THE CROWN ESTATE

Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase 1 (Revised)

Mark Gray, Paige-Leanne Stromberg and Dale Rodmell

Marine Research Report

Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase I (Revised)

Mark Gray (Independent Consultant), Paige-Leanne Stromberg (NFFO) and Dale Rodmell (NFFO)

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The authors are particularly grateful to the fishermen from the North West coast of England (Cumbria down to the Wirral) and Northern Ireland (principally Kilkeel), the local MMO and NWIFCA fishery officers and the developers of the six wind farms in this study (DONG, Vattenfall and E-ON) for their participation in the questionnaire.

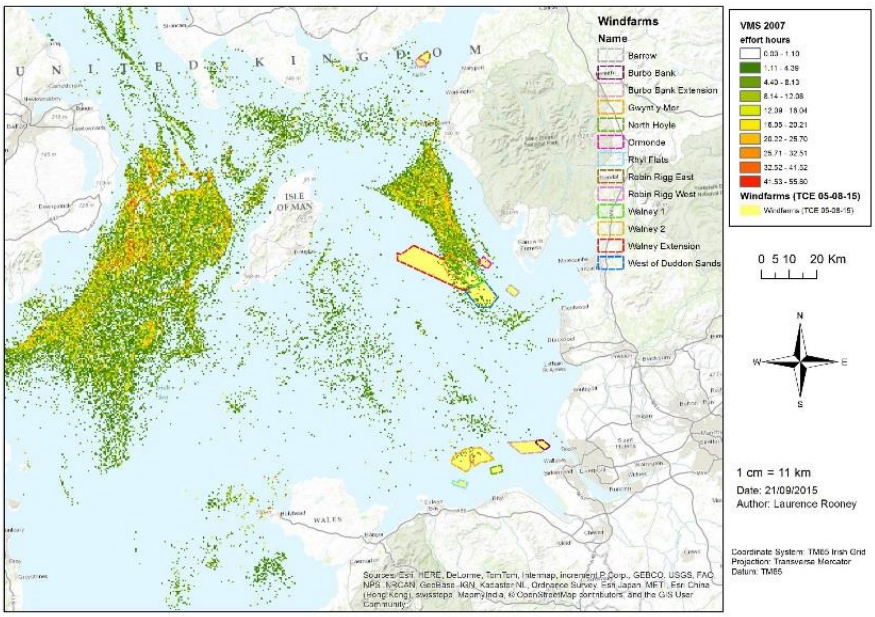
Finally, the authors would like to thank Cefas for their advice on the design and content of the questionnaire.

EXECUTIVE SUMMARY

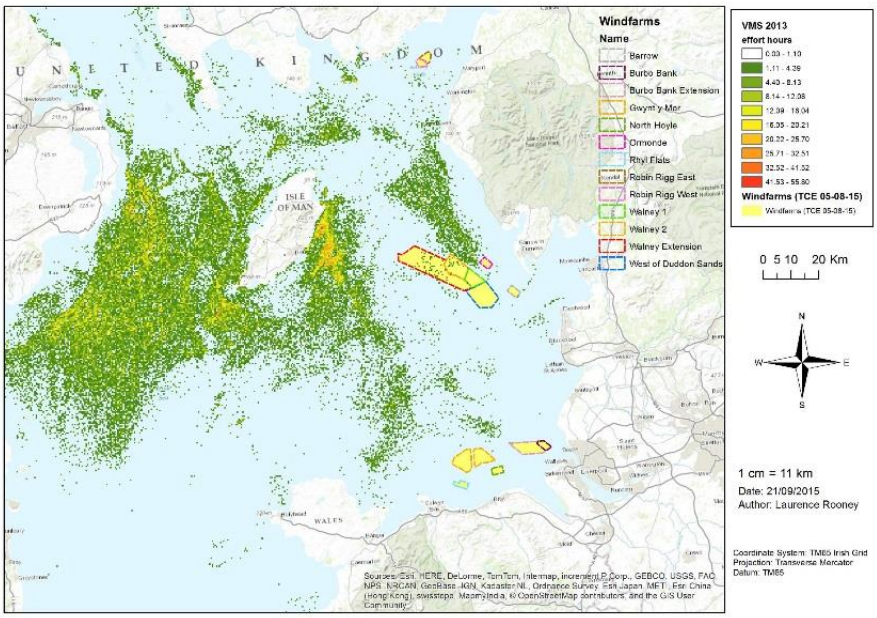
The aim of this project was to determine if, and if so, to what extent and why, fishing activity has changed within the six operating offshore wind farms (OWFs) and export cable routes in the Eastern Irish Sea

