Macjan & Kotkowska, 2023). Offshore export cables can produce EMF and high levels of heat emissions which can impact fish behaviour, resulting in decreased reproduction and greater predator vulnerability (Normandeau et al. 2011, Orsted, 2021). Furthermore, the cables can result in sediment disruption during their construction and decommission resulting in increased water turbidity creating detrimental conditions for the surrounding environment (Mackinson et al. 2006, Bennun et al. 2021, Poseidon, 2021).

2.1.4 Positive impacts of OWF

Knowledge of positive impacts of OWF development on marine biodiversity is still limited. Wind turbine foundations and scour protection often replace soft sediment with hard substrates, creating artificial reefs for sessile dwellers and providing forage bases and shelter for piscivorous predators (Li et al*.* 2023). This leads to new fishing opportunities, such as for the handlining of sea bass around wind turbine bases.

Watson et al*.* (2024) suggest that the OWF construction phase has been found to lead to declines in the landings of cod (*Gadus morhua*), plaice (*Pleuronectes platessa*), dab (*Limanda limanda*) and sand eel (*Ammodytes* spp.). However, the same research found that for cod, pouting (*Trisopterus luscus*), other commercial sessile and mobile benthic macrofauna (e.g. blue mussels (*Mytilus edulis*) and brown crabs (*Cancer pagurus*), the opposite effect occurs during the operation phase of OWF, showing that landings for these species increased. This suggests it is possible for commercial fish and shellfish species to benefit from OWF structures (see Langhamer, 2012; Degraer et al*.* 2020), potentially resulting in increased food provisioning benefits. OWF furthermore leads to a decrease in (and even a cessation of) demersal trawling, thus possibly creating a refuge for some species.

The long-term cumulative impacts of such changes on marine biodiversity remain largely unknown. Li et al*.* (2023) integrating such impacts into characterisation factors for life cycle assessment based on the North Sea and their results suggest that there are no net adverse impacts during OWF operation on benthic communities inhabiting the original habitats within OWFs.

2.1.5 Summary of impacts on fishing activities from OWF

Based on the background review, OWF development has the potential to affect fishing activities in various ways. To date, there has been little detailed information compiled on the sensitivity of different gear types and scales of operation, especially for smaller vessels e.g. <12m fishing activities, to OWF development.

2.2 Under 12m fishing in the east marine plan areas

2.2.1 Numbers and characteristics of fishing vessels

There are 263 <12m vessels that meet the scoping criteria in Section 1.3. Of the 263, 181 (69%) have shellfish licenses. The vessels are predominately <10m (90%, see Table 2 overleaf), although Boston and Skegness have mixed <10m and 10-12m fleets. The majority of vessels are based in home ports under the jurisdiction of the Eastern IFCA (63%, n=167), with the rest in North Eastern IFCA (21%, n=54) and Kent and Essex IFCA (16%, n=42). There is no data on the classification of <12m vessels by gear type.

Based on our current knowledge of fishing in the east marine plan areas, nine gear categories were used for the participatory mapping and sensitivity analyses (second column in Table 3). Some <12m vessels may be polyvalent i.e., change gear over the year depending on species seasonality, weather, and other factors. The gear categories list is reasonably simple and straightforward which avoided any overlap or misunderstanding during the workshop exercises, while obtaining sufficient granularity for use of the outputs, especially the sensitivity analyses.

Table 2: Number of <12m fishing vessels by home port in the east marine plan areas and their proportion by size

Home port	No. of vessels			% <10 m
	<10 m	10 - 11.99 m	Total	
Bridlington	23	5	28	82%
Flamborough	3		3	100%
Hornsea	5		5	100%
Grimsby	11	1	12	92%
Withernsea	6		6	100%
Boston	6	6	12	50%
Brancaster Staithe	3	1	4	75%
Kings Lynn	12	6	18	67%
Skegness	1	1	2	50%
Blakeney	3		3	100%
Cromer	20		20	100%
Sheringham	7		7	100%
Wells	10	1	11	91%
Aldeburgh	7		7	100%
Great Yarmouth	17	1	18	94%
Lowestoft	19	2	21	90%
Orford	4		4	100%
Sizewell Beach	1		1	100%
Southwold	12		12	100%
Winterton	4		4	100%
Brightlingsea	2		2	100%
Clacton	2		2	100%
Colchester	1		1	100%
Felixstowe	15		15	100%
Harwich	18		18	100%
Ipswich	2		2	100%
Walton-On-Naze	1		1	100%
West Mersea	17	1	18	94%
Wivenhoe	6		6	100%
Grand Total	**238**	**25**	**263**	**90%**

Source: Data compiled from MMO vessel lists (<10m & >10m).

Table 3: Fishing gear categories for participatory mapping and sensitivity analyses

Main gear type		Description	Possible interactions with OWF
Active	1. Trawls (demersal)	Beam trawl, demersal otter trawl, demersal pair trawl, Demersal trawls (not specified), Nephrops trawls, Otter twin trawls, shrimp trawls.	Characterised by long, relatively straight tows, likely incompatible with wind farm turbine arrays. Gear (doors) and bobbins can penetrate seabed and damage sub-sea infrastructure, inc. cables.
Active	2. Dredge	Suction, mechanised & unspecified.	
Active	3. Trawls (mid-water)	Mid-water otter trawl, mid-water pair trawl.	Characterised by long, relatively straight tows, likely incompatible with wind farm turbine arrays.
Active	4. Other active gears	Purse seine (inc. ring nets), boat seines (e.g. Danish & Scottish) & trolling lines.	Short, local active operations that may have some light demersal impact. Will be constricted if confined by physical infrastructure e.g. turbines / subsea devices.
Passive	5. Fixed gear (pots & traps)	Pots (inkwell / parlour / whelk) & traps (fish trap / cuttlefish trap).	Set in strings so maybe sensitive to some infrastructure. Will remain unattended ('soak time') for some time.
Passive	6. Static nets (gillnets & trammels)	Static gill (inc. trammel) & small fixed nets (fyke, stake).	Set in lines, maybe sensitive to some infrastructure. Will remain unattended ('soak time') for some time.
Passive	7. Longlines	Demersal-set longlines & longlines (not specified).	
Passive	8. Drifting gear	Drift nets, drifting longlines	Unattended pelagic gear could drift into wind farms / navigation corridors.
Passive	9. Other passive gears	Small fixed nets (fyke, stake), diving (e.g. for scallops), handlines.	Small footprint.

Source: Adapted from Le Clers (2010).

3 Methodology

There are three key methodology sections:

1. Stakeholder engagement and workshop processes: the workshop planning method and how stakeholders were identified and engaged with.
2. Participatory mapping process: the method used in the workshop to identify spatial location, target fishery and nature and intensity of different fishing activities.
3. Sensitivity and coexistence analyses: to quantify and describe the sensitivity of different fishing operations (e.g. location, vessel size category and gear type(s) used).

The east marine plan area was divided into three overlapping regions as follows:

1. **East Yorkshire and the north Lincolnshire coasts** (north of Flamborough Head to Skegness);
2. **The Wash and north Norfolk coasts** (Spurn Head to Southwold);
3. **The south Norfolk, Suffolk and Essex coasts** (Great Yarmouth to West Mersea[5]).

3.1 Stakeholder engagement

3.1.1 Initial identification and categorisation of stakeholders

In order to identify and map potential stakeholders, advice was taken from engagement partners (North Eastern IFCA, Eastern IFCA, Kent & Essex IFCA, National Federation of Fishermen Organisations (NFFO), New Under Ten Fisherman's Association (NUTFA), fishermen's associations and representative bodies across the east of England, MMO Regional Fisheries Groups (RFG), MMO Senior Marine Officers, MMO Catch Recording Application Service Delivery Lead) on engagement with the <12m fleet in the east marine plan areas. To comply with general data protection regulations (GDPR), our partners communicated with fishers to promote the plans to hold workshops along the coast of the east marine plan areas.

A temporary, project-only database of engagement partners, key stakeholders, and key organisations containing names, organisation affiliations, locations and contact information was developed. Furthermore, a record of interactions was kept (both for first contact and meetings) providing a conversation history log.

Based on this initial engagement, a formal 'Stakeholder Engagement Plan' was developed and agreed with MMO. This was followed throughout the undertaking of the project to maximise engagement.

[5] It should be noted that many vessels operate a number of gear types, and the sensitivity analysis was conducted on the more predominant over the year.

3.1.2 Workshops

Location and timing

Eight workshops were held over January and early February 2024. The locations were as follows (see also Figure 3):

East Yorkshire and the north Lincolnshire coasts

1. Bridlington (16 January 2024, full-day)
2. Grimsby (17 January 2024, full-day)

The Wash and north Norfolk coasts

3. King's Lynn (18 January 2024, full-day)
4. Wells-next-to-Sea (29 January 2024, half-day)
5. Cromer (29 January 2024, half-day)

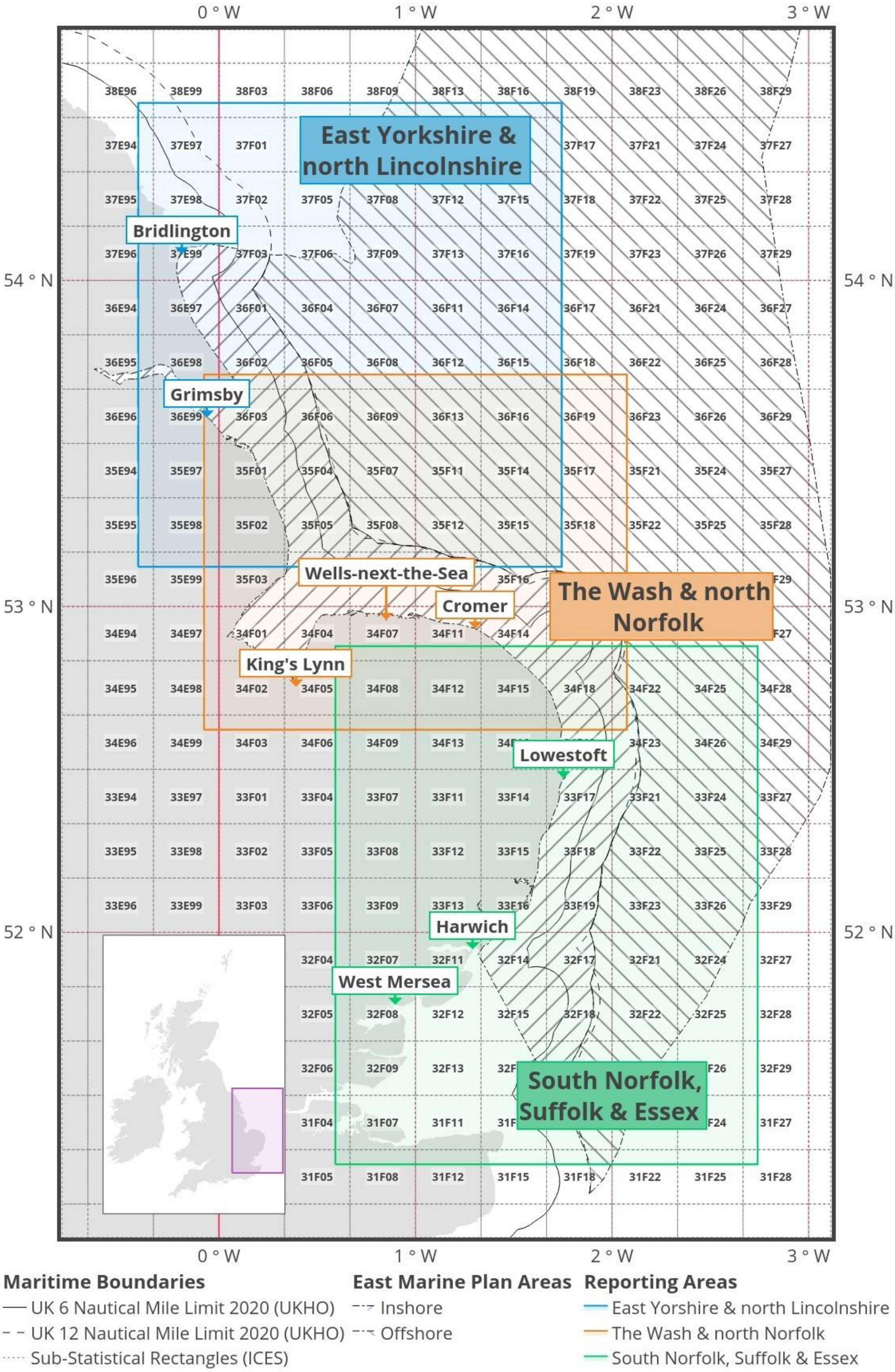
The south Norfolk, Suffolk and Essex coasts

6. Lowestoft (30 January 2024, full-day)
7. West Mersea (31 January 2024, full-day)
8. Harwich (01 February 2024, full-day)

The location of the workshops was primarily based on the distribution of <12m fishing vessels in home ports within the east marine plan areas as identified through the desk-based analysis in Section 2.2. Other considerations included logistics e.g. ensuring participants did not have to travel far to workshop locations as well as advice from engagement partners such as the IFCAs and NFFO and workshop facilitators (see 'Promotion' in Section 3.1.2). Workshops were held in well-known venues in areas fishers regularly visit for social and business purposes.

The timing of the workshops was selected to avoid the busy Christmas period and target a period when the majority of the <12m fleet tie up their vessels for maintenance.

Figure 3: Regions and workshop locations in the east marine plan areas



Promotion

We used a number of methods to promote attendance at the workshops:

- Information sheet: A one-page summary 'Information sheet' (see ANNEX A) providing key workshop information including purpose and outcome. Designed to be circulated either electronically or printed off and displayed as a poster. The information sheet was distributed via the MMO fisheries bulletin, the three IFCAs as well as via workshop facilitators.
- Eventbrite registration: Eventbrite registration was used as an expression of interest and was not mandatory but was encouraged to gauge participation. It was made clear that any spur of the moment availability / drop-ins were welcome.
- Information sent via industry press: Workshops were prompted via popular (among fishers) industry and organisations' newsletters. An article and advert was published in the industry publication 'Fishing News'.
- Identification and use of facilitators: Key individuals in each workshop location were identified and engaged as 'facilitators'. Facilitator knowledge of fishing communities and their status as trusted individuals was harnessed to encourage attendance. The functions of facilitators included:
    1. To help identify a suitable venue for the workshop, fully accessible to participants.
    2. To advise on the best timing and format for the workshop given local fishing patterns.
    3. To contact local fishers and associations to ensure that the nature and timing of the workshop was well communicated to the <12m fishing sector.
    4. If possible, to arrange for workshop participants to arrive over the full workshop duration rather than all at once, so the Poseidon / AVS team could spend quality time with individuals / small groups (e.g. 3 or less).
    5. To assist the workshop organisers in estimating likely attendance levels.
    6. To participate in the workshop and encourage others to do so.
- Reminder emails: We reminded key stakeholders and organisations one week before each set of workshops as well as the day before. Alongside this, calls to the facilitators the week prior to workshops were conducted to check the plans for the event were running smoothly and that some participation was confirmed. Both the emails and calls were to act as a reminder for the workshops as the project team recognise the busy nature of fishing.

The project's participation target was to reach at least 10% of the 263 <12m fishing vessels registered in home ports within the east marine plan area, e.g. 27 vessels total, with some gear and location diversity.

Process

The overall process for each workshop was as follows:

1. Each participant was welcomed and registered on arrival. The registration form included the workshop location, the fisher's name, the vessel name, the administrative port, the home port, the gear usage (main gears used over the first four questions), the vessel length and the fisher's contact details. It was made clear this information was for internal report use only and would not be shared outside of the project team.
2. The participant then moved to the two-person participatory mapping. They used paper maps, supported by online electronic benchmark data (see Section 3.2.1 below) to map out where they fish and with what gears, within the east marine plan areas.
3. The participant then engaged with the two-person sensitivity analysis team, who led both the (i) sensitivity analysis and (ii) the coexistence potential analysis and asked for input.
4. Participants were debriefed at the end of their sessions. The debrief ensured that the above steps had been completed, that the participant was satisfied with proceedings, and that there were no outstanding questions or issues to address.

3.2 Participatory mapping process

We developed a hybrid electronic and paper-based approach for the participatory mapping process, based on previous small-scale fisheries studies (Kafas et al*.* 2013, Thiault et al*.* 2017, Murillas-Maza et al*.* 2023) and MMO experience.

3.2.1 Baseline data

Information on catch and activity was provided by the MMO. The data set included the following information on <12m vessels active in the east of England / Southern North Sea:

- anonymised boat identifier
- landing date
- species
- gear code
- weight
- location of catch
- landing Port.

The information was sourced from a combination of paper logbook returns (for the 10m to <12m fleet) and the catch recording data, for the <10m fleet.

Given catch recording requirements were only recently introduced for <10m vessels, records were only available from 1st April 2022 to 1st November 2023. The paper logbook records for the 10 - 12m fleet covered 6 years of data from 2018 until November 2023.

Analysis of fishing activity data from MMO catch recording and logbooks for the <10m fleet revealed some issues with spatial data collection within catch recording. The limitations identified were primarily in the allocation of catch location to ICES sub-statistical rectangles. In several instances allocation was made to a rectangle which was entirely within the UK landmass. In some instances, the distance from the catch rectangle to the landing port was beyond reasonable distances for an <10m vessel. Examples included instances of potting in the Dogger Bank area and subsequently landing the catch into Wells-next-the-Sea and Felixstowe. The overall picture (as depicted in subsequent mapping outputs) indicates that fishing activity for the <10m fleet mapped reasonably well and demonstrated that the majority of trips were to local, inshore grounds within the 6nm limit. This was in-line with activity based on previous analysis of inshore fishing sightings (Breen et al*.* 2015).

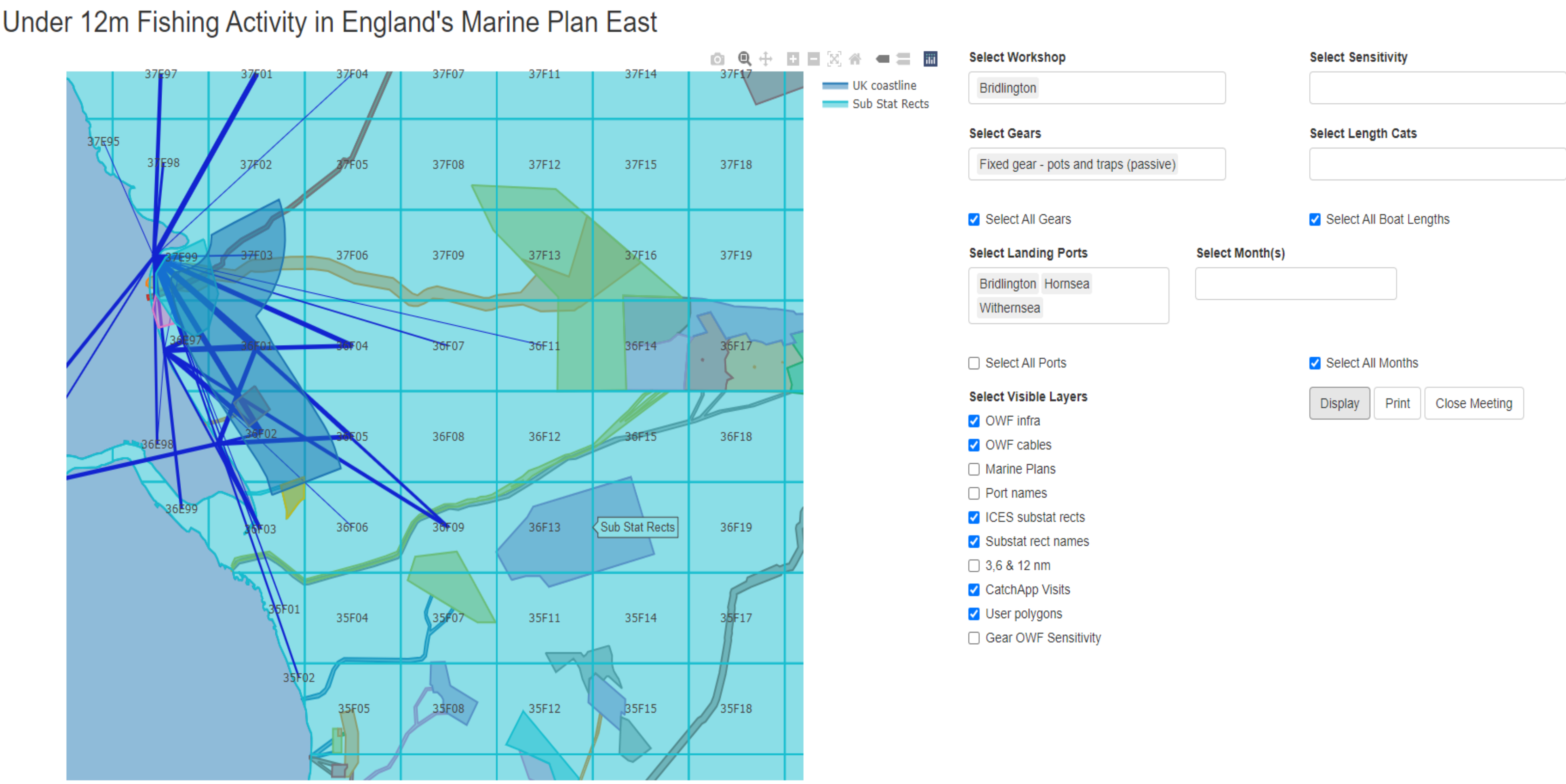
Analysis of the logbook returns for the 10 - 12m fleet was conducted using a similar process to catch recording. The major difference being that logbook reporting is at ICES Statistical Rectangle (which is referenced as an area of 1 degree of longitude and 0.5 degree of latitude). The recording and reporting of this dataset is more mature than <10m catch recording and has fewer anomalies (see Section 1.2). A single vessel may only report activity in 1 or 2 ICES statistical rectangles. This makes the data less insightful than the <10m data, however, it currently represents the only routine spatial collection and reporting system available for this segment of the fleet.