Since 2000, there has been a large reduction in fishing effort and landings of demersal finfish, which was attributed to a reduction of Total Allowable Catch (TAC) and not to the installation of OWFs. Although landings of *Nephrops* from the Eastern Irish Sea remained fairly stable during the period before and after OWF construction, VMS data showed a decline in *Nephrops* trawling following the construction of Walney 2. Confidence in the evidence that suggested a decline in all types of fishing activity in the other OWFs was low to medium.

VMS intensity for the UK fleet operating in the Irish Sea in 2007



VMS intensity for the UK fleet operating in the Irish Sea in 2013



Two main groups of fishermen operated in the area occupied by the OWF in this study; visiting Northern Ireland trawlermen who principally targeted *Nephrops* in Walney 1 & 2 wind farms using vessels over 15m and local fishermen along the North West coast of England who operated mostly under 15m inshore trawlers for *Nephrops* and whitefish, and a smaller number of under 10m vessels that deployed static gear closer to shore. Official fisheries statistics for the activity of vessels over 10m, particularly those over 15m with a long record of VMS data, provided a more accurate picture of fishing activity within and around OWF sites compared to vessels under 10m, although relatively few under 10m vessels were thought to operate in the offshore grounds. Fish plotter data could capture the activity of the under 10m fleet, although it is difficult to find data with an accurate time line. The fish plotter data offered by several fishermen who operated vessels over and under 10m was unsuitable for this reason.

Findings suggest that fishing activity within OWF boundaries has changed, primarily because fishermen are fearful of fishing gear becoming entrapped by seabed obstacles such as cables, cable crossing points and rock armouring, and wary of vessel breakdown with the consequent risk of turbine collision. Wind farm maintenance work was claimed to cause disruption to fishing (for example interrupting tows) and increasing steaming distances to fishing grounds, although fishing is not prevented within OWFs. The relationship between fishermen and wind farm developers and their service companies was often described as poor in terms of communication and information exchange.

However, fishing was found to co-exist with OWFs. A small number of fishermen claimed to operate demersal trawl gear in cable-free corridors between the turbines (for example where interarray cables ran parallel to the trawl tracks). Other fishermen thought confidence to operate inside OWFs would increase as experience and knowledge of those who do increased. Measures suggested by respondents that could help to increase the level of co-existence between the fishing and offshore wind farm industry included: better knowledge of seabed hazards and their location; fishing-friendly methods of cable protection; monitoring of risks and exposure; and regular communication and knowledge exchange between wind farm developers / maintenance companies and fishers.

The co-existence of two or more activities does not necessarily mean that they have to occupy the same space. Indirect measures of assistance could help safeguard fisheries in the locality of offshore wind farms by mitigating the loss of fishing opportunities which could be especially important for smaller vessels that are less able to fish alternative grounds. Indirect measures already in place included: financial compensation for loss of fishing; work opportunities arising from guard ship duty and survey work; and shore side improvements through the West of Morecambe Fisheries Fund (WofMFF) which financed the installation of ice plants at Maryport and Barrow and contributed to a reduction in the cost of fuel at the Whitehaven Fishermen's Cooperative-leased fuel facility.