An electronic data recording system was built using the R programming language and R-shiny web app' infrastructure. This app' allowed for the overlay of a number of data layers including:

- Existing OWF installations;
- Planned OWF installations;
- Existing cable infrastructure;
- Proposed cable infrastructure;
- ICES statistical regions including sub-statistical rectangles;
- 3nm, 6nm and 12nm coastline limits;
- The boundary of the east marine plan areas and the responsibility of respective Inshore Fishing and Conservation Authorities (IFCAs).

An example of the display output is provided in Figure 4.

Figure 4: User Interface of On-line Activity Analysis Tool



Data projected using WGS 84 ellipsoid (Coordinate Reference System 4326). Not suitable for navigation. Data layers provided courtesy of The Crown Estate, Marine Management Organisation and EUNIS Habitat Map, (c) 2024.

Scale: Sub stat rectangle is approximately 8nm in latitude x 10nm in longitude.

3.2.2 Participatory mapping

Participating fishers were led through a series of questions. Firstly, participants were asked whether priority fishing areas they identified were core grounds widely fished by the local fleet or extended personal grounds (i.e. accessed when core grounds were losing productivity) or personal grounds where only a small group fished the grounds.

The second set of questions aimed to understand the sensitivity of fishing gears to OWF activities. These questions were reviewed and revised in consultation with the MMO to ensure a consistent approach was taken in workshops across all team members. Following completion of the questions set, the papers and electronic records were captured and annotated with the location, time, and fisher's numerical identification code.

Imray charts (nautical charts) provided sufficient bathymetry and navigation sources for participants to identify key areas to within 10 arc seconds or ~300 m. This was significantly higher resolution than sub-statistical rectangles, which themselves are 20 arc minutes in longitude (about 20km at 52 degrees latitude) and 10 arc minutes in latitude (about 16km). A graphic of a sample chart is provided in Figure 5.

Fisher inputs were drawn in pencil onto A3 tracing paper overlying the Imray chart. This was an effective medium for maintaining privacy between fishers as well as providing a permanent record of the mapping activity and related conversation. Once the meeting was concluded, paper annotations were captured and digitised using the chart scale annotations. In total 30 interviews with 54 individuals were held and circa 150 polygon sets of information were captured.

3.2.3 Quality assurance processing

The quality assurance process followed three steps:

- Review of paper outputs to ensure all elements were captured from the workshops, including notes and comments.
- Comparison with coastline features and chart axes in order to ensure accurate localisation.
- Review of the information alongside catch recording data location records to identify any major inconsistencies and ensure that they were not a result of errors in the digitisation process.

Figure 5: Participatory mapping example of Imray nautical chart annotation

3.2.4 Presentation of Results

The fishers’ spatial polygon data were provided to MMO as ArcGIS shapefiles or data layers. The following statements apply to all spatial images contained within this report:

- Offshore wind turbine locations and cable infrastructure is reproduced courtesy of The Crown Estate © 2024.
- Fishers’ visit density by sub-statistical rectangle is reproduced courtesy of the MMO Catch Recording data (MMO 2024).
- The cartographic projection used is the World Geodetic System 1984 ellipsoid, now recognised as Coordinate Reference System 4326;
- These charts are not suitable for navigation.
- All charts are displayed in portrait mode with north vertically orientated and therefore no north arrow is required to be displayed.

The main points to note are as follows:

- The key territorial boundaries are shown in grey. They include the landmass above high water, the 6nm,12nm and east marine plan areas.
- The number of visits made to a sub-statistical rectangle from a home port by gear; the purple (#Af58BA) line shows how many visits have been declared to a particular sub-statistical rectangle since April 2022. In order to maintain data privacy, any visits by fewer than three different vessels from one port are not displayed. This reduced the total number of visits displayed by gear groups by circa 40% (from 458 records to 273 records). The line weight is set as a logarithmic value of visits and the approximate number of visits is shown in the legend.
- Current wind farms and cable infrastructure are shown in solid green (#00CD6C).
- Licensed proposed wind farms and infrastructure are shown in hatched green (#00CD6C).
- Other sites which impact on fishing e.g. aggregate extraction are shown in solid brown (#A6761D).
- The fishing areas identified are displayed as either:
    - Personal core fishing grounds where a fisher uses a particular gear on a regular basis –shown in amber (#F28522).
    - Personal extended fishing grounds where a fisher uses a particular gear on an irregular basis, e.g. if yield from core grounds drop –shown in yellow (#FFC61E).
    - Fleet core fishing grounds, where a fisher has said that the port fleet regularly use the same area –shown in hatched blue (#009ADE).
    - Historic, barren, or closed grounds, where a fisher used to fish but is no longer able to, due to byelaw, or grounds which are considered barren or unproductive – shown in red (#FF1F5B).
- The personal fishing areas are overlaid as multiple layers. Therefore, darker areas illustrate common grounds where multiple fishers operate within the same area.
- It should be noted that there are some discrepancies in numbers of fishers operating in each region due to polyvalence i.e. some fishers identified fishing areas for some but not all of their fishing gears.

3.3 Sensitivity and coexistence analyses

3.3.1 Sensitivity analysis

The approach to the sensitivity analysis was as follows:

- After participatory mapping, the participant was briefed on the sensitivity analysis data collection process.
- Based on the results of the participatory mapping for that fisher, the relative sensitivity of their fishing operations to the different activity and infrastructure elements of OWF was assessed. This included both ranking the sensitivity from 'Negligible' to 'High' and characterising the nature of impacts. Our approach triangulated and tested sensitivities through discussion.

The purpose of the sensitivity analysis was to determine how OWF might affect the operation of a fishing boat and its catching ability. There are two main points to be considered here:

- This is a qualitative analysis where the sensitivity is ranked from 'Negligible' to 'High' using standardised definitions commonly used across fisheries chapters for OWF projects (see Table 4 below). These are not based on formal guidance but have been designed to be consistent with broader EIA methodology.
- The <12m fishing sensitivity analysis was conducted against both OWF activities and infrastructure. The main OWF elements are summarised in Table 5 with brief descriptions of their possible areas of sensitivity.

Table 4: <12m fishing vessel sensitivity rankings

Sensitivity	Definition
High	Is highly vulnerable to impacts that may arise from the project and recoverability is long term or not possible. *And/or: No alternative fishing grounds are available / and / or they are out of range*.
Medium	Is generally vulnerable to impacts that may arise from the project and recoverability is slow and/or costly. *And/or: Low levels of alternative fishing grounds are available and/or fishing fleet has low operational range*.
Low	Is somewhat vulnerable to impacts that may arise from the project and has moderate levels of recoverability. *And/or: Moderate levels of alternative fishing grounds are available and/or fishing fleet has moderate operational range*.
Negligible	Is not generally vulnerable to impacts that may arise from the project and/or has high recoverability. *And/or: High levels of alternative fishing grounds are available and/or fishing fleet has large to extensive operational range; fishing fleet is adaptive and resilient to change*.

Source: compiled by the authors from various OWF 'Commercial fisheries' chapters in EIA scoping documents.

Table 5: OWF activities and infrastructure elements for use in the <12m sensitivity analysis

OWF element		Description	Potential sensitivities
Activities	Survey	Geotechnical surveys. Acoustic surveys. Benthic habitat surveys. Fisheries surveys.	• Increased noise and impacts on fish behaviour. • Physical disturbance and impacts on fish behaviour. • Temporary exclusion from historical fishing grounds.
	Construction	Installation of turbines, substations / platforms, inter-array cables and export cables.	• Increased vessel traffic (navigation risks). • Additional noise from vessels, foundation construction and cable laying. • Temporary exclusion from historical fishing grounds. • Increased sedimentation/turbidity from foundation construction/cable laying (impacts fish behaviour). • Temporary safety zones (vessel route disruption n/ increased steaming times to fishing grounds). • Possible chemical pollution (breakages or sediment disruptions).
	On-going maintenance	On-going maintenance and repair of offshore infrastructure.	• Increased vessel traffic (navigation risks). • Temporary safety zones around infrastructure undergoing largescale maintenance (vessel route disruption / increased steaming times to fishing grounds).
	Decommissioning	Most or all of the offshore structures above the seabed level, together with all subsea cables, will be completely removed.	• Temporary increase in noise and vibration as a result of cable decommissioning. • Potential collision risk from lost, dropped or forgotten infrastructure and tools (gear snag risks). • Temporary safety zones surrounding decommissioned infrastructure (route disruption / increased steaming times to fishing grounds). • Increased vessel traffic (navigation risks). • Increased sedimentation/turbidity from foundation decommissioning (impacts fish behaviour). • Possible chemical pollution (breakages or sediment disruptions).

OWF element		Description	Potential sensitivities
Infrastructure	Wind turbine towers	Rotor blades / generators will be supported by foundation structures permanently attached to the seabed. These are typically fabricated from steel or concrete.	• Spatial exclusion for some / all gear types. • Machinery noise and its impact on target species behaviour.
	Substation / platform	Including offshore substation platforms which collect the power generated through the inter-array cables and connect the transmission export cables to shore. They also may include accommodation platforms to host personnel during the lifetime of the wind farm.	• Potential for (mainly active) gear entanglement. • Navigation hazards. • Spatial exclusion for some / all gear types. • Aggregation of surrounding fish stocks, due to artificial reef effect of platform.
	Inter-array cables	Buried subsea cables that will connect the generators to one of the offshore platforms (OPs), typically in branched strings.	• Potential for (mainly active) gear entanglement. • Electromagnetic fields and impacts on elasmobranchs and juveniles and the impact on behaviour. • Possible chemical pollution (breakages or sediment disruptions). • Heat emission from cables impacts on fish behaviour and surrounding habitat.
	Cable protection	In order to protect the seabed around foundation structures from scour and cables in the event that full or adequate burial cannot be achieved (or where other seabed assets are crossed), protection materials may be placed on the seabed.	• Potential for (mainly active) gear entanglement. • Navigation hazards. • Spatial exclusion for some / all gear types.
	Offshore export cables	Cables connecting the OPs to the cable landfall at the adjacent coastline (includes inter-link cables).	• Potential for (mainly active) gear entanglement. • Navigation hazards. • Spatial exclusion for some / all gear types. • Electromagnetic fields and impacts on elasmobranchs and juveniles and the impact on behaviour. • Possible chemical pollution (breakages or sediment disruptions). • Heat emission from cables impacts on fish behaviour and surrounding habitat.

Source: compiled by the authors from various OWF ‘Commercial fisheries’ chapters in EIA scoping documents.

The analysis itself consisted of a simple two-way Excel-based matrix combining gear categories (see Table 3) with the OWF elements (see Table 5). Each cell (e.g. gear type / OWF element combination) was colour-coded with its sensitivity ranking (see Table 4) and the key sensitivities summarised in text on a separate worksheet.

It is important to note that this sensitivity analysis focused on the perceived sensitivity of the <12m fishing catching operations to OWF activities and infrastructure. This was based on fisher experience to date e.g. of the construction and operation of OWF and their anticipated sensitivity to future actions such as decommissioning. It did not examine the sensitivity of fish and shellfish stock recruitment, health, and stock abundance to OWFs, as these were considered out of the scope of the study.

3.3.2 Coexistence potential

The interview method included questions within the sensitivity analysis (see above) to assess mitigation options across the different gear types / OWF element sensitivity combinations. As such, coexistence is discussed qualitatively in combination with the sensitivity analysis results.

3.4 Limitations to the methodology

Considerable effort was made by the study team to engage with relevant fishers and encourage them to attend the different workshops. As a result, over 20% of the <12m fishing vessels in the east marine plan areas were interviewed, more than twice the target of 10%. It is recognised that this may not have covered all the issues encountered by the <12m fleet however, and some gaps in coverage may remain. It is also possible that fishers most impacted by OWF are more likely to attend a workshop than those unimpacted. As a result, there is possible participation bias in the mapping data produced, although there was a high level of consistency between the catch recording, mapping and sensitivity analyses.

The sensitivity analysis was conducted against one specific gear type only. In reality many fishers, especially those using <12m vessels, operate more than one type of gear through the year and it is difficult to pinpoint a ‘main’ gear. To overcome this, the interviewer first discussed the different gear types used over the year and then agreed which gear type would be considered during the interview. The number of participatory mapping interviews does not precisely match the number of sensitivity analyses due to the focus on main gears in the sensitivity analyses. The polyvalent nature of many workshop participants does not affect the outcome of the sensitivity analysis however, it means the sensitivity analysis is not exhaustive.

Finally, we emphasise that this is a participatory, fisher knowledge-based study. It is based on the wealth of experience of the <12m fleet participants in the east marine plan areas. As such, it includes the perceptions of fishers which may not be based on empirical evidence but on a long association with the region’s waters. Additionally, it required fishers to provide conjecture on aspects outside their immediate experience e.g. the potential impact of the future decommissioning of OWFs.

4 Results

Eight workshops were successfully undertaken in the east marine plan areas. Overall, 54 vessel owners and operators were interviewed, of which 51 were individual vessel skippers / crew of <12m fishing vessels and three were trawl fleet operators with a good knowledge of their vessel's activities. This represents over 20% of the 263 vessels in scope. Over 55% of interviews were conducted with potters, 18% with demersal trawls, 8% with static nets, 6% with longlines and the remaining 13% with dredges (4%), drifting gear (4%), handlines (2%) and mid-water trawls (2%). Overall, 72% of interviews were held with passive gears and the remaining 28% with active gears.

Most interviews were with 8-9.99 m vessels (69%), with 24% <8m and 8% in the 10-11.99m size class. 17% were from Lowestoft, 17% from West Mersea and 9% each from Bridlington and Harwich and the rest from the other four workshop locations (see ANNEX B for more details).

The following section provides the results of both the participatory mapping and the sensitivity analysis. This section is structured around three regions which focus on characterising the <12m fisheries in each and their overall sensitivity to OWF. A more detailed discussion on these results and their implications for coexistence policies for <12m fishing with OWFs is provided in the subsequent Section 5.

4.1 East Yorkshire and the north Lincolnshire coasts

The fishers from the East Yorkshire and north Lincolnshire coast were almost entirely potters (n=11), fishing for crab (*Cancer pagurus*) from May to December and targeting lobster (*Homarus gammarus*) from June till December. Some vessels supplemented activity with fishing for whelks (*Buccinidae spp.*) from January through to about May. There was one demersal trawler included from this area (see below).

Table 6: Number of vessels by primary[6] gear type and vessel length class in East Yorkshire and the north Lincolnshire

Gear type		Vessel length class			
		<8m	8-9.99m	10-11.99m	Total
Passive gears (potters)		3	6	2	**11**
Other passive gears	Static nets				
	Longlines				
	Drifting				
	Other				
Active	Demersal trawl		1		**1**
	Dredge				
	Mid-water trawl				
Total		**3**	**7**	**2**	**12**

[6] It should be noted that many vessels operate a number of gear types, and the sensitivity analysis was conducted on the more predominant over the year. These numbers are reflected here.

4.1.1 Passive gears (potters)

Participatory mapping of fishing activities

Crab and lobsters: The activity map (Figure 6) has been created from interviews with 11 participants (two 10-12m vessels and nine <10m). The highest density of core fishing grounds (shown in amber) is seen within 7nm offshore extending from Flamborough Head down to the mouth of the Humber Estuary, core grounds are seen to extend almost as far south as Skegness and out beyond the 12nm east of Grimsby. These areas align closely with the purple catch recording data lines. There are also large fleet and extended fishing grounds (blue & yellow) seen beyond 12nm east of Withernsea / Hornsea and Flamborough. These were identified by vessels 10 - 12m.

The rectangles identified for 10 - 12m potters operating in this area are summarised in Table 7. This table provides the number of visits identified in the logbook data, together with area of personal, fleet and extended grounds which intersect with the rectangle (in square kilometres). This shows that all areas identified in the mapping process have corresponding visits recorded in skippers' logbooks.

Table 7: Summary of Logbook visits for 10 - 12m potters in the Yorks & North Lincs sea region

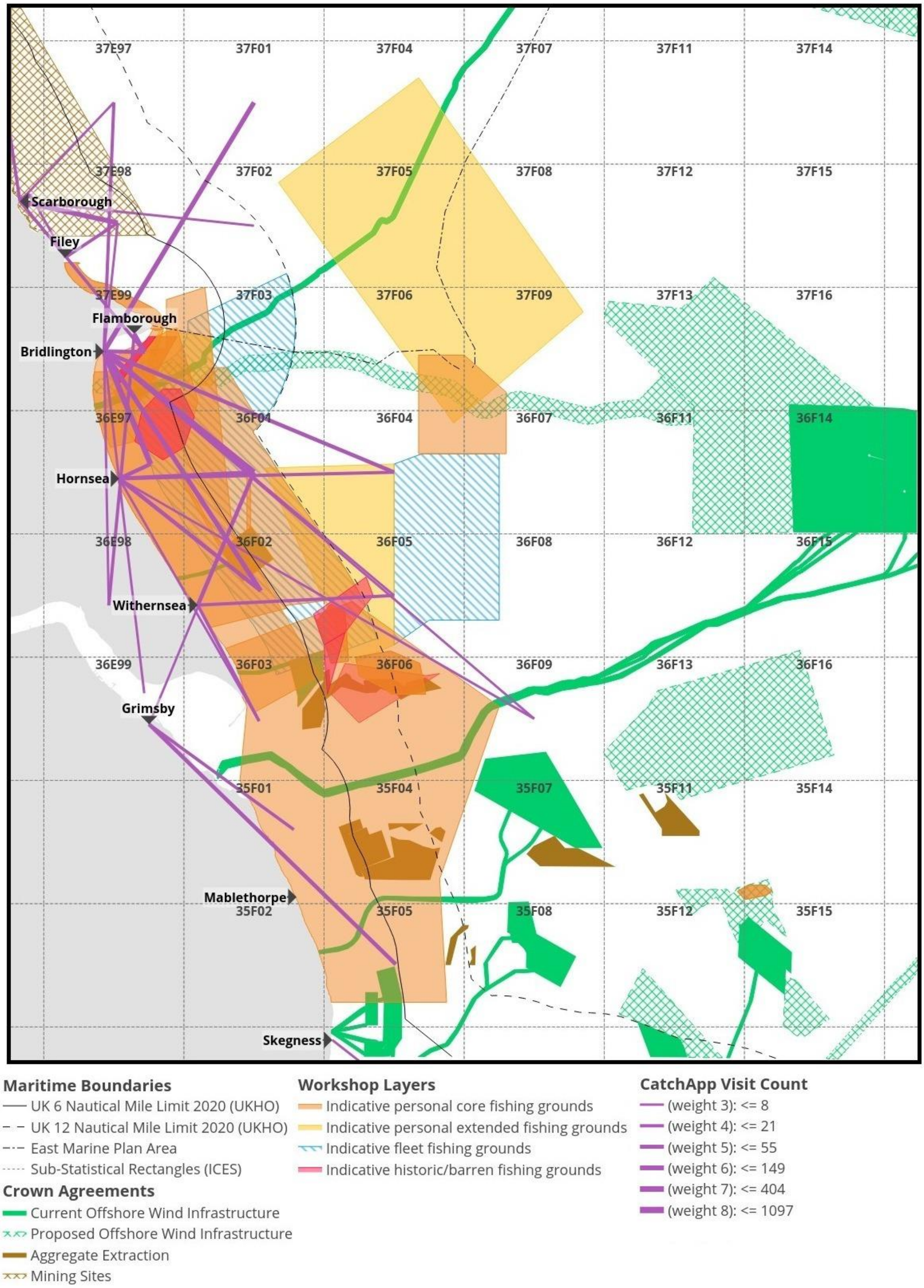
ICES rectangle	Visits made by 10 - 12m vessels (6 years)	Intersecting Area of Participating Mapping (km^2)
35F1	872	325
36E9	75	216
36F0	4,122	1,639
36F1	23	243
37E9	1,051	145
37F0	380	1269

These areas are used by fishers in the winter months when the crab and lobster migrate to sheltered areas. Participants did not identify the grounds recorded via catch recording that extend north of Bridlington (e.g. ICES sub rectangles 37F01, 37E97). These are outside of the east marine plan areas and are therefore not within scope of this study. Section 3.2.1 discusses logbook data analysis in further detail.

The fishers also identified three areas of historic / barren grounds, within their core grounds. According to participants, barren grounds are a result of capital dredging activities near the Humber Estuary (to the south of the area) and sediment deposition near Bridlington Harbour. The core grounds identified overlap with a number of offshore wind farms, Westernmost Rough, Humber Gateway and Lincs and the export cables for Triton Knoll, Hornsea Project 1 & 2 and Dogger Bank A & B. Fishers stated that colocation with this infrastructure was not a major concern.

The accessible areas, particularly for beach launched boats, is limited by sandbanks and tidal stream. It was pointed out that the slipway at Hornsea has suffered increased scour which is limiting access to launch and recover at low tide. Fishers were concerned that any further development on this coastline could increase scouring and reduce accessible grounds further. This would impact all inshore fishers launching from the slipway, irrespective of gear used.

Figure 6: Potting (n=11) activity in East Yorkshire and north Lincolnshire targeting crab and lobster

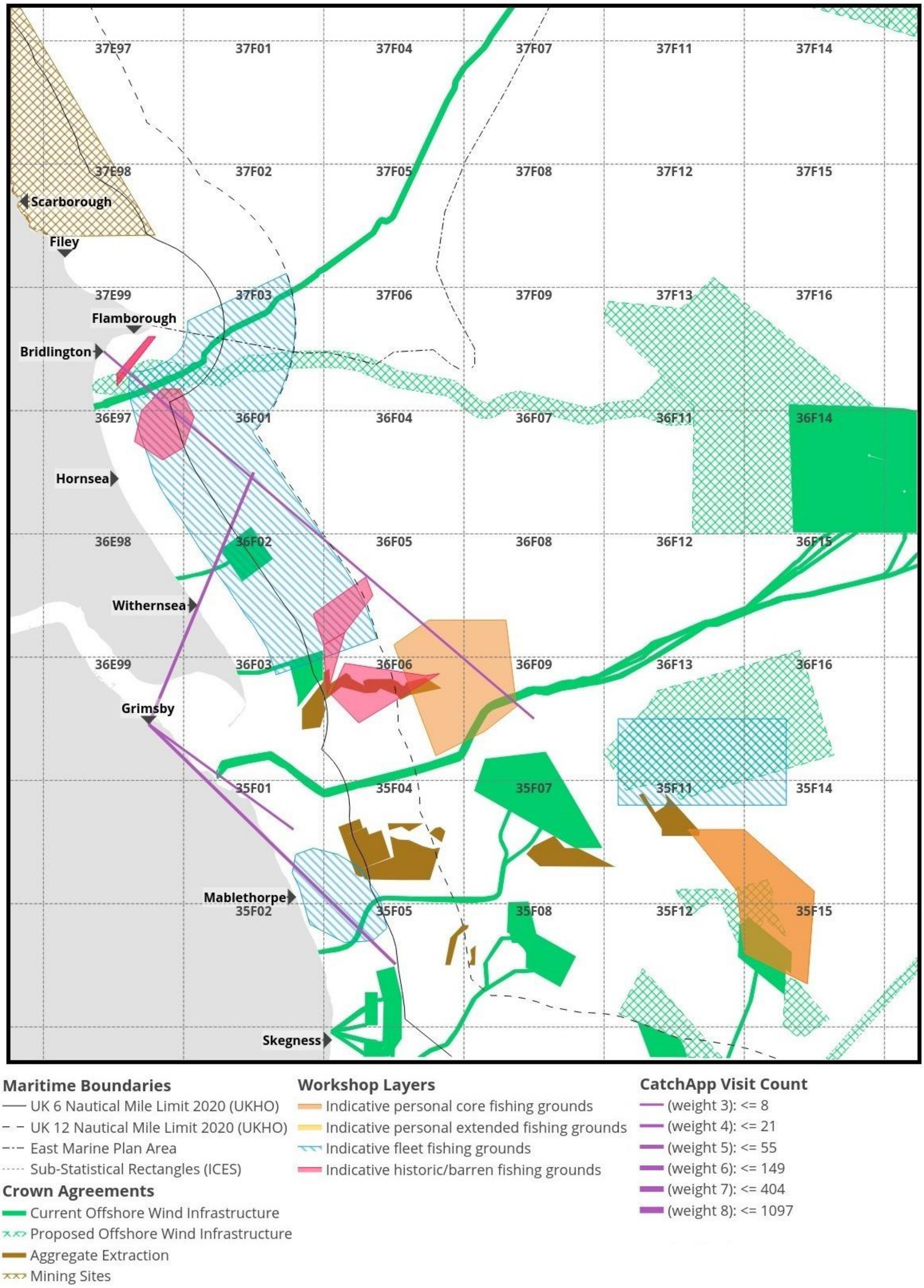


Whelks: Grounds for whelking shown in Figure 7 were identified by four fishers (two fishers <10m boats and 2 fishers 10 - 12m). These are winter grounds and are scattered throughout the region. Some are significantly further from shore than the traditional crab and lobster grounds. Fleet grounds are identified in the region of the proposed Outer Dowsing Offshore wind farm. The core grounds identified in the south-east of the map overlap with Dudgeon wind farm. The overlay of the catch recording data shows less whelk fishing than the narrative indicated. The cause of this may be that <10m catch data is only available for one winter season. If so, it would be reasonable to expect the spatial extent of catch recording data will grow over years and reflect the fisher's narrative on where whelk fishing occurs. Fishers reported that predicting whelk location is difficult, hence more prospecting activity is necessary and grounds are inherently less well defined than traditional crab and lobster grounds. The three barren / historic regions are the same regions identified by the crab and lobster potters and believed to be caused by capital dredging and sediment deposition.

One 10 - 12m vessel skipper reported that dead whelks were discovered in an area subject to seismic surveys necessary to support OWF infrastructure around the Dudgeon OWF.

Logbook records are as Table 7 above. The gear group remains as Fixed Pots and Traps. Areas identified remain consistent with the ICES rectangles recorded in logbooks.

Figure 7: Potting for whelks (n=4) off East Yorkshire and north Lincolnshire



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Sensitivity analysis

The sensitivity ranking of potting in the East Yorkshire and north Lincolnshire region to OWF is shown in Table 7. It suggests that the smaller boats (e.g. <8 m) have a largely negligible to medium sensitivity (see Table 4 for more explanation of these relative terms), whilst 8 – 11.99 m vessels showed a higher sensitivity, especially during the construction phase. In general, the post construction sensitivity was lower than pre-construction (e.g. survey) with the construction phase showing the highest sensitivity. These results are discussed in more detail in Section 5.

Table 8: Sensitivity analysis - pots in E Yorkshire & N Lincolnshire

Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
		Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
<8m	Bridlington	1	2	1	1	2	2	1	2	1	2	0	0	0	0	0
	Bridlington	1	1	0	0	2	2	2	3	0	3	1	1	0	0	0
	Flamborough	1	0	1	2	2	2	2	2	1	2	1	2	0	0	0
8-9.99m	Bridlington	1	1	0	0	3	3	3	1	2	3	3	3	0	0	0
	Bridlington	3	1	1	1	3	2	2	3	2	2	1	1	1	0	0
	Flamborough	1	2	1	1	2	2	1	2	1	2	0	0	0	0	0
	Grimsby	3	3	0	0	3	3	3	3	1	2	1	1	3	0	2
	Grimsby	2	3	0	0	1	1	1	2	1	2	2	1	1	0	0
	Hornsea	0	1	0	0	3	1	2	2	1	2	1	1	0	0	0
10-11.99m	Bridlington	3	1	1	1	3	2	2	3	2	2	1	1	1	0	0
	Grimsby	2	3	0	0	1	1	1	2	1	2	2	1	1	0	0

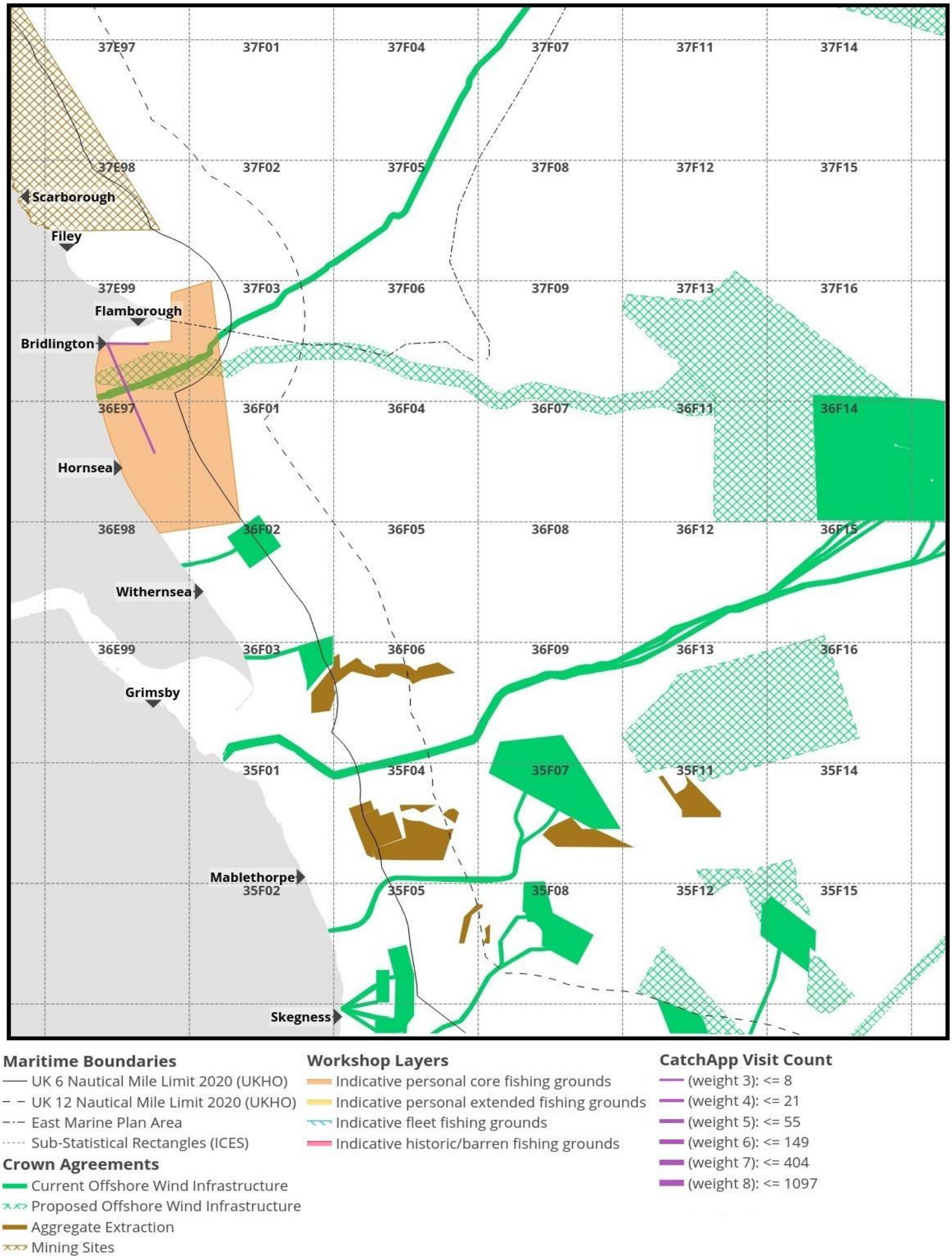
Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

4.1.2 Other passive gears

Participatory mapping of fishing activities

Static netting: One <10m fisher identified static netting as an alternative fishing method in the area between Flamborough Head and the Humber Estuary (Figure 8). The core grounds identified by the fisher are consistent with the catch recording data. The area overlaps with the export cable of Dogger Bank A and B offshore wind farms and no interaction or issues with OWF were reported. The fisher stated that their fishing is tide dependent and that they have two boats, one rigged for potting and one rigged for static netting. Netting was identified as a risk mitigation against crab and lobster coming under too much fishing pressure within the area.

Figure 8: Static netting (n=1) off East Yorkshire and north Lincolnshire



Sensitivity analysis

We did not carry out a sensitivity analysis for the category of ‘other passive gears’ as static netting was not a primary fishing method. As described at the beginning of this section, fishers participated in the sensitivity analysis on their primary fishing gear.

4.1.3 Active gears

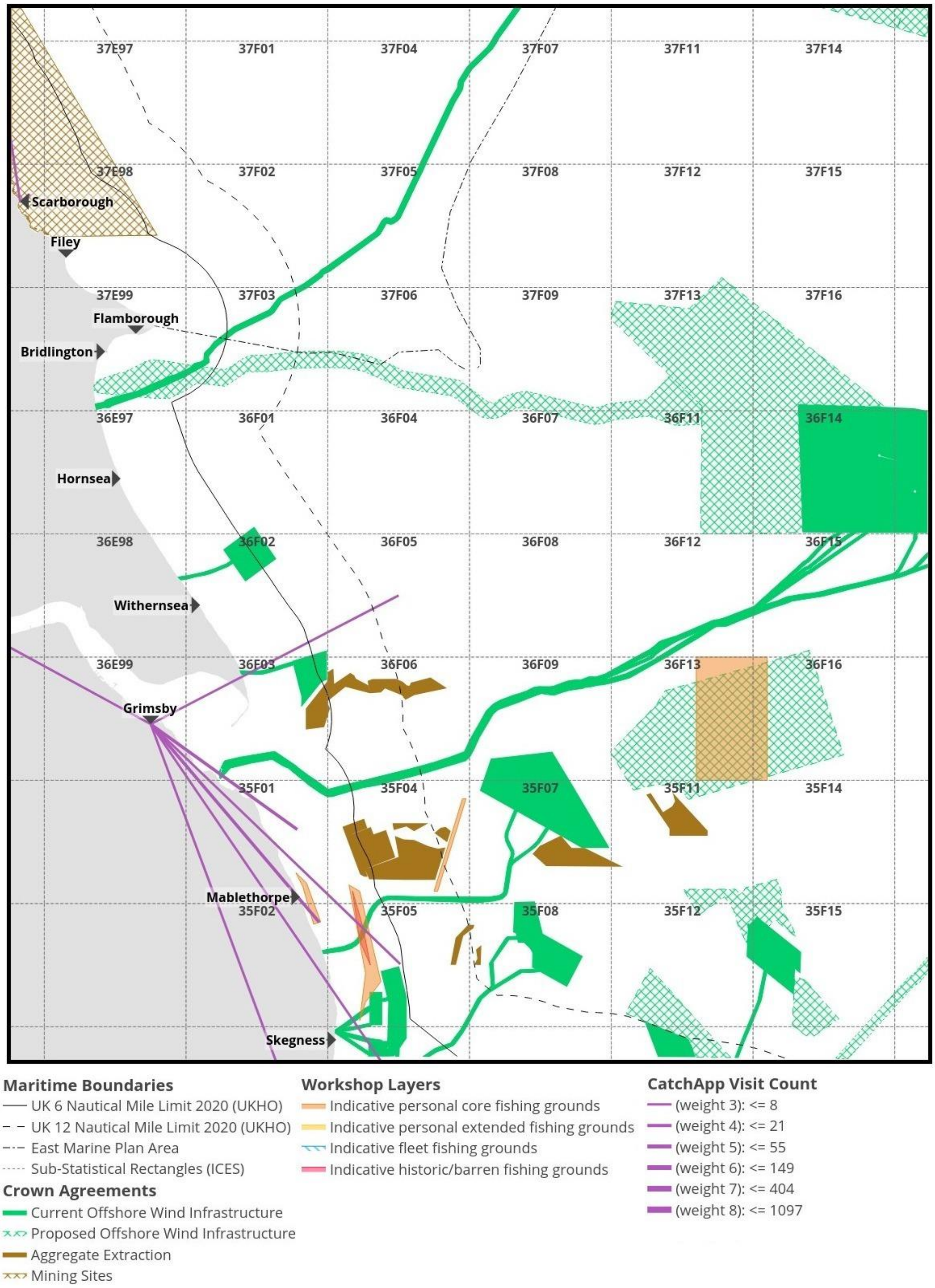
Participatory mapping of fishing activities

Demersal trawling: Only one fisher identified demersal trawling as their primary gear (<10m). Their core grounds are shown in Figure 9. The largest core ground is located offshore in the same area as the proposed Outer Dowsing offshore wind farm (36F13), this does not however correlate with any catch recording data. Three smaller grounds were identified inshore, within the largest of these there is an area considered barren by this fisher. Catch recording data correlates with smaller core grounds in 35F01, 35F02 and 35F05 but not the grounds in 35F04. Catch recording data also indicates fishing trips from Grimsby to 36F05 which participants did not identify.

Recently, trawl fishing has been limited by high fuel costs and low yields making current fishing areas significantly smaller than the historic grounds of 20 years ago. The fisher reported that continuing to trawl is economically unviable in the current economic climate. The catch recording data and narrative from the demersal trawl fisher corresponds.

It was also noted that demersal species, most notably ray species, were declining rapidly throughout the core grounds in the last two years for an unknown reason.

Figure 9: Demersal trawling (n=1) for skate, rays, sole, cod off East Yorkshire and north Lincolnshire



Sensitivity analysis

The sensitivity ranking for the one demersal trawler interviewed in the East Yorkshire and north Lincolnshire region to OWF is shown in Table 8. A high level of sensitivity to most aspects of OWF was described.

Table 9: Sensitivity analysis – active gears in E Yorkshire & N Lincolnshire

		PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
Vessel length	Home port	Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
8-9.99m	Grimsby	3	1	0	0	3	3	3	3	0	3	3	3	1	3	2

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

4.2 The Wash and north Norfolk coasts

The fishers from the Wash and north Norfolk coasts are primarily potters (n=13), with some vessels (primarily from Kings Lynn) also dredging for cockles and trawling for shrimp and prawns (see Table 10 below). Where numbers are identified in square brackets, [ ], this indicates that polyvalent fishers mapped areas for alternative gears to their predominant gear type.

Table 10: Number of vessels by primary gear type and vessel length class in the Wash and north Norfolk (numbers in square brackets include polyvalent fishers who identified spatial data for alternative gear types)

Gear type		Vessel length class			
		<8m	8-9.99m	10-11.99m	Total
Passive gears (potters)		6	6	1	**13**
Other passive gears	Static nets				
	Longlines				
	Drifting				
	Other				
Active	Demersal trawl		[3]	[1]	**[4]**
	Dredge		1		**1**
	Mid-water trawl				
Total		**6**	**7[3]**	**[1] 1**	**14 [4]**

4.2.1 Passive gears (potters)

Participatory mapping of fishing activities

Crab and lobsters: The activity map in Figure 10 shows the fishing grounds of crab and lobster potters in the Wash and north Norfolk, it was produced by compiling the inputs of 9 participants, of which all but 1 vessel was under 10m[7]. It shows that potting occurs widely throughout the region. The core grounds depicted are located primarily within 6nm of the coast with some offshore grounds in 35F12. This largely correlates with the activity data from catch recording. Catch recording data does however show fishing activity further north and east of the grounds identified, suggesting that the core grounds mapped are not exhaustive. Core grounds that have been identified overlap with the export cables of Race Bank, Lincs, Dudgeon and Sheringham Shoal OWFs. There is also some overlap with the southern region of Race Bank OWF. There are a number of grounds beyond the 6 and 12nm lines. This may be due to the presence of 'Super 10' vessels, which are vessels capable of operating further out to sea, targeting crab and lobster in deeper waters. There were no 'Super 10' vessel skippers in the interviews.

The mapped areas identified in the interview process was intersected with ICES rectangles and the corresponding records of logbook data. This is summarised in Table 11. Mapping is consistent with logbook records.

Table 11: Summary of recorded visits by 10 - 12m intersecting with grounds identified by potters in The Wash & North Norfolk

ICES rectangle	Visits made by 10 - 12m vessels (6 years)	Intersecting Area of Participating Mapping (km^2)
34F0	135	41
35F0	417	154
35F1	872	179

No specific concerns of operating over or near cables were mentioned in the interviews in this area and no barren grounds were identified.

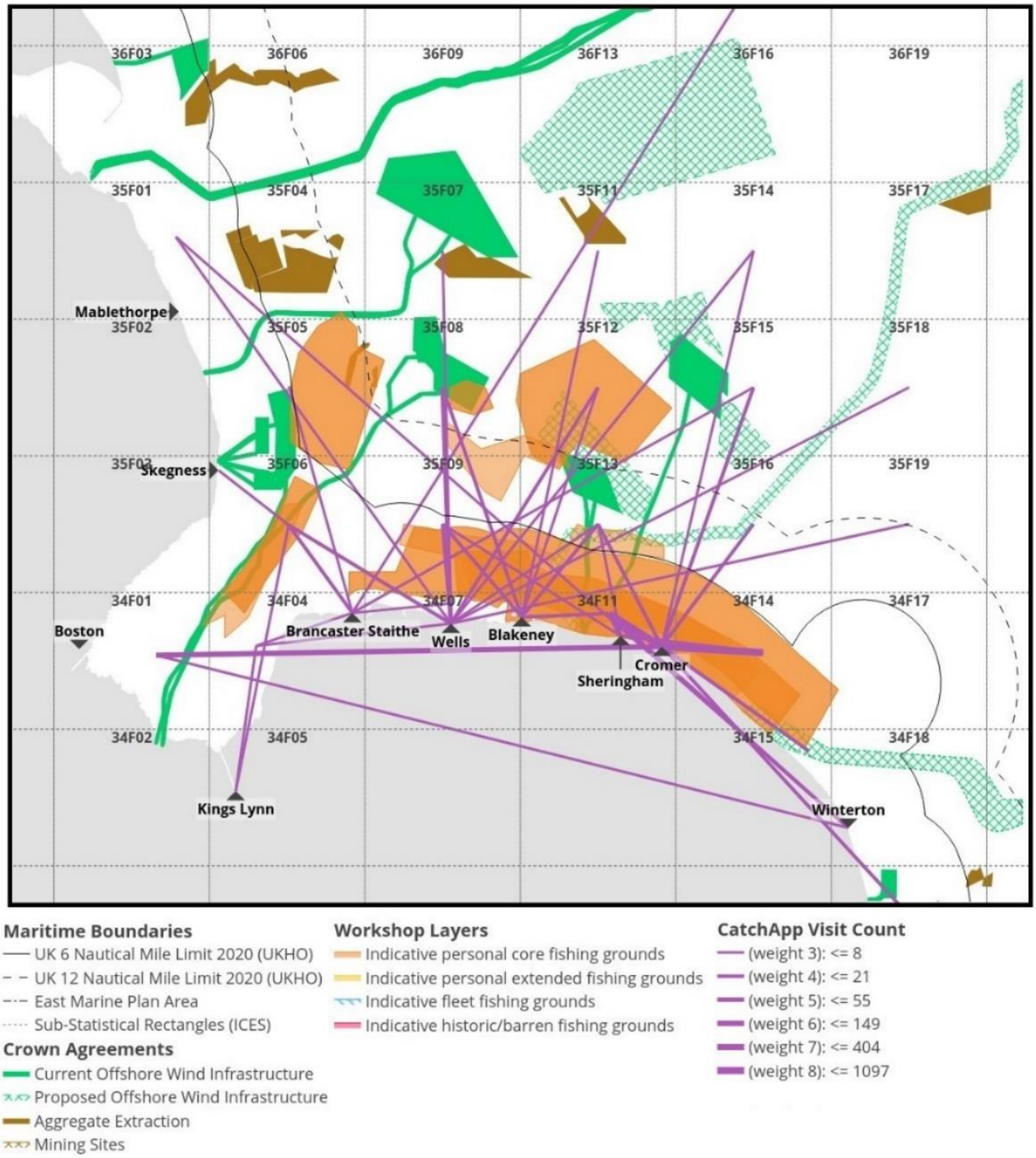
Fishers in this region consider that the area is under significant over-fishing pressure as a result of a "historic laxity" in issuing shellfish licences to fishers who wanted to convert their boats for potting. Now with the advent of powerful, wide beam catamarans, a single 'Super 10' fishing boat can operate with upwards of 3-5,000 pots in the water all year round, whilst the inshore fleet may operate on only 300 pots each.