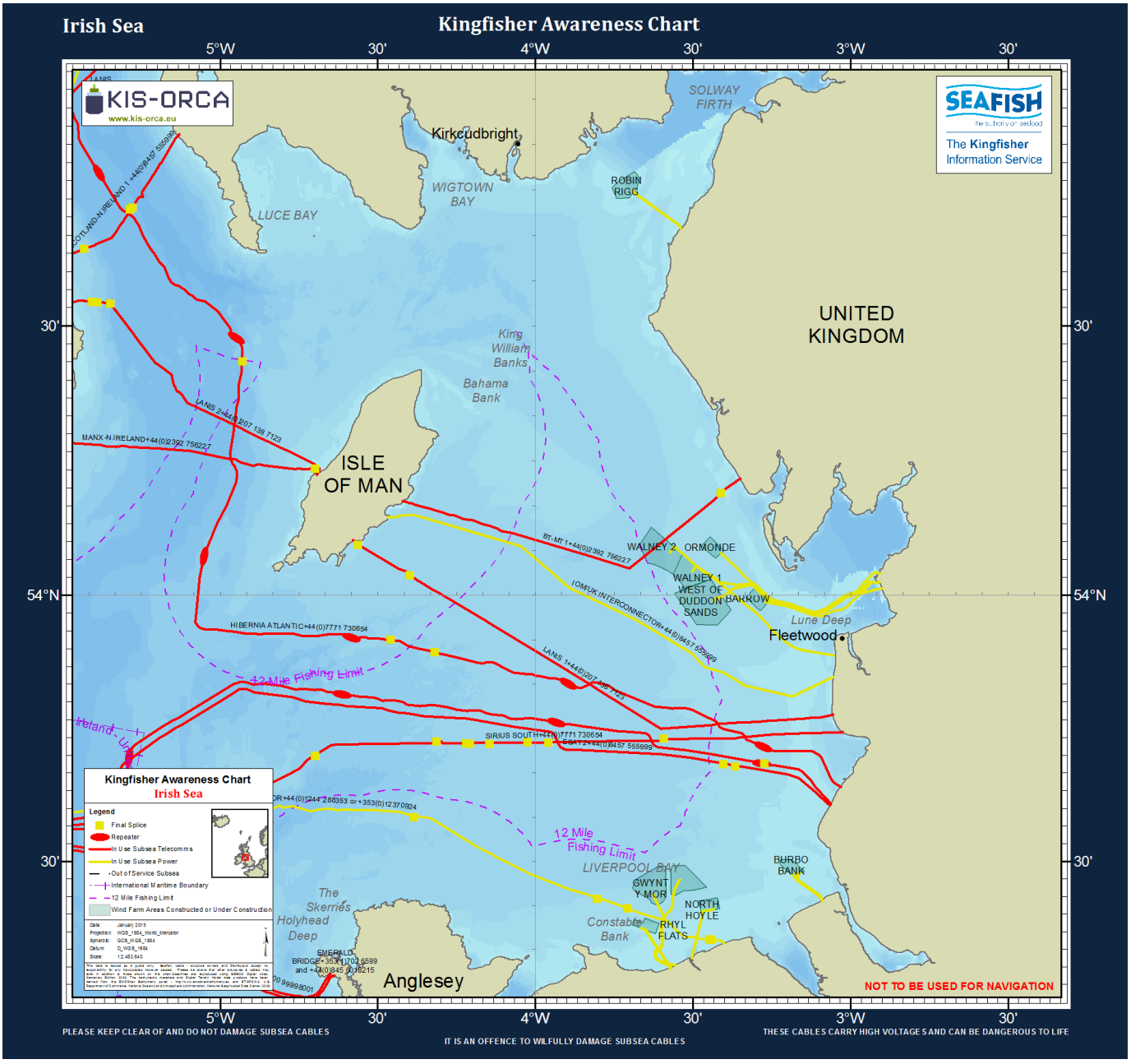
A workshop facilitated by The Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) is recommended to consider the suggestions made in this and previous studies on how to improve the co-existence of fishing and offshore wind power generation.

1. INTRODUCTION

1.1 Project Outline

There is considerable uncertainty over the extent to which commercial fishing activities may have changed on fishing grounds now occupied by operational OWFs and export cable routes. The Crown Estate (CE) commissioned the National Federation of Fishermen's Organisations (NFFO) to investigate the impact of existing Eastern Irish Sea OWFs on commercial fishing. The project examined whether there have been any changes, and if so, the location, nature and extent of those changes to commercial fishing activities (mobile and static gears) within the six operating wind farms and export cable routes in the eastern Irish Sea - Robin Rigg, Walney 1 & 2, Ormonde, Barrow and Burbo Bank (Figure 1).