While the presence of OWFs is not the primary concern of fishers interviewed, the impact of effort concentration, as described in the section on East Yorkshire and the north Lincolnshire coasts, impacts fishers in this region as well. The concern was very similar throughout the region but particularly at Wells-next-the-Sea and Cromer,

[7] Where differences in number of participants in sensitivity analysis and spatial mapping exists, this is due to sensitivity interviews being held over the telephone (no spatial data provided) and polyvalent fishers identifying additional areas fished with alternative gears shown in square brackets.

fishers were concerned that a ‘compensation culture’ may start to pervade if control of effort is not considered early.

Figure 10: Potting for crabs and lobster (n=9) in The Wash and north Norfolk coasts



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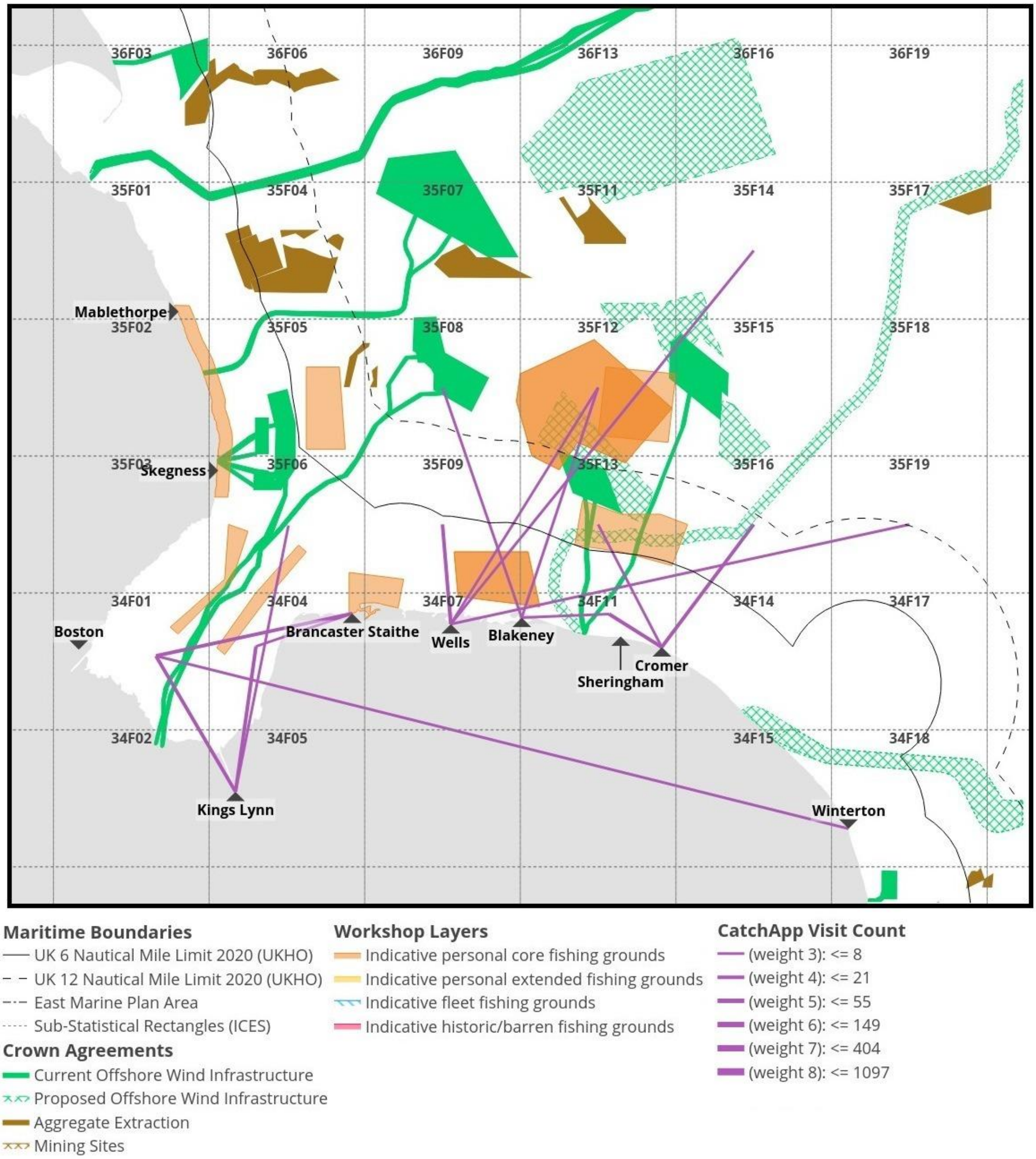
Whelks: Whelk fishing is predominantly a winter fishery. The chart for activity associated with whelk fishing in the Wash and north Norfolk Coast is shown in Figure 11. It represents seven participants' activity, all Under 10m vessels. The core grounds have very little interaction with OWF, only overlapping with the export cables in the far inshore region between Mablethorpe and Skegness. The core ground in 35F05 does not correlate with catch recording data, however this may be due to the removal of catch recording data for under three unique vessels (Section 3.2.4).

There are a number of regions where catch recording suggests fishing (35F08, 35F14, 35F16 and 35F19) which were not identified by participants as core grounds. The largest area identified by multiple participants (n=3) as core whelk fishing grounds is within 35F12 where the Sheringham Shoal Extension OWF will be developed.

Figure 11: Potting for whelk (n=7) in the Wash and north Norfolk Coast



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Sensitivity analysis

The sensitivity ranking of potting to OWF in the Wash and north Norfolk region is shown in Table 12. The table suggests that there is a higher sensitivity to OWF in this region than for the potters in the East Yorkshire / north Lincolnshire region, possibly due to the high level of OWF activity in this area and the high concentration of cable routes, especially in the Wash. There was no discernible difference between the three different vessel size classes in this analysis.

Table 12: Sensitivity analysis - pots in the Wash and the north Norfolk Coast

Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
		Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
<8m	Brancaster	2	1	2	2	3	3	3	3	2	3	2	2	2	2	2
	Cromer	3	1	1	1	2	2	1	3	1	3	1	1	1	Don't know	2
	Cromer	3	3	1	0	2	2	2	3	2	3	2	2	0	1	2
	East Runton	3	2	2	0	3	3	3	3	3	3	3	3	3	3	2
	East Runton	3	2	2	0	3	3	3	3	3	3	3	3	3	3	2
	Wells	2	1	0	0	1	1	1	1	1	1	1	1	1	0	1
8-9.99m	Brancaster	2	1	1	1	3	3	3	3	2	3	2	2	2	2	1
	Cromer	3	2	2	0	3	3	3	3	3	3	3	3	3	3	3
	East Runton	3	2	2	1	3	3	3	3	3	3	3	3	3	3	2
	King's Lynn	3	1	1	0	3	3	3	3	1	3	2	2	2	1	2
	King's Lynn	2	0	1	1	3	2	3	3	2	3	3	1	1	0	2
	Wells	2	1	2	3	3	2	3	3	2	3	3	3	3	1	0
10-11.99m	King's Lynn	3	1	1	1	3	3	3	3	0	3	3	2	3	3	2

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

4.2.2 Other passive gears

No users of other passive gears were interviewed as part of this study.

4.2.3 Active gears

Participatory mapping of fishing activities

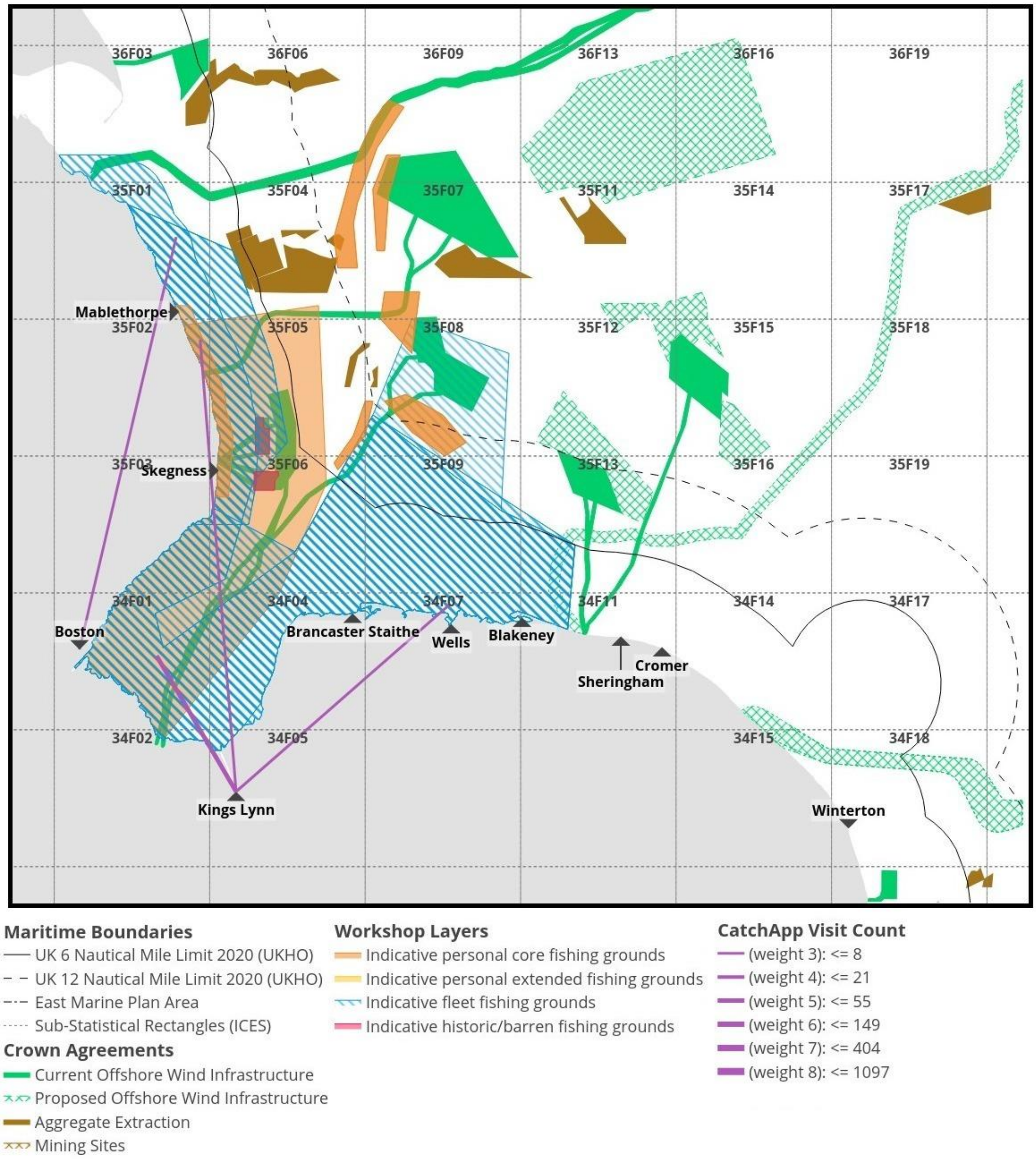
Demersal trawling (prawn and shrimp): Demersal trawling in the Wash targets brown and pink shrimp (*Crangon crangon* and *Pandalus montagui*). The core areas described by four fishers (three <10m and one 10 to <12m) are shown in Figure 12. Participants identified a large fleet fishing ground for this gear type. The smaller core grounds show activity largely occurring away from installed OWF but there is overlap with OWF export cables. The larger core and fleet areas show activity overlapping with Race Bank, Lincs and Inner Dowsing OWFs. Catch recording data corresponds well with inshore fishing grounds mapped by participants. Grounds identified beyond 6nm have no corresponding fishing trips recorded. There are two areas shown as “historic / barren” which correlate with Inner Dowsing OWF.

The mapped areas identified in the interview process were intersected with ICES rectangles and the corresponding records of logbook data. This is summarised in Table 13. Mapping is consistent with logbook records for the core areas of 34F0, 35F0. The further outreach of the mapped area (34F1, 35F1 and 36F0) is significantly lower. This could be for two reasons, either: rectangles need only to be identified for the predominant area fished in a visit or the outer extremes of the mapped area to the North and East are slightly overstated.

Table 13: Summary of recorded visits by 10 - 12m vessels intersecting with grounds identified by trawlers in The Wash & North Norfolk

ICES rectangle	Visits made by 10 - 12m vessels (6 years)	Intersecting Area of Participating Mapping (km^2)
34F0	642	545
34F1	91	28
35F0	302	1,255
35F1	7	67
36F0	0	74

Figure 12: Demersal Trawl (Brown shrimp and pink shrimp) in the Wash and North Norfolk Coast (n=4)



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Prior to the construction of the Inner Dowsing Wind Farm (shown in pink as historic / barren grounds) located to the north of the Wash (commissioning date 2009), the *Sabellaria* reef (also known as Ross Worm) was a habitat for seed mussels. Fishers harvested the seed mussel and relocated it to inter-tidal and sub-tidal habitats to grow. Seed mussel farming previously provided up to 25-30% of their revenue (n=3). Fishers reported that following the construction of the wind farm, the reef has been lost and is no longer a source of seed mussel for onward growing. This has virtually stopped the harvesting of mussels within the Wash, transferring effort to brown and pink shrimp for these participants.

Currently, contention between fishers and the OWFs are centred on the high voltage cables in the Wash which reach land near Wisbech Cut (34F02). Issues include:

- Cables have lifted during operation; use of matting or rock armour has impact on the habitat and on the ability for the fisher to fish safely;
- Communication and co-operation during the operation phase has diminished post-handover from the constructor to the offshore transmission owner.

Sensitivity analysis

We did not carry out a sensitivity analysis for demersal trawling as dredging was the primary fishing method. As described at the beginning of this section, fishers participated in the sensitivity analysis on their primary fishing gear.

Participatory mapping of fishing activities

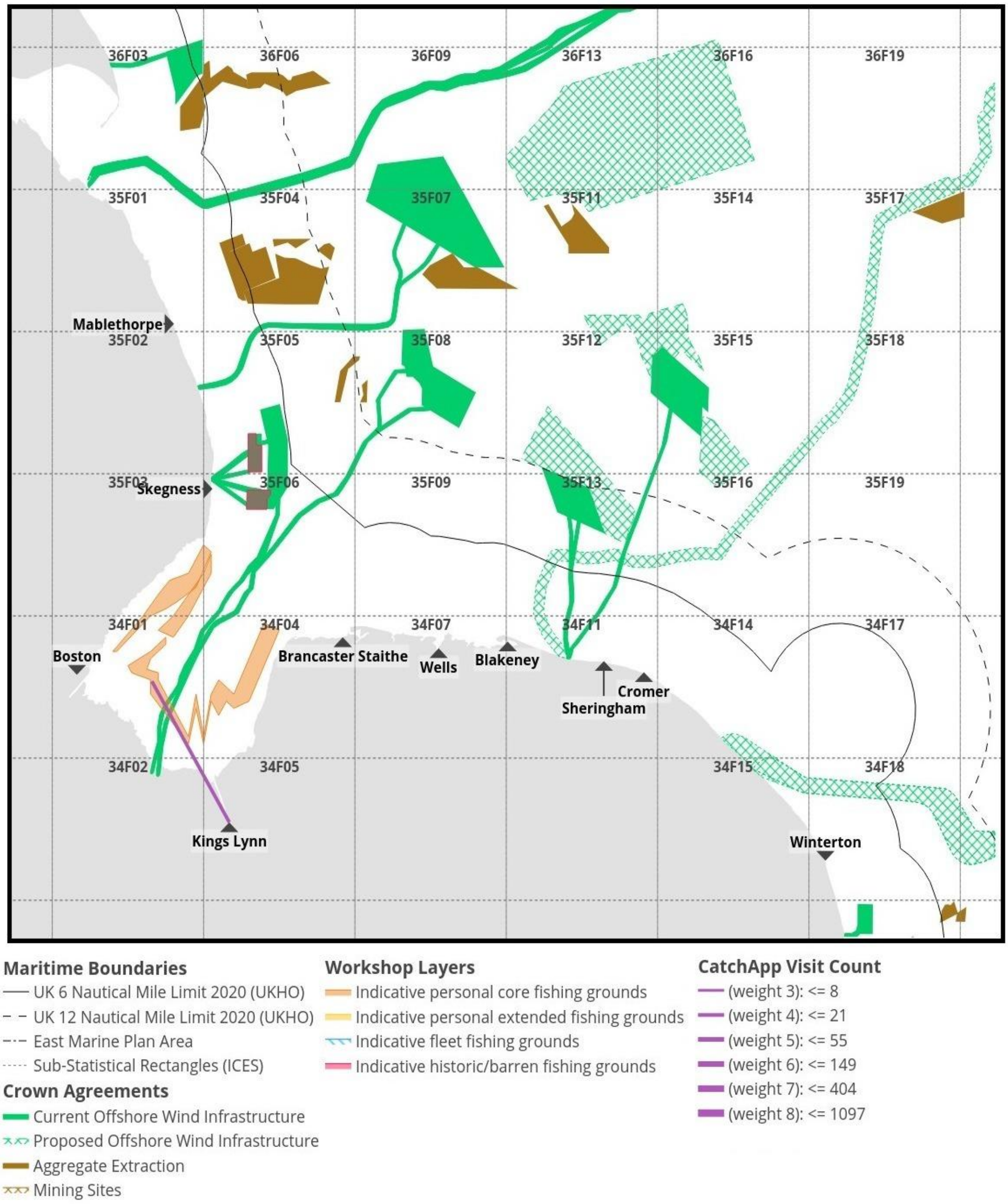
Dredges: Cockle fishing operates on the near low water line of the intertidal mud habitat within the Wash (Figure 13). Although designated as a dredge, the technique is not a conventional mechanical or a hydraulic dredge. The process generally involves stirring the mud with the boat's propeller as low water approaches and then once the boat has bottomed-out on the mud, the crew move onto the mudbank and hand rake the cockles from the surface. Figure 13 had input from one participant. It shows little overlap with OWF infrastructure. There is limited data reported through the catch recording application for this gear / fishery and as such it doesn't capture the activity mapped by participants in 34F04 or 35F02. It is expected that these areas are accessible by the <10m fleet and therefore will likely become included in catch recording data over time.

The spatial extent of cockle fishing is limited to the low water mark and operates within a set of IFCA byelaws governing annually set total allowable catch (TAC) limits and open and closed seasons.

It was noted that some of the workshop participants also dredge for seed mussels for relaying in more sheltered inshore areas under the Wash Fishery Order 1992 Regulations[8]. Many seed mussel beds were said to be located within wind farm arrays and it was suggested that their disappearance was a result of habitat change following OWF construction.

[8] https://www.legislation.gov.uk/uksi/1992/3038/contents/made

Figure 13: Dredging (Cockles) in the Wash (n=1)



Sensitivity analysis

The sensitivity ranking of dredging in the Wash and north Norfolk region to OWF is shown in Table 14. This one example suggests that OWF turbine tower construction and operation is a particular issue for this gear type, mainly due to the difficulties of operating within wind farm arrays. Most other aspects are of medium sensitivity, mainly due to the potential interaction between using dredge gear within inter-array cabling, scour protection and export cables.

Table 14: Sensitivity analysis – active gears (dredging) in the Wash and north Norfolk coasts

Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
		Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
8-9.99m	King's Lynn	3	1	2	0	3	2	2	3	0	3	3	1	2	2	2

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

4.3 The south Norfolk, Suffolk and Essex coasts

The third spatial area considered is the south Norfolk, Suffolk and Essex coasts. This spans Great Yarmouth down to West Mersea within the outer Thames Estuary. This region has a much more diverse set of fisheries than the regions further north, due to the variety of habitats along the eastern coast of East Anglia and the entrance to the Thames Estuary. Around half of all the 54 vessel representatives interviewed were from this region. There was more representation from vessels using active gear (mainly demersal trawl) here, and a diversity of passive gears including pots, static nets, longlines, drifting gear and others (see Table 15 below for the full sample set).

Table 15: Number of vessels by predominant gear type and vessel length class in south Norfolk, Suffolk & Essex (Numbers in square brackets include polyvalent fishers who identified spatial data for alternative gear types)

Gear type		Vessel length class			
		<8m	8-9.99m	10-11.99m	Total
Passive gears (potters)		2	2 [4]	[1]	**4 [5]**
Other passive gears	Static nets	[2]	4 [2]		**4 [4]**
	Longlines		3	1	**4**
	Drifting	[1]	1		**1 [1]**
	Other	[1]	1		**1 [1]**
Active	Demersal trawl		8	1	**9**
	Dredge	1 [1]	1 [1]		**2 [2]**
	Mid-water trawl		1		**1**
Total		**3 [5]**	**21 [7]**	**2 [1]**	**26 [11]**

4.3.1 Passive gears (potters)

Participatory mapping of fishing activities

Potters: Figure 14 shows the range of potting activity as identified by eight <10m fishers and one 10-12m vessel who potted as an alternative gear. Participants identified the area within 12nm of the shore from Great Yarmouth down to Walton-on-the-Naze as their core grounds. Some fleet grounds (primarily in 33F2) were identified beyond 12nm from shore by one 10-12m vessel potting as a secondary gear; the area does not correspond well with logbook visits to the area (33F2). The core ground between Great Yarmouth and Southwold is darker as multiple fishers identified this area as core personal grounds. Catch recording data however suggests this area is no more fished than the grounds identified to the south of the region. There was little reported contention with OWFs and the grounds identified. There is some overlap with export cables, and overarching fleet grounds overlap with the future East Anglia Two OWF. The information provided by participants was largely consistent with catch recording, although no fishers reported working on the north Norfolk coast which conflicts with the two catch recording lines heading north-west from Great Yarmouth and Winterton (Table 16).

Table 16: Summary of recorded visits by 10 - 12m boats intersecting with grounds identified by potters in South Norfolk, Suffolk and Essex

ICES rectangle	Visits made by 10 - 12m vessels (6 years)	Intersecting Area of Participating Mapping (km²)
32F1	377	19
32F2	0	11
33F1	216	838
33F2	9	1,003
34F1	10	195
34F2	67	200

Sensitivity analysis

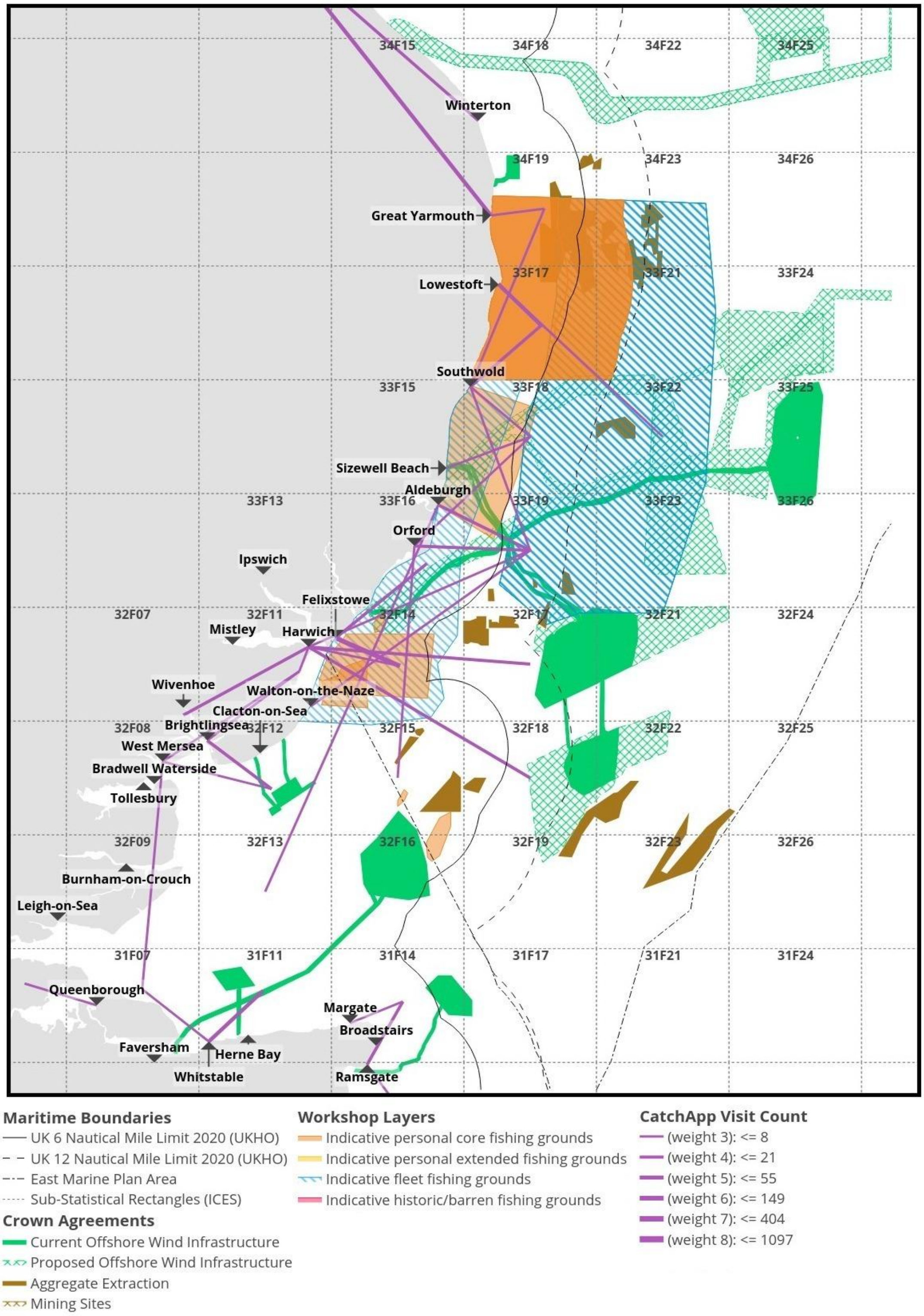
The sensitivity ranking of potting in the south Norfolk, Suffolk and Essex region to OWF is shown in Table 17. Potters in this area described a particular sensitivity to the existence of offshore export cables, as well as any associated cable protection or armouring. Larger vessels (e.g. 8 - 9.99 m) have a high sensitivity to the construction of wind farms, more so than smaller vessels, although smaller vessels did express high sensitivity to the laying of the export cables during the construction phase too.

Table 17: Sensitivity analysis – pots from south Norfolk, Suffolk and Essex

Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
		Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
<8m	Harwich	1	1	0	0	0	0	0	3	3	3	1	1	1	3	3
	Lowestoft	2	1	3	n/a	2	2	1	3	1	1	0	0	0	3	3
8-9.99m	Felixstowe F.	3	2	3	1	3	3	3	3	2	3	2	2	2	3	3
	Harwich	2	0	0	0	3	3	3	2	2	2	2	2	2	1	1

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

Figure 14: Potting (crab and lobster) (n=9) from south Norfolk, Suffolk and Essex



4.3.2 Other passive gears (excluding potting)

Participatory mapping of fishing activities

Longlining: The spatial extent of longlining activity is larger than most of the other gears mapped in this study (totalling nearly 4,000 sq.km). Four fishers (three <10m and one 10 - 12m) contributed to Figure 15. Fishers are generally laying up to 3nm of line with ~1,000 hooks on each line. The line is left three to four hours and then recovered. The majority of activity mapped by participants was off Lowestoft.

Two areas were identified as historic / barren grounds (32F17 and 32F18) and correspond to the footprint of the Greater Gabbard OWF. Galloper OWF (32F41) directly to the east of Greater Gabbard was not identified as historic / barren but does overlap with the core grounds identified. The core grounds also overlap with the export cables of East Anglia One, Greater Gabbard and Galloper and the future East Anglia Two OWF.

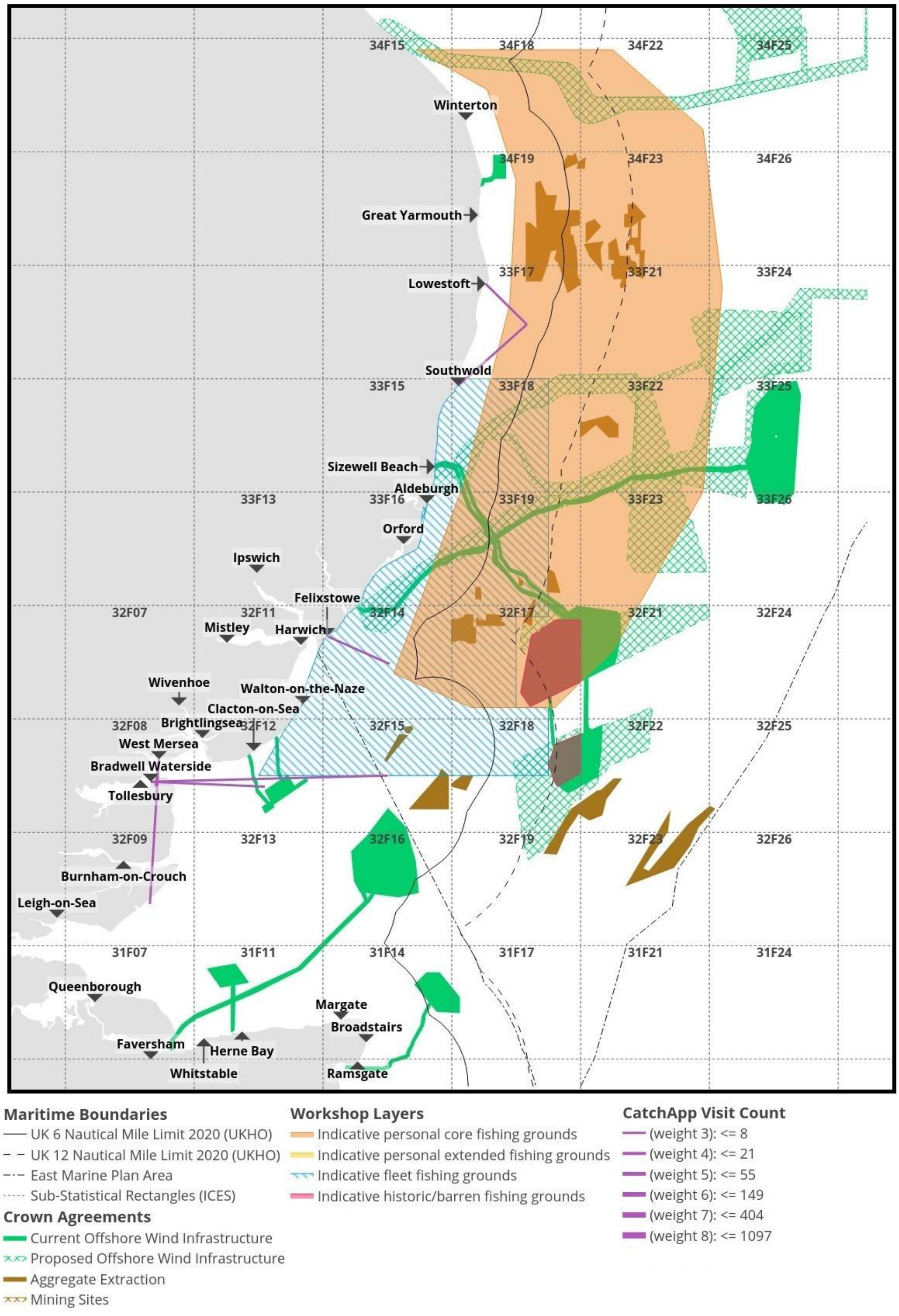
Overall, catch recording data doesn't correspond with the participatory mapping data. Catch recording data shows fishing activity taking place in 33F17, 32F14 and 32F15 (within the east marine plan areas). This is likely to be a result of the filtering of catch recording for privacy reasons described earlier (Section 3.2.4). Given the large spatial extent over a number of statistical rectangles and a small number of fishers, the number of reported visits to a sub-statistical rectangle may become quite small. It would be expected that this issue would be resolved as more records are gathered.

Analysis of the 10 - 12m logbook data (Table 18) identified a low level of similarity between recorded visits and spatial definition. The overall number of visits is low compared with potters and trawlers whilst the spatial extent is very large. The concentration of visits was recorded in ICES statistical rectangle 33F1 which covers inshore and offshore waters east of Lowestoft and Harwich.

Table 18: Summary of recorded visits by 10 - 12m boats intersecting with grounds identified by longliners in The Wash & North Norfolk

ICES rectangle	Visits made by 10 - 12m vessels (6 years)	Intersecting Area of Participating Mapping (km^2)
33F1	113	1,406
33F2	20	3,785
34F1	7	1,135
34F2	3	3,141
32F1	1	1,441
32F0	0	33
32F2	0	1,888

Figure 15: Longlining (n=4) off south Norfolk, Suffolk and Essex



Static netting: Core fishing grounds for static netting include the sandbanks in the outer part of the Thames Estuary, southern Essex coast and the Suffolk coast east of Aldeburgh, all within 6nm of the coast (Figure 16)**.** Eight fishers participated in the mapping exercise (all <10m vessel length) and their data corresponds with catch recording data. Participants missed some of the reported areas from catch recording closer to Great Yarmouth and Lowestoft (e.g. 34F17 and 34F19). This may be because the participants were mostly longliners, who switch to netting as a secondary technique i.e. there were no participants using static nets as their primary fishing method. No major issues with OWF infrastructure were reported despite the grounds overlapping with both East Anglia One and Greater Gabbard OWF export cables. Static netters from West Mersea reported barren grounds on the banks to the east of Burnham on Crouch (north-east corner of 32F13). This was believed to be due to dredging activity.

Drift netting: Participatory mapping data for drift netting is presented in Figure 17. Two fishers (all <10m vessels) identified drift netting as their secondary gear. The grounds identified by these fishers are all within 6nm of shore. They overlap with the export cables of East Anglia One and Greater Gabbard OWFs. Catch recording activity indicates that drift netting is quite sporadic activity. Participatory mapping data is not consistent with catch recording, the latter shows activity both north and east of Southwold. There may be multiple reasons for this including insufficient representation of this gear type in the workshops or inaccurate gear code identification in the catch recording data (there are at least six different gear codes for netting activity).

Handlining: Fishing for bass using lure, bait and trolling (running a lure behind a boat at low speed) within and around OWFs was identified as an emerging fishery. This could indicate that OWF may act as a shelter for the species. Figure 18 was produced with input from one <10m fisher. Core grounds overlap with Greater Gabbard and London Array OWFs. All core grounds identified correspond to catch recording fishing trips except the grounds within 32F16. Handlining activity, reported through catch recording, east of Southwold was not identified by the fishers that attended the workshops – there was no representation from fishers with Southwold or Great Yarmouth as their registered home port.

Figure 16: Static nets (n=8) off south Norfolk, Suffolk and Essex

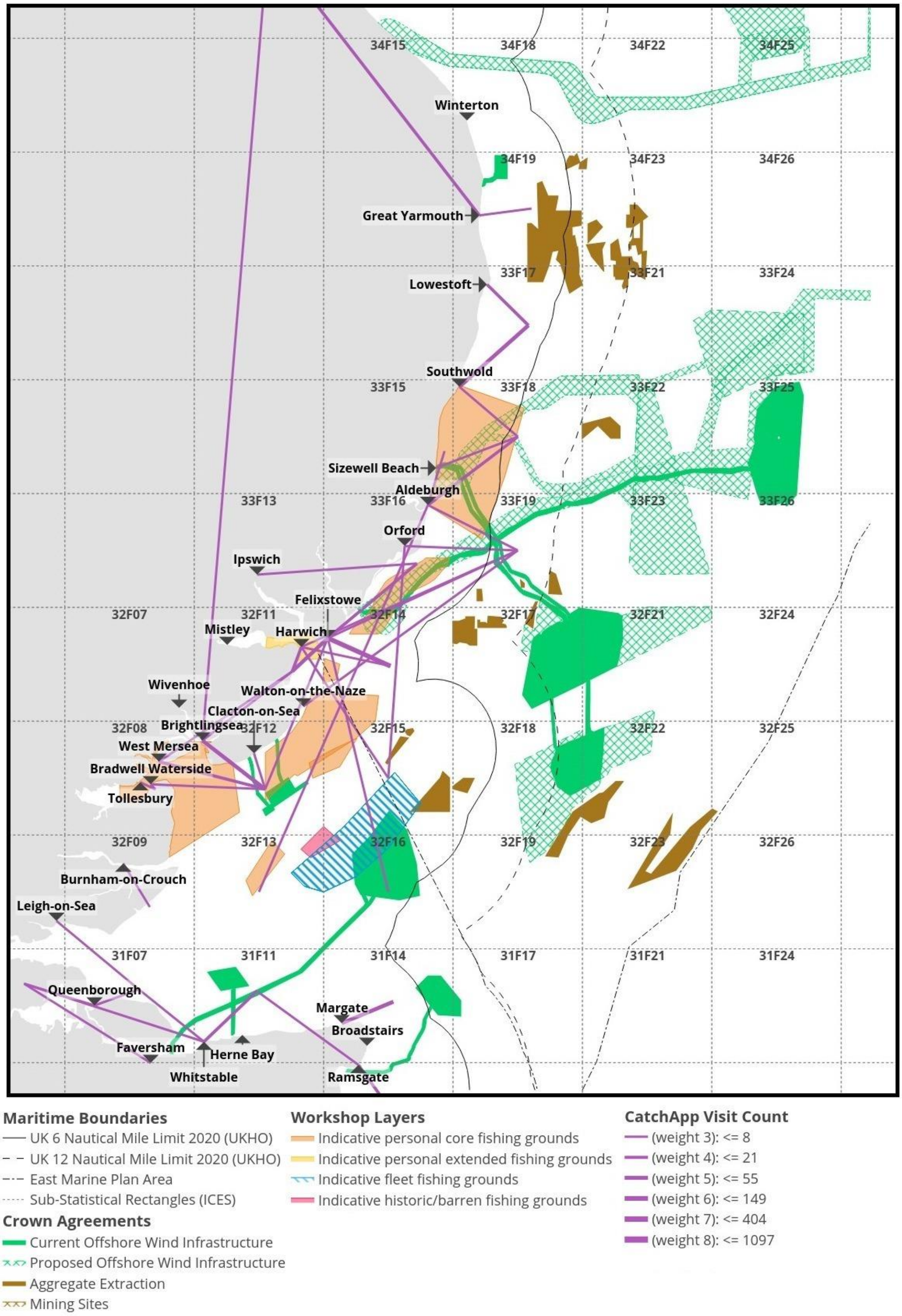


Figure 17: Drift nets (n=2) off south Norfolk, Suffolk and Essex

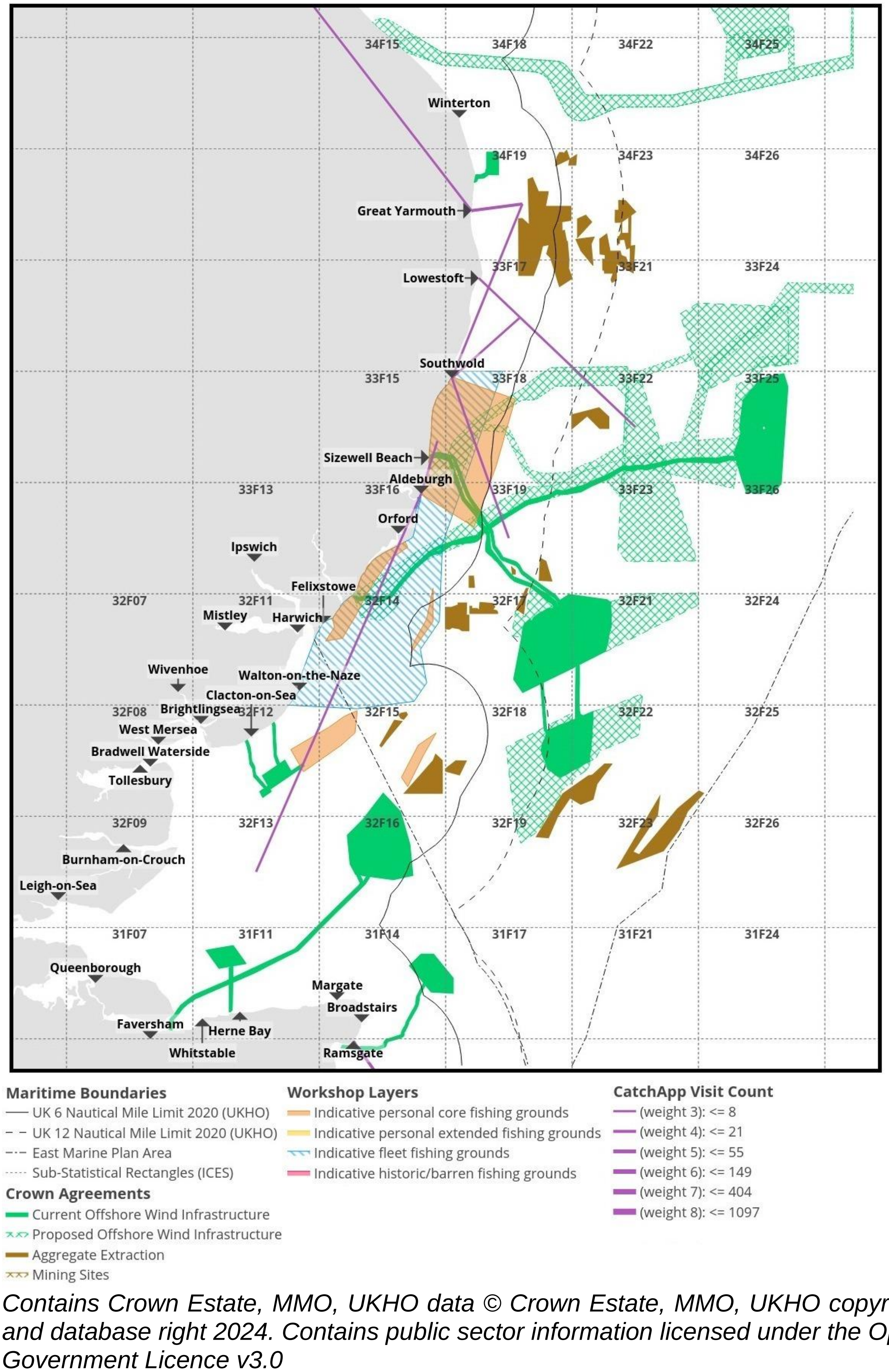
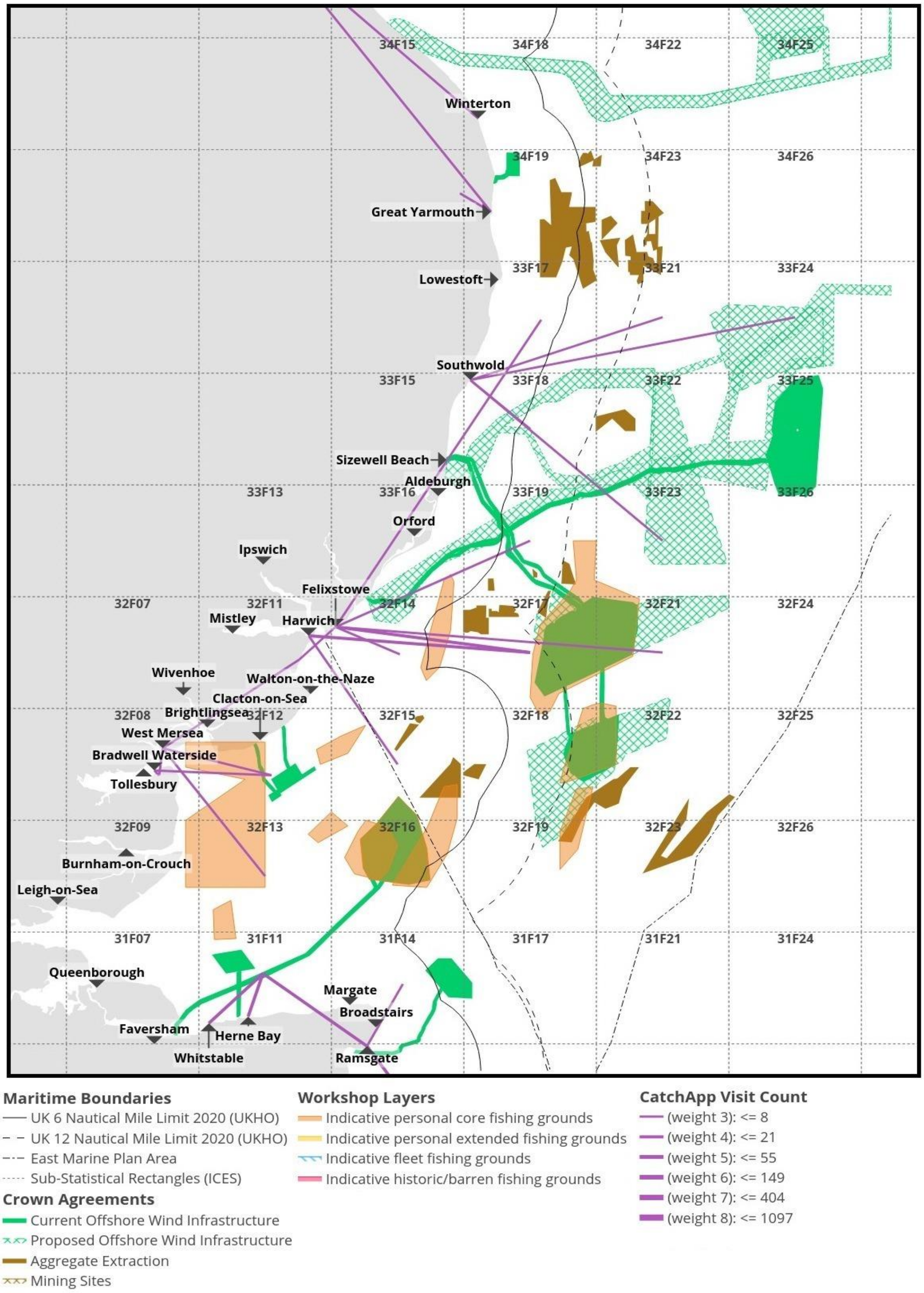