Fig 1. Offshore wind farms and cable routes in the Eastern Irish Sea (Seafish Kingfisher Services)



1.2 Project Rationale

The project comprised three elements:

- To determine the location, nature and extent of commercial fishing activities before and after the development of OWFs off the Dee, Cumbrian and Solway estuary;
- To build an evidence-based method of assessing whether such changes are caused by the impact of offshore renewables on commercial fishing activities; and
- To document case studies of best practice in achieving co-existence between the fishing industry and future offshore developments.

The location, nature and extent of change

Information on fishing activity such as the type of fishing gear, target species, the size of the fishing vessels and their home port, fishing effort and landings data provided an insight into the **location** and importance of fishing grounds for the different fishing fleets that operated within and around the Eastern Irish Sea OWF areas.

The **nature** of change was determined by the fishermen's behavioural response to the placement of wind turbines on their fishing grounds.

A comparison was made of the spatial **extent** of fishing activity before the wind farms were constructed and after they became operational.

An evidence-based method

Evidence to demonstrate and explain the reasons for a change in fishing activity pre- and post-wind farm construction was gathered from existing information (secondary data) on fish landings, vessel movements and a questionnaire (primary data) conducted with fishermen, fisheries managers and offshore wind farm companies.

The combination of multiple observations, methods and materials, known in social science as 'triangulation', validates data through cross verification. This method can be employed in both quantitative and qualitative studies to increase the credibility and validity of the results.

A combined quantitative and qualitative approach was recommended as the best method to determine the impact of existing offshore renewables on commercial fishing activities.

Co-existence

Examples of how and where fishing took place within OWF areas and along cable routes were recorded, as well as suggestions from fishermen, fisheries managers and wind farm companies on how co-existence could be improved.

1.3 Study area

Eastern Irish Sea offshore wind farms

In addition to the six operating OWFs in this study, construction of West of Duddon Sands wind farm off the Cumbrian coast took place at the beginning of the study and was fully commissioned in October 2014, two months ahead of schedule; consent was given to an extension of the Burbo Bank wind farm and Walney wind farms; and there were two wind farms operating off the Welsh coast (Rhyl Flats and North Hoyle) and one under construction (Gwynt y Môr). None of these OWFs were considered in this study.

The ownership, location, spatial coverage, construction and operational dates, and number of turbines for each of the six OWFs in this study are summarised in Table 1 below. The configuration of the turbines and interconnecting cables for each OWF are presented in Annex A.

Table 1 Details for each of the wind farm studies

Wind Farm	Owner	Location	Coverage	Construction	First power generated	Date of full commission	Turbines
Robin Rigg	E.ON Climate & Renewables UK Ltd	Solway Firth, 11 km from shore	18 km²	September 2007	September 2009	September 2010	60
Ormonde	Vattenfall Wind Power Ltd	9.5 km off Barrow-in-Furness	10 km²	May 2010	August 2011	February 2012	30
Barrow	DONG Energy	7.5 km SW off Walney Island	10 km²	May 2005	March 2006	September 2006	30
Walney 1 & 2	DONG Energy (>50%)	14 km off Walney Island	73 km²	March 2010	January 2011	June 2012	102
Burbo Bank	DONG Energy	Liverpool Bay, 6.4 km from the coast	10 km²	June 2006	July 2007	October 2007	25

Details of the other Eastern Irish Sea Offshore Wind Farms

Immediately to the south of Walney 1, the construction of the West of Duddon Sands OWF started in 2013 and was completed in October 2014. The 108 turbine farm covers 67km^2 and is 15km from the Cumbrian coast.

A north westerly extension to the existing Walney OWF was consented on 7th November 2014. The extension is around 19km WSW of the Walney Island coast in Cumbria and will cover an area of 145km² holding 87 turbines.

The Secretary of State granted development consent in September 2014 for an application to extend Burbo Bank wind farm by 40km². The proposed project would be located west of the operational Burbo Bank OWF in Liverpool Bay, around 7km north of the North Wirral coast and comprise 32 turbines.