Figure 18: Handlining (n=1) from south Norfolk, Suffolk and Essex (predominantly targeting bass)



Sensitivity analysis

The sensitivity ranking of passive gears (excluding potting) in the south Norfolk, Suffolk and Essex region to OWF is shown in Table 19. There is a perceived high degree of sensitivity to all aspects of OWF activities and infrastructure. Participants in this region expressed concern that OWF development is yet another spatial pressure in an area already subject to considerable spatial squeeze from marine conservation zones, power and telecom cables and high levels of marine vessel traffic entering the Thames estuary.

Some of these gears are mobile in nature (drift with currents) whilst others occupy large areas (e.g. longlines), both features make these gears more sensitive to physical obstructions such as OWF infrastructure.

Table 19: Sensitivity analysis – passive gears in south Norfolk, Suffolk and Essex

			PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
Gear type	Vessel length	Home port	Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
6. Static nets - gillnets & trammels (passive)	8-9.99m	Bradwell	3	0	3	2	3	2	3	3	2	3	3	2	3	3	2
		Harwich	3	1	1	1	2	2	2	3	1	3	1	2	1	1	1
		Lowestoft	3	3	2	0	3	3	3	3	3	3	3	3	3	2	3
		West Mercia	2	2	2	1	3	3	3	3	1	3	3	3	3	3	3
7. Longlines (passive)	8-9.99m	Lowestoft	3	3	2	0	3	3	3	3	1	0	3	2	1	3	3
		Lowestoft	3	3	2	0	3	3	3	3	1	3	3	3	3	1	1
		Lowestoft	3	3	2	0	3	3	3	3	3	3	3	3	3	0	3
8. Drifting gear (passive)	8-9.99m	West Mercia	1	0	0	0	3	3	3	1	1	1	2	2	2	0	1
	10-11.99m	Lowestoft	3	3	2	1	3	3	3	3	1	3	3	3	3	3	3
9. Other passive gears	8-9.99m	West Mercia	3	3	1	0	3	3	3	1	3	3	1	0	0	0	0

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

4.3.3 Active gears

Participatory mapping of fishing activities

Demersal trawl activity: Figure 19 shows the demersal trawling grounds off the coast of south Norfolk, Suffolk and Essex as identified by nine fishers (8 <10m and 1 10 – 12m). Participants mapped the entire area from Lowestoft, out to the 12nm limit, and down to the Thames Estuary. Most participants agreed on the spatial extent of core grounds, as represented in dark amber. Fishers also identified a number of historic / barren fishing grounds, two correspond with the OWF Greater Gabbard (dark pink areas in the east – 32F17 and 32F21) and the large rectangular barren area (south of Harwich, mostly 32F12 and 32F15) overlaps with both the London Array OWF and Gunfleet Sands OWF. The fishing grounds drawn in the mapping process correspond well with the catch recording data. Although no future OWFs are planned for development within the core grounds identified, export cables from East Anglia One North and East Anglia Two are set to transect them.

Analysis of the 10 - 12m logbook data (Table 20) identified a reasonable level of similarity between recorded visits and spatial definition. The logbook data identified the area most visited was 32F1 which is the rectangle to the east of West Mersea. This corresponded well with the identified spatial data from the participating vessel.

Table 20: Summary of recorded visits by 10 - 12m boats intersecting with grounds identified by trawlers in The Wash & North Norfolk

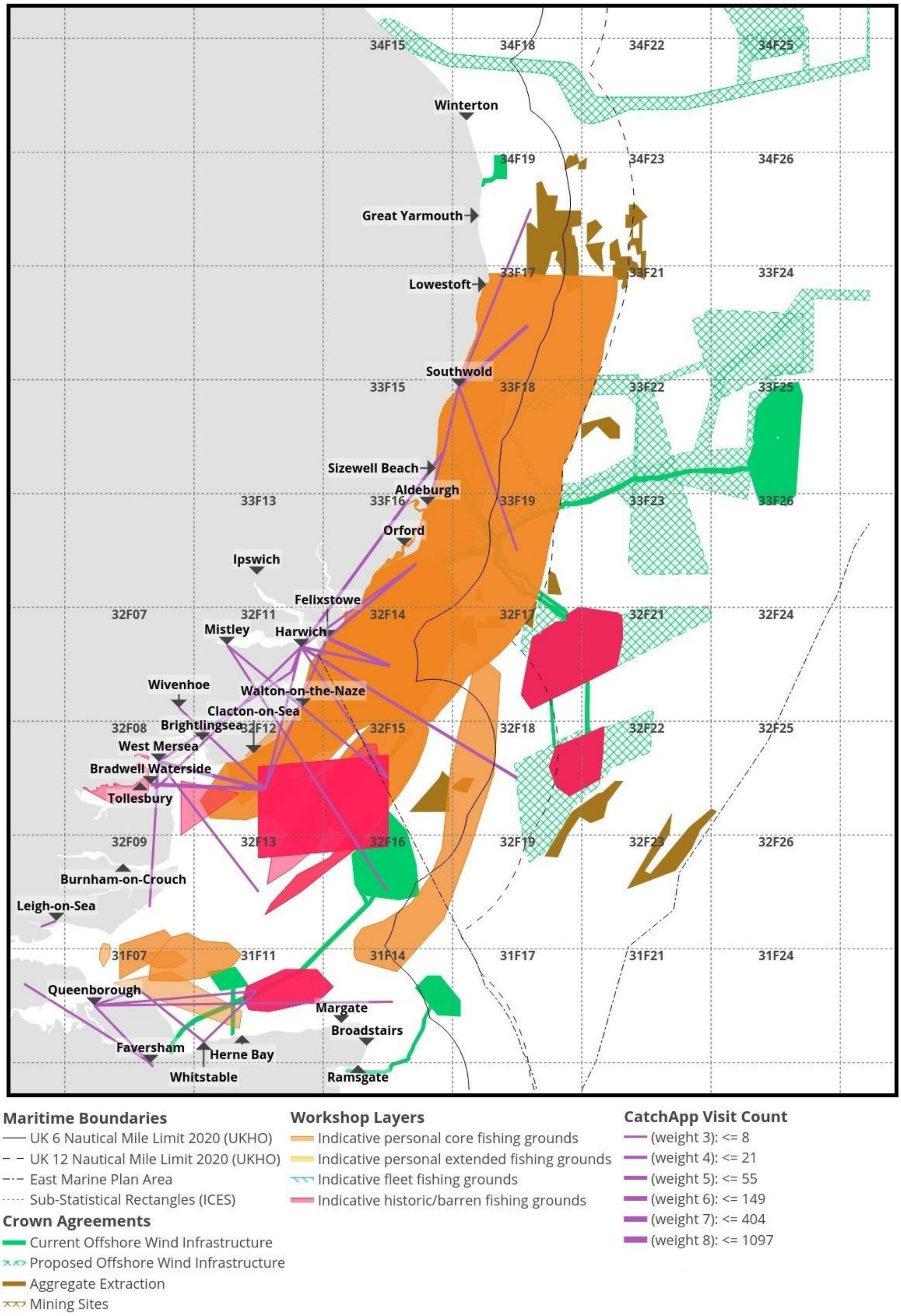
ICES rectangle	Visits made by 10 - 12m vessels (6 years)	Intersecting Area of Participating Mapping (km^2)
31F0	96	61
31F1	56	59
32F0	3	26
32F1	589	630

Participants described fishing for key benthic species such as rays (*Raja* spp.) and sole (*Solea solea*) as increasingly difficult in the southern North Sea. This is particularly the case in the channels in the outer Thames Estuary such as the Wallet, Kings Channel and Black Deep (within rectangles 32F12 and 32F15). This is despite fishers recording that the size of the local trawling fleet has halved in terms of the number of vessels in the last 20 years.

A number of fishers raised concern about the recent and sudden change in behaviour of ray species including the thornback ray (*Raja clavata*). Catch has declined “alarmingly” in the last two years throughout the area. There is increased incidence of rays being found up stream in the rivers and tributaries such as the Black Water River and the River Crouch as well as being more common in the intertidal region.

The ability to catch sole has also dropped significantly throughout the region, observed by both longliners (n=3) and demersal trawlers (n=9).

Figure 19: Demersal trawling (n=9) from south Norfolk, Suffolk and Essex



Dredging: Dredging in the south Norfolk, Suffolk and Essex coast is limited to the dredging of oysters in the intertidal and subtidal area off the Essex coast, centred on West Mersea (Figure 20 overleaf). OWF activity has little or no impact on dredging, according to participants. No dredging has been shown to occur within the east marine plan areas and this corresponds with the lack of any catch recording data for this gear type.

Sensitivity analysis

The sensitivity ranking of (i) demersal trawling (n=8), (ii) dredging (n=2) and (iii) mid-water trawling (n=1) in the south Norfolk, Suffolk and Essex region to OWF is shown in Table 21 below.

Demersal trawling showed particular sensitivity through all three main phases (e.g. pre-construction, construction and operation), although there was some variability with the eight different respondents. On this, nearly half (3/8) considered the inter-array cabling to be of low or negligible sensitivity.

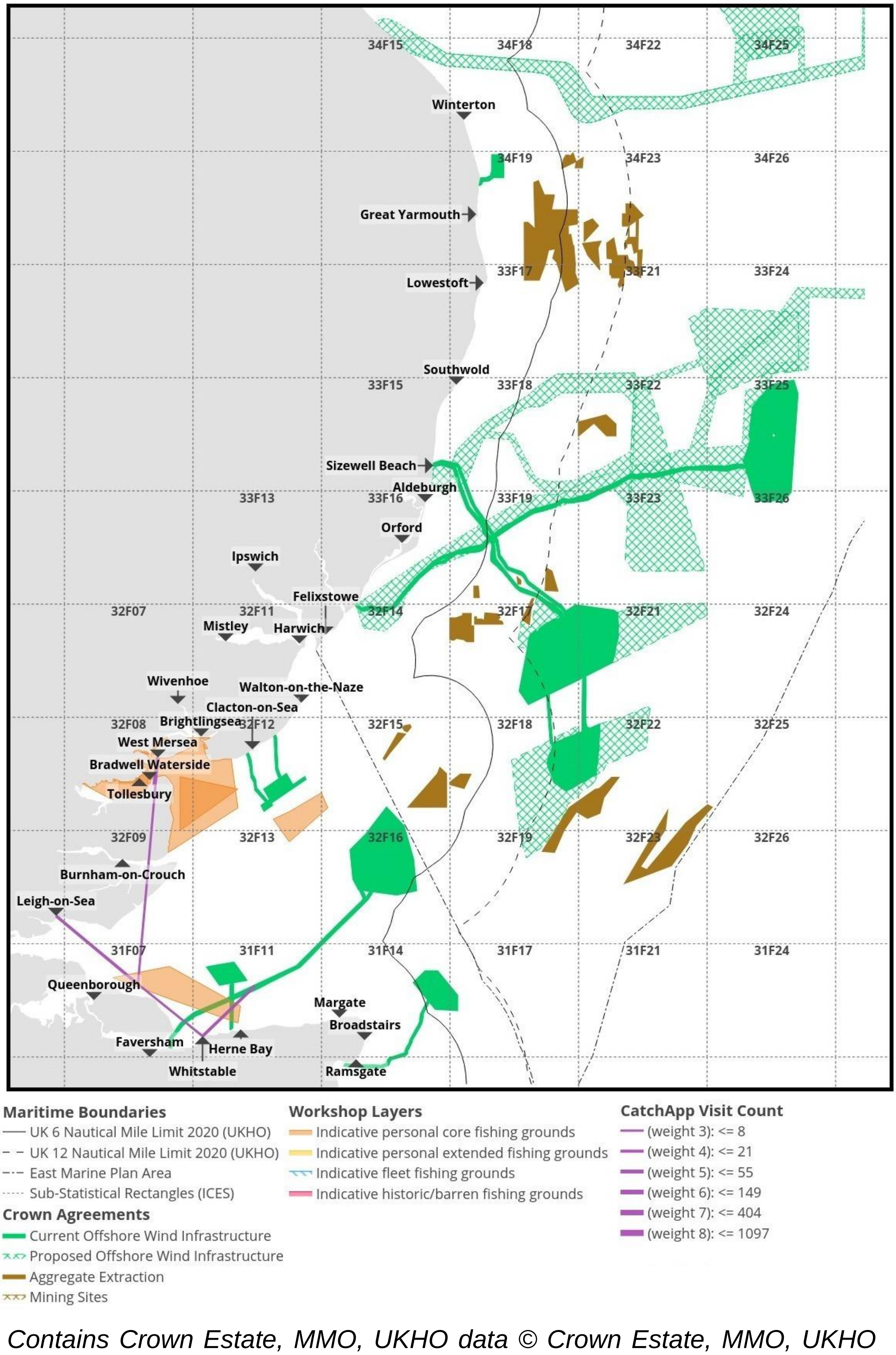
For the dredgers the impact was generally low, although the smaller vessel (<8 m) ranked sensitivity to OWF construction as high. The one mid-water trawler ranked most aspects of OWF construction and operation as high, mainly as this form of fishing is very difficult in OWF arrays.

Table 21: Sensitivity analysis – active gears in the south Norfolk, Suffolk and Essex coasts

			PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
Gear type	Vessel length	Home port	Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
1. Demersal trawl (active)	8-9.99m	Harwich	2	3	3	3	3	3	3	3	1	3	3	3	3	3	1
			3	1	1	0	2	2	2	3	0	3	2	2	0	3	3
		Ipswich	2	2	2	0	2	2	2	3	2	3	1	1	1	3	3
		Lowestoft	3	3	2	3	3	2	2	3	2	3	3	2	0	3	3
			3	3	2	0	3	3	3	3	3	3	3	3	3	3	3
		West Mercia	1	0	0	0	3	3	3	1	1	1	2	2	2	0	1
			2	2	1	1	2	1	2	3	2	3	2	1	2	3	2
			3	3	3	3	3	3	3	3	1	3	3	3	3	3	2
2. Dredge (active)	8-9.99m	King's Lynn	3	1	2	0	3	2	2	3	0	3	3	1	2	2	2
	<8 m	West Mercia	1	0	0	0	3	3	3	1	2	3	0	0	1	0	0
	8-9.99m		0	0	0	0	2	1	1	0	1	1	0	0	0	0	0
3. Mid-water trawl	2. 8-9.99m	Lowestoft	3	3	2	0	3	3	3	3	2	3	3	3	3	1	1

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

Figure 20: Dredging (n=4) on the mud-flats on south Norfolk, Suffolk and Essex



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5 Discussion and recommendations

5.1 Sensitivity of the <12m fishing fleet to OWF development in the east marine plan areas

The results focus on the mapping of important fishing areas and assessing their overall sensitivity to OWF development, recognising the importance of the different geographical locations and types of fishing as key variables. The implications for this in terms of the future development of OWF in the east and other marine plan areas is discussed below.

This discussion is framed around (i) active and (ii) passive gear types and is further disaggregated by the sensitivity to the different activities and infrastructure elements of OWF. The results of the participatory mapping and sensitivity analyses provide the views and perceptions of around 20% of the <12m vessels working in the east marine plan areas. Results were contrasted with the current understanding of OWF impacts on fishing, as summarised in Section 2.1.

5.1.1 Active gears

The analysis of active gears covers 13 <12m fishing vessels, consisting of demersal trawls (n=9), dredges (n=3) and a mid-water trawl (n=1). The results of the sensitivity ranking are shown in Table 22 and are discussed below.

Pre-construction

The pre-construction activities essentially consist of marine surveys. The key sensitivities are as follows:

<u>Geotechnical surveys</u> – which may involve towing instruments over a grid-pattern in potential OWF areas or over potential cable routes - present a risk of collision / gear conflict with active fishing gear. As such, the sensitivity of active fishing gear to geotechnical surveys is high to medium. The main points include:

- Areas being surveyed are often issued with a notice to mariners requesting the removal of fishing gear to enable surveys to take place without damaging the gear or survey equipment, this may last for a considerable length of time. This is considered very impactful and will temporarily remove traditional fishing grounds from an area subject to substantial spatial squeeze (see Section 5.1.4).
- Some respondents stated that they were not always made aware of surveys, so had to change fishing plans mid-trip.
- It may be possible to fish around moving survey vessels.

Table 22: Sensitivity ranking – all active gears

Gear type	Area	Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
				Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
1. Demersal trawl (active)	E Yorks/N Linc coast	8-9.99m	Grimsby	3	1	0	0	3	3	3	3	0	3	3	3	1	3	2
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	Harwich	2	3	3	3	3	3	3	3	1	3	3	3	3	3	1
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	Harwich	3	1	1	0	2	2	2	3	0	3	2	2	0	3	3
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	Ipswich	2	2	2	0	2	2	2	3	2	3	1	1	1	3	3
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	Lowestoft	3	3	2	3	3	2	2	3	2	3	3	2	0	3	3
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	Lowestoft	3	3	2	0	3	3	3	3	3	3	3	3	3	3	3
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	West Mersea	1	0	0	0	3	3	3	1	1	1	2	2	2	0	1
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	West Mersea	2	2	1	1	2	1	2	3	2	3	2	1	2	3	2
1. Demersal trawl (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	West Mersea	3	3	3	3	3	3	3	3	1	3	3	3	3	3	2
2. Dredge (active)	Wash & N. Norfolk	8-9.99m	King's Lynn	3	1	2	0	3	2	2	3	0	3	3	1	2	2	2
2. Dredge (active)	S. Norfolk, Sussex & Essex coasts	<8 m	West Mersea	1	0	0	0	3	3	3	1	2	3	0	0	1	0	0
2. Dredge (active)	S. Norfolk, Sussex & Essex coasts	8-9.99m	West Mersea	0	0	0	0	2	1	1	0	1	1	0	0	0	0	0
3. Mid-water trawl	S. Norfolk, Sussex & Essex coasts	2. 8-9.99m	Lowestoft	3	3	2	0	3	3	3	3	2	3	3	3	3	1	1

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

Acoustic surveys, e.g. those that produced loud, percussive sounds from airgun arrays and other devices, had a wider range of sensitivity ranking from negligible to high. Main points include:

- A slight majority of respondents (7/12) stated that acoustic surveys disturbed fish and lead to short-term lower catches, although catch losses were not quantified.
- Overall, there was an assumption that acoustic surveys were impactful, but this has not been evidenced by or verified in this project.

Other surveys (including benthic surveys) have lower impacts on active fishing gears and as such they have a negligible to low sensitivity classification. Main points include:

- It is usually possible to fish around benthic surveys, as the vessels are usually stationary e.g. using a grab or ROV.
- Some participants indicated that large grab sampling may change the seabed topography which will impact demersal gear use.

Construction

The construction activities are centred around the installation of the turbine foundations, towers and turbines, the sub and surface platforms, the inter-array cables (e.g. those within the wind farm from the turbines to the substation platform) and the offshore export cables back to shore.

The installation of turbines and inter-wind farm infrastructure excludes fishing activity from an area, and noise has an impact on finfish. As such, the sensitivity of active fishing gear to OWF construction is high – medium. Main points include:

- Displacement during OWF construction from traditional trawling grounds. Many of the OWF sites are on flat grounds which are often high value demersal trawling areas.
- Fishing activity is highly sensitive to underwater noise, especially from pile driving, as it is perceived to impact fish behaviour, even at a considerable distance from the site.
- Oyster dredge fishers have noted a particular impact of noise on oysters e.g. behaviour responses such as ‘spitting’.
- The one mid-water trawler interviewed also noted their fishing activity as highly sensitive to construction due to the loss of fishing area and the perceived impact of noise.

Fishing across all active gears is considered to be highly sensitive to the installation of the export cables exporting power from the OWF to the shore, which usually involves the digging of a trench and then laying the cable[9]. Main points raised by fishers include:

- Exclusion from cable areas that cross traditional trawling routes is a major issue.

[9] After laying the cable most trenches are left to backfill through natural processes.

- As cable trenches are often left to backfill naturally, there may be a considerable time before the area becomes workable again.
- There is often a lot of debris left around cable route areas e.g. boulders, lost equipment, etc, that can cause problems for demersal gears.

Post-construction

Post-construction includes three elements:

a) OWF related vessel activity both within the array area and to and from shore.

b) The impact of operational offshore wind farm infrastructure on fishing activities.

c) The impact of decommissioning of the wind farm once its life is deemed to be over.

OWF are mainly served by fast catamarans, know widely as ‘wind cats’. Moving at speeds of up to 25 knots, they operate both between and within the wind farms. Of the 12 participants interviewed using active gear, half considered the sensitivity of their fishing activity to post-construction activities to be negligible to low; the other half classified their sensitivity as medium - high. The main points include:

- Fishing vessels towing gear (both pelagic and on the demersal) need to maintain a steady speed and course. In general, ‘wind cats’ are respectful of this, but there are exceptions. Vessels passing at speed can result in partial or full gear loss from vessels towing gear, as well as heightened risk of collision.
- The noise and increased wake from fast moving ‘wind cats’ is also perceived to be an issue.

Active fishing gear has high – medium sensitivity to operational turbines and inter-wind farm infrastructure. Main points include:

- Active gear is rarely deployed within wind farms due to the high risk of gear entanglement or vessel collision with the turbines, especially during strong winds / currents.
- Some dredgers used to target seed mussels for relaying into inshore beds. Mussel beds seem to have been lost permanently e.g. don’t regrow in the altered hydrodynamic and substrate environment. The loss of mussel beds has had considerable repercussions for the industry as seed has to be brought in from elsewhere.

Sensitivity to completed cable routes back to shore is variable. Main points are:

- The demersal trawlers seem to be particularly sensitive compared to demersal dredges and mid-water trawlers.
- The completed cable routes are fishable once they have stabilised e.g. when they have been backfilled through natural processes, but they can cause

problems if the cable becomes exposed and potentially snag demersal gear e.g. trawl doors.

- If cables become exposed, then a common response from OWF companies is to either dump boulders on top or lay mats / mattresses over exposed cables. Both of these make ground difficult and dangerous to work with active demersal gears. Rock or mat armoured cable sections are often not mapped.
- Many fishers maintain that the ground within the cable routes never fully recovers and is permanently altered e.g. the sediment type changes as does the topography. For instance, exposed cables are often associated with deep scour holes in the seabed.
- There was a lot of concern over the impact of electromagnetic fields emanating from buried or exposed cables that affects the behaviour and migratory patterns of finfish such as rays, small sharks, and flatfish. EMF are often blamed for the drop in catch rates of rays in particular, especially in the south Norfolk, Suffolk and Essex region.

The sensitivity to decommissioning end-of-life OWFs was considered to be almost universally high. It should be noted that this was a perception, as no OWFs have been decommissioned in the east marine plan areas to date. Main points include:

- Removing the turbines and their foundations will result in a protracted exclusion period and considerable noise and sediment disturbance.
- There is a real fear that much of the sub-sea equipment will be left *in situ* and without maintenance, posing a real threat to demersal fishing gear, with the attendant gear loss and vessel safety issues.

Coexistence potential

The main coexistence issues between active fishing operations and wind farms raised in the workshops was that of fishing on the export cable routes. Demersal trawling tends to be conducted in well-established areas with repeated tows over the same routes and start / stop points. Discrete demersal trawling areas are evident in both East Yorkshire and north Lincolnshire and the Wash and north Norfolk (Figure 10 and Figure 13 respectively) but are less visible in the activity from participatory mapping in south Norfolk, Suffolk and Essex region (Figure 19). Given the number and pattern of inter-array cable routes, these often bisect demersal trawl tow areas. Whilst most cable routes do not cause an issue once the seabed has re-settled after the cable is buried, if the cable subsequently becomes free of the seabed, it can create a major snag hazard for demersal gear. The consequences are gear damage and vessel safety issues.

Fishing-cable interactions can be further complicated if the wind farm operators defend the emergent cable with concrete mattresses, rock armour, and rock bags, which represent obstacles and possible snag hazards for towed gear particularly.

Workshop participants mainly expressed the opinion that alternative solutions, such as re-burying the cable or implementing cable protection measures like bend restrictors, bend stiffeners, or protecting and ballasting shells, would be an improvement to existing practices. In any case, if cable protection or local conditions result in seabed protrusions then these must be promptly included in marine charts and well communicated to local fishing interests.

5.1.2 Passive gears (pots and traps)

Passive gear analysis covers 28 <12m fishing vessels using pots or traps gears, consisting of vessels under 8m (n=11), vessels 8 – 9.99m (n=14) and vessels 10 – 11.99m (n=3). The results of the sensitivity ranking are shown in Table 23 and are discussed below.

Pre-construction

The pre-construction activities essentially consist of marine surveys. The key sensitivities in relation to potting vessels are discussed below.

Geotechnical surveys – which may involve towing instruments over a grid-pattern in potential OWF areas or over potential cable routes - are high to low risk due to the risk of collision / gear conflict. The main points include:

- In general, areas being surveyed are issued a notice to mariners requesting the removal of fishing gear, acting effectively as a recommended exclusion zone that may last for a considerable length of time. This is considered very impactful and will temporarily remove traditional fishing grounds from areas already subject to considerable spatial squeeze (see Section 5.1.4).
- Some respondents stated that they were not always made aware of surveys, so had to change fishing plans mid-trip.
- Traps / pots may need to be moved to accommodate wind farm surveys. It should be noted that removal might include gear stored on the seabed but not fishing[10].
- A key indirect impact is that gear moved out of survey areas may be laid onto other ground that is used by different fishers. This displacement process is a major complaint from fishers using passive / static gear.
- The impact of displacement appears to be particularly consequential for smaller vessels that are both weather and power-limited to fishing in certain areas.
- It is also alleged by participants that as soon as surveys start, fishers working outside these areas will deliberately start fishing there to build track record in advance of any compensation payment scheme.
- There is the potential for equipment towed by survey vessels to tangle with demersal set gear, particularly the terminal buoys (often known as ‘ends’ or ‘dhans’).

[10] After laying the cable most trenches are left to backfill through natural processes.

Acoustic surveys had a wider range of sensitivity ranking from low - medium. Main points include:

- Most felt their fishing activity had low sensitivity to acoustic surveys, but some disagreed, including one who attributed a major whelk mortality incident to an acoustic survey. Others think that crabs / lobsters move out of areas during and after acoustic surveys.
- Overall there was an assumption that acoustic surveys were impactful, but this could not be proven, and participants would like more research on the subject.

Other surveys are lower impact e.g. fishing activity had negligible to low sensitivity, although acoustic surveys are perceived to scare fish and reduce catch rates. Main points include:

- Some indicated that large grab sampling may change the seabed topography which will impact potting gear.

Construction

The key sensitivities are as follows:

The installation of turbines and inter-wind farm infrastructure is high - medium risk, with higher sensitive found to the southern extent of the east marine plan areas e.g. the Wash and East Anglia. Main points include:

- The underwater noise, especially from pile driving, is perceived to have a high impact on shellfish behaviour, even at a considerable distance from the site.
- The displacement during farm construction from traditional potting grounds is the key issue, voiced by many participants (16 of 28 potters). This results in potting effort being concentrated on inshore grounds in areas between cable routes. This is exacerbated by those larger potters who have received compensation and have been permanently displaced from offshore grounds, resulting in higher incidents of gear conflict and increased fishing pressure on the lucrative but finite inshore grounds.

The installation of the transmission cables exporting power from the OWF array to the shore, which usually involves the digging of a trench and then laying the power cable, was generally considered to be high across all passive gears. Main points include:

- Exclusion from cable areas that transect traditional potting areas is a major issue.
- There is often a lot of debris left around cable route areas e.g. boulders, lost equipment, etc, that can snag with pots and anchors.
- Raised silt levels immediately after the cables are laid can cause an issue e.g. is perceived to stop crabs feeding.

Table 23: Sensitivity ranking – passive gears (pots and traps only)

Area	Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
			Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
01 E Yorks/N Linc coast	<8m	Bridlington	1	2	1	1	2	2	1	2	1	2	0	0	0	0	0
		Bridlington	1	1	0	0	2	2	2	3	0	3	1	1	0	0	0
		Flamborough	1	0	1	2	2	2	2	2	1	2	1	2	0	0	0
	8-9.99m	Bridlington	1	1	0	0	3	3	3	1	2	3	3	3	0	0	0
		Bridlington	3	1	1	1	3	2	2	3	2	2	1	1	1	0	0
		Flamborough	1	2	1	1	2	2	1	2	1	2	0	0	0	0	0
		Grimsby	3	3	0	0	3	3	3	3	1	2	1	1	3	0	2
		Grimsby	2	3	0	0	1	1	1	2	1	2	2	1	1	0	0
		Hornsea	0	1	0	0	3	1	2	2	1	2	1	1	0	0	0
	10-11.99m	Bridlington	3	1	1	1	3	2	2	3	2	2	1	1	1	0	0
		Grimsby	2	3	0	0	1	1	1	2	1	2	2	1	1	0	0
02 The Wash & N. Norfolk coasts	<8m	Brancaster	2	1	2	2	3	3	3	3	2	3	2	2	2	2	2
		Cromer	3	1	1	1	2	2	1	3	1	3	1	1	1	n/a	2
		Cromer	3	3	1	0	2	2	2	3	2	3	2	2	0	1	2
		East Runton	3	2	2	0	3	3	3	3	3	3	3	3	3	3	2
		East Runton	3	2	2	0	3	3	3	3	3	3	3	3	3	3	2
		Wells	2	1	0	0	1	1	1	1	1	1	1	1	1	0	1
	8-9.99m	Brancaster	2	1	1	1	3	3	3	3	2	3	2	2	2	2	1
		Cromer	3	2	2	0	3	3	3	3	3	3	3	3	3	3	3
		East Runton	3	2	2	1	3	3	3	3	3	3	3	3	3	3	2
		King's Lynn	3	1	1	0	3	3	3	3	1	3	2	2	2	1	2
		King's Lynn	2	0	1	1	3	2	3	3	2	3	3	1	1	0	2
		Wells	2	1	2	3	3	2	3	3	2	3	3	3	3	1	0
	10-11.99m	King's Lynn	3	1	1	1	3	3	3	3	0	3	3	2	3	3	2
03 S. Norfolk, Sussex & Essex	<8m	Harwich	1	1	0	0	0	0	0	3	3	3	1	1	1	3	3
		Lowestoft	2	1	3	n/a	2	2	1	3	1	1	0	0	0	3	3
	8-9.99m	Felixstowe F.	3	2	3	1	3	3	3	3	2	3	2	2	2	3	3
		Harwich	2	0	0	0	3	3	3	2	2	2	2	2	2	1	1

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

Post-construction

Post-construction includes three elements, (i) wind farm related vessel activity both within the farm and to and from shore, (ii) the impact of operational offshore wind farm infrastructure on fishing activities and (iii) the impact of decommissioning of the wind farm once its life is deemed to be over. The key sensitivities are as follows:

Wind farms are mainly served by fast catamarans. Over the 25 vessels using pots interviewed, 13 (46%) considered their sensitivity to 'wind cats' to be negligible to low and the rest (54%) medium - high. Main points include:

- Whilst the risk of complete gear loss is low, the partial loss of gear does occur e.g. the terminal surface component of buoys especially at nighttime.
- The noise and wake from fast moving 'wind cats' is also perceived to be an issue. Given their speed, there is concern that they might not see small, slow moving fishing vessels.
- Sometimes wind cats anchor at sea and there is a risk of fouling pot strings.

The impact of operational turbines and inter- wind farm infrastructure is low – medium, with some high risk. Main points include:

- It is possible to shoot potting gear within a wind farm, especially if the turbine array orientation is suitable for fishing given local currents and tidal movements. In general, turbines and inter-array OWF infrastructure are considered high risk and generally avoided.
- The reluctance to fish in OWF is compounded by the high level of maintenance vessel activity within the farm, that may give rise to gear conflict and additional navigation burdens. Issues are particularly problematic for smaller fishing boats that are usually single-handed.

The impact of the completed cable routes back to shore is variable. Main points include:

- There was a strong geographical divide in that almost all the vessels on the Yorkshire / Lincolnshire coasts considered the impacts of cable routes to be Negligible. Those in the Wash and the rest of East Anglia scored this mainly medium - high. The fleet from The Wash to the south is more polyvalent and includes more trawling activities, where gear can become snagged on unburied cables or rock armour.
- If cables become exposed, then a common repair activity from OWF companies is to either deposit boulders or lay mats / mattresses over the top of exposed cables. Both options can lead to pot strings being snagged. Rock or mat armoured cable sections are often not mapped.
- Many fishers maintain that the ground within the cable routes never fully recovers and is permanently altered e.g. the sediment type changes as does the topography.
- There was a lot of concern over the impact of EMF from buried or exposed cables, with some potters maintaining that cable routes are 'dead ground'. There was concern raised about the impact of OWF and related cable infrastructure on the migration pattern of crabs. The example cited by

participants was the spring migration of crab from offshore areas to the inshore. The migration is thought to have been restricted as crabs reached the high voltage cable infrastructure which comes ashore on the Lincolnshire Coast, this is not OW cabling but the recently commissioned high voltage Viking Link Interconnector between the UK and Denmark. Fishing was good for two weeks after commissioning of the interconnector, however, although the quantity of crab caught in this area was good, the quality of the crab (low meat weight) meant the area became unviable.

- Conversely, it is also recognised by some participants that boulder protection, whether it be around turbine bases or along cable routes, provides additional habitat which is good for shellfish.

The impact of decommissioning end-of-life wind farms was considered to be almost universally high. Removing the turbines and their foundations will result in a protracted exclusion period and will result in considerable noise and sediment disturbance.

- Fear was expressed that much of the subsea equipment will be left *in situ* and without maintenance, posing a real threat to demersal fishing gear including pots, with the attendant gear loss and vessel safety issues.

Coexistence potential

Most pot fishers accept the need for the temporary exclusion from certain sea areas during construction, so long as this is well advertised and communicated in advance, and that there is proportionate and targeted compensation for loss of earnings where no alternative opportunities are available. It was noted that these safety zones / periods could be made less damaging if OWF contractors and operators could proactively plan them to coincide with fishing interests. One example might be agreeing the timing of extensive surveys to avoid the peak crab / lobster fishing season over June to September.

Whilst most pot fishers will avoid fishing in operational OWF, the lower competition, and possible higher catches of crabs within OWF areas appeals to more experienced fishers. Fishing within OFWs could be actively encouraged or at least facilitated if OWF array spacing was orientated against local tidal currents, so that it improves catchability.

5.1.3 Passive gears (other)

Passive gear analysis covers 10 to <12m fishing vessels using passive gears other than pots/ traps, consisting of static nets (n=4), longlines (n=3), drifting gear (n=2) and other passive gear (n=1), such as handlines. The results of the sensitivity ranking are shown in Table 24 and are discussed below.

Pre-construction

The pre-construction activities essentially consist of marine surveys. The key sensitivities are as follows:

Geotechnical surveys – which may involve towing instruments over a grid-pattern in potential OWF areas or over potential cable routes risk collision with fishing gear and the sensitivity was considered between mostly high by participants but some considered it to be low. The main points include:

- In general, developers request that areas being surveyed are closed to fishing, and closures may last for a considerable length of time. This is considered very impactful and will remove traditional fishing grounds from areas subject to considerable spatial squeeze (see Section 5.1.4).
- Some respondents stated that they were not always made aware of surveys, so had to change fishing plans mid-trip.
- Static gear e.g. fixed gillnets and longlines may need to be moved to accommodate OWF surveys.
- A key indirect impact is that gear moved out of survey areas may be laid onto other ground that is used by different fishers. This displacement process is a major complaint from fishers using passive / static gear.
- The impact of displacement appears to be particularly consequential for smaller vessels that are both weather and power-limited to fishing in certain areas.
- There is the potential for equipment towed by survey vessels to tangle with both demersal set gear such as static gillnets and the terminal buoys (often known as 'ends' or 'dhans').

Acoustic surveys had a wider range of sensitivity ranking from low - medium. Main points include:

- Compared to the shellfish targeted pots / traps, the finfish-targeted gillnets and longlines were considered to be highly sensitive to acoustic surveys. This was the same for demersal set gear such as static gillnets and longlines, as well as the pelagic drift nets and handlines.
- Overall, there was an assumption that acoustic surveys were impactful, but this could not be proven or verified, and participants would like more research on the subject.

Table 24: Sensitivity ranking – all other passive gears

Gear type	Area	Vessel length	Home port	PRE-CONSTRUCTION				CONSTRUCTION				POST-CONSTRUCTION						
				Geotechnical survey	Acoustic survey	Benthic habitat survey	Fisheries survey	Turbines construction	Sub station / platform construction	Inter-array cables construction	Export cables construction	On-going maintenance	De-commission-ing	Wind turbine towers	Sub station / platform	Inter-array cables	Scour and cable protection	Offshore export cables
6. Static nets - gillnets & trammels (passive)	03 S. Norfolk, Sussex & Essex coasts	8-9.99m	Bradwell	3	0	3	2	3	2	3	3	2	3	3	2	3	3	2
			Harwich	3	1	1	1	2	2	2	3	1	3	1	2	1	1	1
			Lowestoft	3	3	2	0	3	3	3	3	3	3	3	3	3	2	3
			West Mersea	2	2	2	1	3	3	3	3	1	3	3	3	3	3	3
7. Longlines (passive)	03 S. Norfolk, Sussex & Essex coasts	8-9.99m	Lowestoft	3	3	2	0	3	3	3	3	1	0	3	2	1	3	3
			Lowestoft	3	3	2	0	3	3	3	3	1	3	3	3	3	1	1
			Lowestoft	3	3	2	0	3	3	3	3	3	3	3	3	3	0	3
8. Drifting gear (passive)	03 S. Norfolk, Sussex & Essex coasts	8-9.99m	West Mersea	1	0	0	0	3	3	3	1	1	1	2	2	2	0	1
		10-11.99m	Lowestoft	3	3	2	1	3	3	3	3	1	3	3	3	3	3	3
9. Other passive gears	03 S. Norfolk, Sussex & Essex coasts	8-9.99m	West Mersea	3	3	1	0	3	3	3	1	3	3	1	0	0	0	0

Sensitivity key: 3. High | 2. Medium | 1. Low | 0. Negligible

Construction

The installation of turbines and inter-wind farm infrastructure is almost universally considered a high risk. Main points include:

- The underwater noise, especially from pile driving, is perceived to have a high impact on finfish behaviour, even if at a considerable distance from the site.
- The displacement during OWF construction from traditional fishing grounds is the key issue, voiced by many participants. Displacement results in fishing effort being concentrated in inshore grounds in areas between cable routes.

The installation of the export cables from the OWF array area to the shore, which usually involves the digging of a trench and then laying the power cable, was generally considered to be high across all active gears. Main points include:

- Exclusion from cable areas that transect traditional fishing areas is a major issue.
- There is often a lot of debris left around cable route areas e.g. boulders, lost equipment, etc, that can snag lines and anchors.

Post-construction

Post-construction includes three elements, (i) wind farm related vessel activity both within the farm and to and from shore, (ii) the impact of operational offshore wind farm infrastructure on fishing activities and (iii) the impact of decommissioning of the wind farm once its life is deemed to be over. The key sensitivities are as follows:

Wind farms are mainly served by fast catamarans. Main points include:

- Whilst the risk of complete gear loss is low, the partial loss of gear does occur e.g. the terminal surface component of buoys, especially at nighttime.
- The noise and wake from fast moving wind cats is also perceived to be an issue. Given their speed, there is concern that they might not see small, slow moving fishing vessels.
- The other passive gears (e.g. handlines) had negligible to low sensitivity to wind farm operations.

The sensitivity to operational turbines and inter- wind farm infrastructure is low – high. Main points include:

- It is possible to shoot gear within a wind farm, especially if the turbine array orientation is suitable for fishing given local currents and tidal movements. In general however, it is considered high risk and generally avoided.
- The reluctance to fish in wind farms is compounded by the high level of maintenance vessel activity within the OWF array area, that may give rise to gear conflict and additional navigation burdens. Conflict is particularly an issue for smaller fishing boats that are usually single-handed.

The impact of the completed cable routes back to shore is variable. Main points include:

- If cables become exposed, then a repair activity from OWF companies is to either deposit boulders or lay mats / mattresses over the top of exposed cables.
- Many fishers maintain that the ground within the cable routes never fully recovers and is permanently altered e.g. the sediment type changes, as does the topography.
- Again, there was a lot of concern expressed over the impact of EMF emanating from buried or exposed cables (see Gill et al. 2023), with some fishers maintaining that cable routes are ‘dead ground’. The root cause of this reduction in activity is not known. Fishers are increasingly concerned that the network of high voltage cables is creating a fence which deters natural migration of benthic species. Fishers recognised that in this crowded area, there are other factors to consider, including the dredging of channels, to increase capacity in ports for example Felixstowe and further south in the Thames estuary. Other external factors reported included the increase in the local seal populations, climate change and offshore fishing pressure where beam trawlers continue to operate on the eastern side of the OWF network.