Eastern Irish Sea fisheries

The offshore commercial species characteristically found on fine sediment that dominates the seafloor across much of the fairly shallow (< 30m) Eastern Irish Sea include Dover sole, plaice, rays, cod, whiting, turbot and brill (Figure 2). Off the Cumbrian coast, a strip of predominantly shallow mud approximately 60km long and no wider than 20km is inhabited by the mud burrowing Dublin Bay prawn *Nephrops norvegicus*. Otter trawling for sole, plaice and rays occurs throughout the Eastern Irish Sea from spring to autumn, with cod and whiting being landed during the winter.

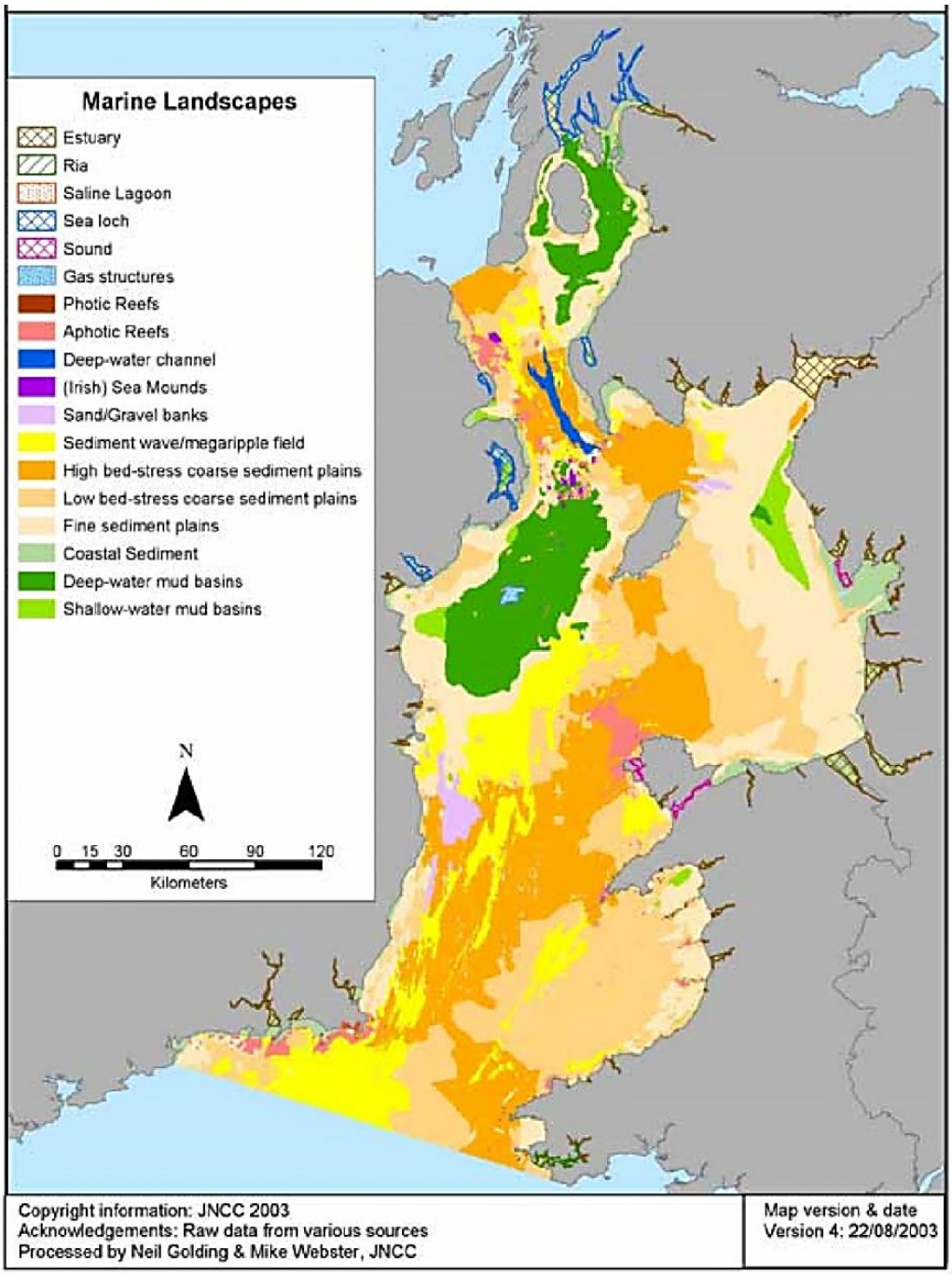


Figure 2. Composition of the Irish Sea bed

Visiting beam and otter trawlers (e.g. from Belgium and Ireland) traditionally arrive on grounds beyond 6 nm during the spring and autumn sole and plaice fishery. Rays and other flatfish, such as turbot and brill are an important part of the demersal trawl fisheries. From May to September, the