The impact of decommissioning end-of-life wind farms was considered to be almost universally high. Main points include:

- Removing the turbines and their foundations will result in a protracted exclusion period and will result in considerable noise and sediment disturbance.
- There was a lot of suspicion and uncertainty over what equipment might or might not be removed during decommissioning and the impact of passive fishing.

5.1.4 Other findings

The impact of fishers displaced by OWF activities to other areas was highlighted, specifically:

1. If fishing vessels are displaced from certain areas, either temporarily or permanently, more consideration is needed of where displaced fishing effort may move to and the impact on vessels already fishing in these areas. If necessary formal impact assessments need to be made and possibly conditions or even restrictions made on displaced vessels to make sure others are not unnecessarily disadvantaged.
2. Allied to temporary and permanent displacement is the unintended consequence of compensation in both displacing and increasing fishing effort. An increase in effort can be driven by the extra investment into new / upgraded boats and new fishing gear and was frequently mentioned during the workshops as contributing to the declining catch rates of crab and lobster in the southern North Sea. Evidence suggests that compensation, whilst welcome by many, needs to be more carefully considered, especially when it can result in negative consequences for fishers and fishing communities outside of the compensation schemes. Indeed, the receipt and issue of

compensation can be very polarising and was stated to have further divided fishing communities already riven by economic and spatial pressures on their livelihoods.

3. The effort concentration issue is not confined to one particular area (e.g. <3nm or <6nm limit) and needs to be considered across the entire space as the larger fleet has much greater freedom to operate. Therefore, a pot limit within one area, e.g. 6nm, does not prevent significant additional catch capacity being laid beyond the 6nm limit, and depletes the entire stock. Cumulative impacts are especially important to consider with respect to the migration patterns of crab which migrate to deeper waters for winter and return inshore during spring. The issue was voiced many times and is worthy of further exploration with the appropriate stakeholders including the Department for Energy Security and Net Zero (DESNZ), MMO, IFCAs and OWF representatives.

It is also apparent that good communication via the fisheries liaison officers (FLOs) at all stages in the OWF life cycle (e.g. survey, construction, operation, decommissioning) is essential. FLOs are vital as OWF are operated by multiple different contractors and sub-contractors, as such a single, well-informed point of contact for the fishing industry is important. For instance, concerns were expressed over notice periods given to fishers to move gear. In some instances, fishers stated they were only given one day’s notice to move pots, risking gear damage from OWF vessel propellers. During the winter months when weather conditions are worse and with gear up to 20nm away from shore, these short notice periods can cause significant disruption to fishers and their livelihoods. This is particularly of note, since determining grounds for productive whelk fishing is considered more unpredictable and less easy to plan fishing operations.

Another view expressed by a number of workshop participants was the inadequate level of field trials assessing the operational impacts of OWF on fishing. In one trial, which was referenced by a number of different respondents, a demersal trawl was used to demonstrate the possibility of fishing within an OWF. It was conducted in good weather conditions, on neap tides, and in day light and as a result, was concluded that trawling activities within OWF arrays is possible without impact. It did not account for poor weather conditions, strong spring tides, or the frequent practice of fishing at night, all of which considerably increase the risk of snagging or colliding with OWF infrastructure. Participants argued such demonstrations need to be conducted in real world conditions.

Concern was also expressed by longline fishers about the method used to validate the safety of longline fishing in OWFs. On two occasions, in two separate OWFs, fishers were asked to go out during good weather with light winds and slight swell and lay lines. In both instances, the trials passed without incident, and this was used as evidence that longliners could operate in the wind farms. As a test this was not considered sufficient for single handed boats which would need to be able to access the wind farm in moderate swell, winds of moderate to fresh breeze and with poor or zero visibility, including in the darkness of the early morning during winter months. According to the longline fishers interviewed, a more realistic test would demonstrate that it is not safe to fish using longline gear in those conditions. The result of inappropriate safety tests has a consequential impact on access to compensation, according to participants. They suggested that compensation measures should be considered using location and frequency of past longline fishing activity on or near to sandbanks, which are the predominant location of the existing OWFs off the Essex and Suffolk Coast.

Whilst the ecological impact of OWF and the consequences for <12m fishers was out of scope, this should be considered as a future research direction. Ecological impacts need to be considered over a number of different axes, including (i) in relation to the impact of fishing itself on the environment, (ii) understanding the cumulative impact of other anthropogenic maritime activities such as marine aggregate dredging, vessel traffic and oil and gas exploration and (iii) the impact of climate change on these factors.

Lastly it was evident that, whilst OWF impact assessments are conducted on a case by case basis, impacts are cumulative and should be assessed in this light. Compared to 20 – 30 years ago, fishing is now competing with multiple activities including wind farm developments and their extensions, marine protected areas (MPAs), aggregate dredging, oil and gas extraction, increased marine vessel traffic and offshore aquaculture development e.g. seaweed and mussel farms. It is felt that spatial squeeze needs to be better understood and acknowledged by both spatial planners as well as individual developers and their impact assessments.

5.2 Adapting the methodology for use in other marine plan areas

5.2.1 Stakeholder engagement

The key feature of this exercise was the use of participatory methods to understand both the spatial distribution of fisheries activities and the sensitivity of these in relation to offshore wind farms.

We utilised a series of sub-regional workshops that were located according to the official distribution of <12m fishing vessels in their home ports based on the MMO vessel lists. The existence, timing, and location of these were communicated to fishers through a variety of means, including managing authorities and private sector association newsfeeds, publication of a web-based registration platform and the engagement of local facilitators for each of the eight workshops.

The key lessons learned included:

1. It is useful to have engagement with the statutory authorities early on in the process, including the IFCA(s) and local MMO marine officers. They will know the local fisher groups and provide introductions where appropriate. It is noted that GDPR rules made it difficult for contact details to be shared directly with the workshop organisers, so adequate time and effort needs to be made to map and communicate with potential stakeholders.
2. The timing of the workshops is important. Firstly, they should be convened during the fishing low season, e.g. the first two months of the year after the Christmas / New Year period. Secondly, the timing should reflect a period when fishers are most likely to be available and least inconvenienced, including considering weather and tidal conditions in advance.
3. The web-based registration system was hardly used, and we would not recommend its future use in similar surveys.
4. The development of a well-written information sheet demonstrating why the meetings are being held, the benefits to the fishing industry and their timing / location was considered useful.
5. The local facilitators were key. It is worth ensuring they are well-connected, bipartisan, and active communicators.
6. It transpired that a key communication tool used by facilitators was social media, especially Facebook. This should be encouraged where possible.
7. Some level of remuneration to the facilitators is highly recommended. Whilst some are motivated by the benefits of the consultations themselves, others need to be compensated for their time and effort.
8. Some participants argued that participants' costs, time, and knowledge should be remunerated as well - this would certainly increase participation. In any case it is important to ensure that participants feel that the workshop process and outputs are worth their attendance.

5.2.2 Participatory mapping of the spatial distribution of <12m fishing activity

The workshop methodology detailed in Section 3.2 worked well in all cases. Fishers were open and became fully engaged in the process. The use of an electronic tool also allowed for discussions around proposed sites for OWF development as well as showing recorded activity information, neither of which appear on nautical charts.

Given the numerous challenges face by fishers, it may be challenging to compartmentalise problems and their root causes. Discussion in the workshops covered the widest range of pressures on the marine environment. It is recommended that if the approach is used in other marine plan areas, the preparation phase should include other pressure sources such as shipping, military activity and nuclear energy facilities in order to understand their spatial extent compared with OWFs and fishing activity.

It is possible that fishers most impacted by OWF are more likely to attend a workshop than those unimpacted. As a result, there is possible participation bias in the mapping data produced. This is most visible in passive gears, where attendance levels were low and there was consistency between the mapping and catch recording.

Two fishers voluntarily brought their own mapping / plotter software with them, complete with tracks and marks for debris fields, key marks, etc. This served to validate that spatial information had been gathered correctly.

Finally, there are key findings from the use of the catch recording data. All data collected was mapped against the lowest spatial resolution of the catch recording data, which is the sub-statistical rectangle level, see Figure 2. Overall, there was reasonable correspondence between the participatory mapping data and fishing trips data from the catch recording application. When using catch recording data some data cleaning is required to remove incorrect data. Suggestions for data cleaning include:

- Validating time between leaving date and return date to be applicable to boat size.
- Validating distance covered from leaving port to arrival port over the trip duration.
- Validating the extent of sea area within the sub-statistical rectangle and the likelihood of fishing including tidal extent of major river estuaries such as the Humber or the Thames.
- There were many instances where it appeared that default or near distance sub-statistical rectangles had been selected by the fisher.

5.2.3 Stakeholder-based sensitivity analysis of <12m fishing operations

The use of a dual sensitivity ranking (see Table 4) and its qualitative description via an Excel-based tool worked well in workshop conditions and allowed a nuanced analysis to be conducted. Beyond the basic methodology in Section 3, we note the following:

1. The Excel-based system works well and benefits from (i) being operated by two people so that more than one participant can be engaged at one time and (ii) being located on an internet-connected file share system so both interviewees can update the same file at the same time.
2. Many fishers operate more than one gear and it is often difficult to identify a primary gear type on which to base the sensitivity analysis. This can be overcome by either (i) repeating the sensitivity analysis for each gear type used or (ii) making it clear with the respondent that only one gear type will be assessed and that they should rank / describe the sensitivity accordingly.
3. We needed to systematically clarify the different survey types to ensure consistent responses as follows:
    a. Geotechnical: a moving vessel that may or may not be towing an instrumentation package.
    b. Acoustic: a towed or static vessel deploying a loud, percussive device such as an airgun array.
    c. Benthic: a static or slow moving vessel that is deploying a benthic sampling grab or similar device, such as a remotely operated vehicle.
    d. Fisheries: usually a slow-moving[11] vessel replying sampling equipment or standardised fishing gear.
4. Future assessments should disaggregate decommissioning into two different elements:
    a. Decommissioning activities: the impact of decommissioning a wind farm e.g. removal of the turbines, foundations, substation platforms and cables.
    b. Post-decommissioning conditions: the condition of the seabed following completion of decommissioning e.g. any remaining infrastructure or associated objects (e.g. rock armouring) that might have an impact on fishing activities.
5. The ‘coexistence’ part of the survey should be simplified and consist of a single question: How can the licensing authorities and wind farm operators reduce or mitigate the impact of wind farms (singularly or in combination) on your fishing activities?

[11] For instance, the usual speed of the ICES International Demersal Trawl Survey (IBTS) is around four knots.

6 Conclusions

6.1.1 Spatial distribution of <12m fishing areas sensitive to wind farming in the east marine plan areas

As discussed in Section 5, there are differences in the levels of sensitivity between fishers in the three regions analysed (i.e. East Yorkshire and north Lincolnshire, the Wash and north Norfolk, and the south Norfolk, Suffolk and Essex coasts).

In East Yorkshire and north Lincolnshire, the majority of participants are potting for crab, lobster and whelk. Their major area of sensitivity is from the displacement of offshore fleets from the wind farm areas into the inshore fishing area. Displacement has concentrated effort in an already heavily fished area. The problem is exacerbated by those being displaced claiming compensation whereas those indirectly impacted by concentration have no route to claim any loss of earnings.

In the Wash and North Norfolk, there are a wider range of fishing gears including shrimp trawling, and cockling. The potters reported similar sensitivity rankings as the potters further north. Trawlers particularly in the Wash reported problems with cable laying including spoil and cables lifting. Fishers raised the impact of destruction of *Sabellaria* habitats in the Inner Dowsing wind farm which had been a lucrative source of seed mussels for growing within the Wash. A number of fishers reported that mussel farming in the Wash was no longer viable after loss of the seed mussel beds.

The level of sensitivity to wind farms is particularly high in the south Norfolk, Essex and Suffolk area. Here demersal trawlers reported large areas of fishing grounds which are considered no longer productive or viable in recent years i.e. barren, despite a perceived long-term decline in fishing pressure. Participants in this region emphasised the significant recent decline of sole and rays.

Traditionally drift netters would have used the sandbanks in the outer Thames Estuary, including Gunfleet Sands, Long Sands and further east, the Gabbard and Galloper Sands. A significant proportion of these sands are now occupied by OWFs and therefore a sizeable element of their accessible grounds has been lost. Although, beyond the scope of the east marine plan area, fishers from within the east marine planning area fish these grounds and therefore it does have an impact on the local economy within the east marine planning areas.

6.1.2 Sensitivity of <12m fishing to offshore wind and coexistence potential

The sensitivity of <12m fishing operations to OWF activities and infrastructure is summarised in Table 25 overleaf.

Table 25: Modal average sensitivity of <12m fishing to OWFs in the east marine plan areas by gear type, area and vessel length

	Gear type	Area	Vessel length class	Sensitivity to OW activities	Sensitivity to OW infrastructure
Active	1. Demersal trawl (active)	01 Yorks/Lincs	8-9.99m	3. High	3. High
		03 East Anglia		3. High	3. High
	2. Dredge (active)	02 The Wash	8-9.99m	3. High	2. Medium
		03 East Anglia	8-9.99m	0. Negligible	0. Negligible
	3. Mid-water trawl	03 East Anglia	8-9.99m	3. High	3. High
Passive	5. Fixed gear - pots and traps (passive)	01 Yorks/Lincs	<8m	2. Medium	0. Negligible
			8-9.99m	1. Low	0. Negligible
			10-11.99m	1. Low	1. Low
		02 The Wash	8-9.99m	3. High	2. Medium
			10-11.99m	3. High	3. High
		03 East Anglia	<8m	3. High	3. High
			8-9.99m	3. High	3. High
	6. Static nets - gillnets and trammels (passive)	02 The Wash	8-9.99m	3. High	3. High
		03 East Anglia	8-9.99m	3. High	3. High
				3. High	1. Low
	7. Longlines (passive)	03 East Anglia	8-9.99m	3. High	3. High
	8. Drifting gear (passive)	03 East Anglia	8-9.99m	1. Low	2. Medium
			10-11.99m	3. High	3. High
	9. Other passive gears	03 East Anglia	<8m	3. High	0. Negligible
			8-9.99m	3. High	0. Negligible

Demersal trawls are particularly sensitive to all aspects of OWF construction and operation, irrespective of the location within the east marine plan areas. This is mainly because they tend to favour the same type of ground (relatively shallow with an even, non-rocky substrate). Demersal trawling is also conducted in reasonably straight lines and is therefore particularly sensitive to sub-sea or surface obstructions. Given the nature of the gear, there are also safety concerns over snagging trawl gear, which is exacerbated by the often single-handed nature of these smaller (8 - 9.99 m) vessels. Other active gears (dredge and mid-water trawls) are less sensitive, as they tend to be lighter gear, but are still impacted by offshore wind farm activities.

Pots and traps in the north of the area are largely outside of survey and construction activities and are therefore currently at low – medium sensitivity. Those further south, e.g. in the Wash and East Anglia seem to be much more sensitive, probably due to the higher density of both inshore and offshore wind farms, as well as the cumulative spatial squeeze from other marine activities. What was striking in all parts of the east marine plan areas was the impact of displaced fishing from wind farms on potting, either through increased gear conflict or additional pot fishing pressure as those displaced from wind farm areas move into areas traditionally fished by others. This latter aspect has been exacerbated through new vessels and equipment purchased by potters compensated by wind farm operators.

Those fishing with other passive gear, e.g. static gillnets, longlines and drifting gear are mainly found in the congested southern extent of the east marine plan areas.

Overall, these vessels are found to be highly sensitive to offshore wind development, both because of the level of exclusion during both survey and construction, as well as wind farm operation. There is also a view that the finfish targeted by these gears are particularly sensitive to the noise, increased sedimentation, changed benthic structure, hydrology and electro-magnetic forces. The only exception is bass handlining, which is seen as being benefitted by the aggregating effect of the turbine tower bases and associated armouring.

In conclusion spatial squeeze is a reality for many <12m fishers. Fishers who would traditionally fish in areas of offshore wind development are being displaced and move into already congested fishing grounds. OWF is perceived to have an overall negative impact on <12m fishing in the east marine plan areas. This is nuanced as follows:

- In the East Yorkshire / north Lincolnshire coasts this is mainly indirect, due to the increased level of potting effort from larger vessels displaced from east offshore.
- In the Wash, the presence of multiple cable routes, the loss of mussel seed and perceived changes in demersal substrate and topography contribute to a high sensitivity to OWF development, especially during the construction phase.
- Many of those targeting finfish with both active and passive fishing techniques consider that a combination of disturbance during OWF construction, changes to substrate topography in both the turbine fields and cable routes, as well as other factors such as the EMF effects of cabling, have had a profound effect on fishing yields, especially in the Suffolk / Essex portion of the marine plan areas.
- Although not formally excluded from wind farms, most fishers don't fish within the turbine fields due to the risk of gear engagement or vessel damage.

The findings in this report supports the current coexistence policies where fisheries and OWF occur alongside or in close proximity to each other in the same area or at the same time. It is clear though that their implementation in regard to the <12m fleet needs to be strengthened, especially with regard to:

- Whilst it was acknowledged that the design and scheduling of exclusion zones had improved over the last decade, they still needed more proactive consideration of the potential impacts on fishers and how these could be mitigated.
- More forward planning and better communication of anticipated OWF activities so that the <12m fleet can adapt as necessary. The form and nature of this communication needs to meet the cultural and logistical characteristics of the <12m fleet, which tends to be heterogeneous across different locations, target fisheries and vessel sizes. The choice, location and workload of FLOs is therefore key.
- Displacement of fishing effort due to temporary or permanent changes in fishing patterns due to OWFs was universally raised as a major issue. The potential for displacement and the impact on other fisheries needs further

attention during OWF licensing, including the effect of compensation and how it is used e.g. the potential for increasing fishing effort.

- According to many workshop participants, the impacts on some aspects of OWF development on commercial fisheries resources, such as the use of highly percussive surveys and construction techniques, and the EMF effects from undersea cables, are considered to be under-estimated by developers and have had insufficient attention from independent scientific research. Impacts of OWF development needs to be researched further and the results communicated objectively and effectively to all stakeholders.
- The majority (about 90%) of the <8 m vessels (n=12) and around half of both the 8-9.99 m (n=35) and 10-11.99 m (n=4) were polyvalent. This suggests some level of resilience in the <12m fleet, especially the smaller boats. It was suggested that a number of fishers face difficulties in diversifying away from potting to finfish-targeted fisheries, mainly due to licencing issues, lack of local markets and other logistical or financial reasons.

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ANNEX A: Information Sheet

Under 12m Fishing Sensitivity to Offshore Wind

Marine Management Organisation

POSEIDON AQUATIC RESOURCE MANAGEMENT

AVS DEV

What's happening and why?

Study investigating the sensitivity of the **<12m** fishing fleet to offshore wind development in the **east marine plan areas** (see map to the right).

This information will be analysed and the results published by the MMO to be used across marine planning and consenting processes.

Who? Poseidon and AVS on behalf of the MMO.

What? Drop-in workshops.

Where and when (for venues see link/QR code below)?

1. Bridlington | 16/01/2024 | 08:00-16:00
2. Grimsby | 17/01/2024 | 08:00-16:00
3. King's Lynn | 18/01/2024 | 08:00-16:00
4. Wells-next-the-Sea | 29/01/2024 | 09:30-12:00
5. Cromer | 29/01/2024 | 14:00-16:00
6. Lowestoft | 30/01/2024 | 09:00-16:00
7. West Mersea | 31/01/2024 | 12:00-16:00
8. Harwich | 01/02/2024 | 08:00-16:00

Why should you get involved?

- To enhance the evidence base for your fishing activity and your sensitivities to offshore wind.
- Although anonymised the overall outputs of this project will be made publicly available. It can therefore be used by you or your representatives when engaging with offshore wind consultations.
- We recognise that the offshore wind sector is already well established but as its development continues, it is important that the coastal fishing fleet's activities are accurately represented.

Please register your interest on Eventbrite here: https://www.eventbrite.com/cc/under-12m-fishing-sensitivity-to-offshore-wind-2901399 or use the QR code.

Drop ins are also very welcome.

Any queries, please contact [redacted]**@consult-poseidon.com** or [redacted]

ANNEX B: Number of interviews completed by vessel length class, home port and gear type

Table 26: Number of interviews completed by vessel length class, home port and gear type

Vessel length class / home port	Gear type								Grand Total
	Active gears			Passive gears					
	1. Bottom trawl (active)	2. Dredge (active)	3. Mid-water trawl (active)	5. Fixed gear - pots and traps (passive)	6. Static nets - gillnets and trammels (passive)	7. Longlines (passive)	8. Drifting gear (passive)	9. Other passive gears	
1. <8m				**11**				**1**	**12**
Brancaster-Staithe				1					1
Bridlington				2					2
Cromer				2					2
Harwich				1					1
Lowestoft				1					1
Wells				1					1
West Mercia								1	1
Flamborough				1					1
East Runton				2					2
2. 8-9.99m	**9**	**2**	**1**	**14**	**4**	**3**	**1**	**1**	**35**
Bradwell					1				1
Brancaster-Staithe				1					1
Bridlington				2					2
Cromer				1					1
Felixstowe Ferry				1					1
Grimsby	1			2					3
Harwich	2			1	1				4
Hornsea				1					1
Ipswich	1								1
King's Lynn		1		2					3
Lowestoft	2		1		1	3			7
Wells				1					1
West Mercia	3	1			1		1	1	7
Flamborough				1					1
East Runton				1					1
3. 10-11.99m				**3**			**1**		**4**
Bridlington				1					1
Grimsby				1					1
King's Lynn				1					1
Lowestoft							1		1
Grand Total	**9**	**2**	**1**	**28**	**4**	**3**	**2**	**2**	**51**