Nephrops fishery off the Cumbrian coast attracts visiting otter trawlers, principally from Kilkeel, and supports the smaller trawling fleets based at Fleetwood, Barrow, Whitehaven and Maryport. Peak landings are made during neap tides when *Nephrops* spend more time out of their burrows foraging for food.

In Liverpool Bay and further north in coastal waters, the inshore static gear fleet target flatfish, rays and bass using gill nets, both fixed and drifted, from spring to autumn. These vessels also set pots for lobsters, brown and velvet crab in rocky areas closer inshore. Whelk pots are set further off the coast. The numbers of vessels engaged in the crustacean pot fisheries is low because of poor first sale prices, the lack of local processing plants along the Cumbrian coast, and alternative work opportunities afforded by the offshore wind farms (NWIFCA pers comm).

1.4 Project scope

The project tender document outlined an approach to the study; suggested data sources and a methodology; stipulated a list of consultees and a consultation timetable; and stated how data would be processed and what and how results would be reported.

Outline approach

The proposed approach was split into three distinct phases:

i. A desk-top scoping and study phase to collate and review available data (e.g. from MMO landings, VMS, POs, the Crown Estate Marine Resource System (MaRS), Seafish Economics, Crown Estate, and developer assessments) to highlight key issues to inform data requirements of the consultation process;

ii. A 30-day consultation and data collection phase, to obtain quantitative and qualitative data on the spatial changes to fishing patterns, and on whether and how both the developers and the fishing industry have adapted in order to promote efficient business operations; and

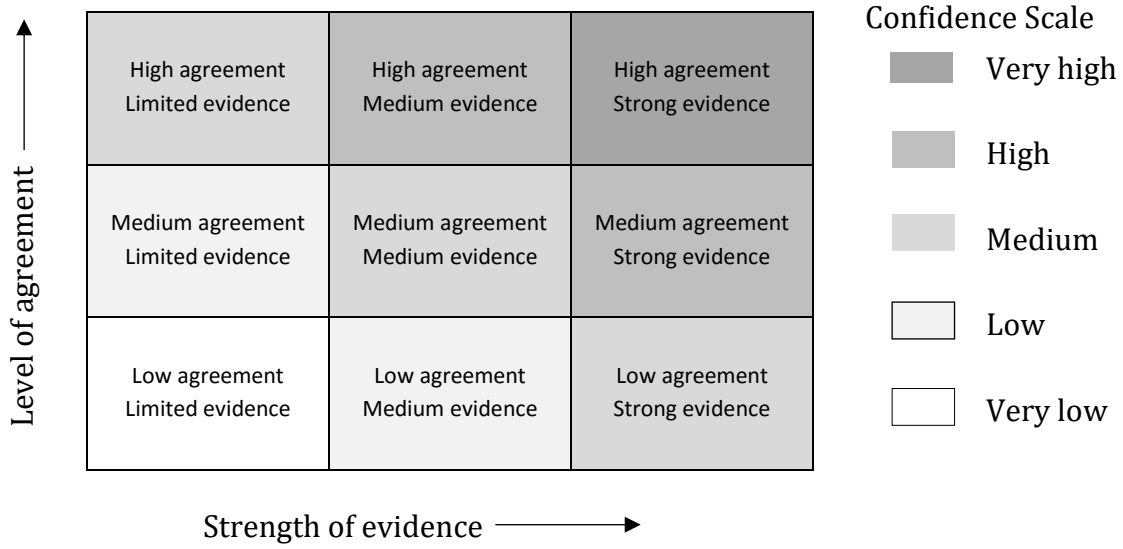
iii. To collate and review evidence and produce a final report to be peer-reviewed.

2. PROJECT APPROACH

2.1 Evidence-based method

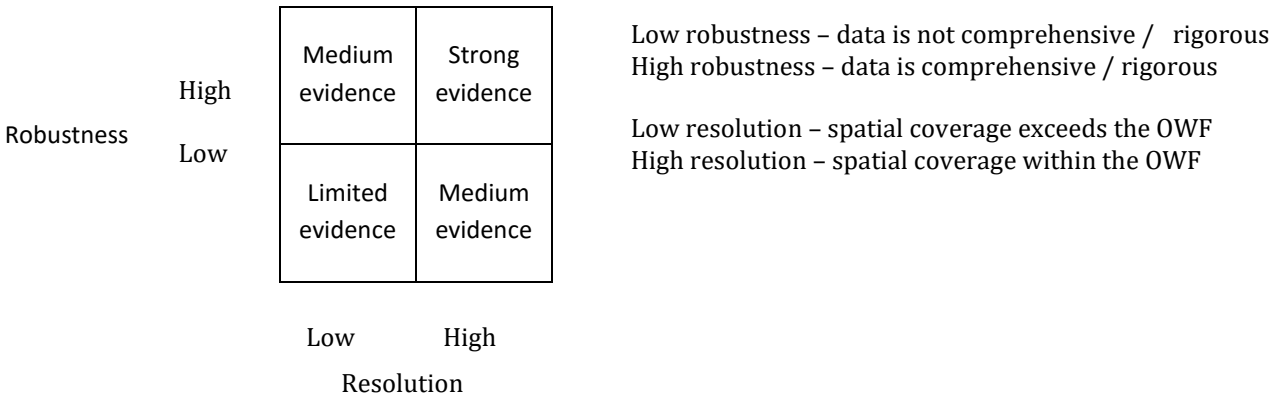
Multiple sources of secondary and primary data on fishing activity in the Eastern Irish Sea were analysed to identify any change in fishing activity pre- and post-wind farm construction. The degree of certainty of the findings was evaluated using a matrix method devised by the Intergovernmental Panel on Climate Change (IPCC, 2010) which was based on the combination of the strength of evidence and the level of agreement (Figure 3).

Figure 3. An evidence and agreement matrix and their relationship to confidence (confidence increases towards the top-right corner).



The strength of evidence was categorised according to robustness (the comprehensiveness of the fishing activity dataset) and resolution (the spatial accuracy of the dataset in relation to the offshore wind farm). The strength of evidence was rated according to the combinations in the matrix below.

Figure 4. The strength of evidence according to the robustness and resolution of the data



Justification for the robustness and resolution categorisation of each dataset is provided in table 2.

Table 2. Strength of evidence for each dataset according to robustness and resolution

Data source	Robustness	Resolution	Strength of evidence	Justification
(a) MMO iFISH dataset for vessels over 10 metres in length	High	Low	Medium	Data collected on landings and fishing effort by over 10m vessels comes primarily from a fishing logbook, but also from landings declarations and sales notes. Supply of logbook data is mandatory for all vessels over 10m. The fishing logbook records details of the catch, fishing gear and the ICES division and rectangle for the activity. An ICES rectangle is 0.5 degree of latitude by 1 degree of longitude - at UK latitudes they measure approximately 30 x 30 nautical miles. The approximate proportion of ICES rectangle occupied by each of the wind farms are: Robin Rigg (<5%); Walney 1 & 2 (<10%); Barrow (<5%); Ormonde (<5%); Burbo Bank (<5%).
(b) MMO iFISH dataset for vessels under 10 metres in length	Low	Low	Weak	For vessels under 10m, there is no statutory requirement for fishermen to declare their catches. Obtained from the registration for buyers and sellers (RBS) scheme and voluntary information, catch information is recorded according to ICES divisions and statistical rectangles. Many under 10s do not report or are not captured by RBS. For example, no reporting is needed when daily quantities of each species are less than 25kg.
(c) VMS data	High	High	Strong	Coverage is limited by the length of the fishing vessel as VMS was introduced for all vessels ≥24m on 01 January 2000 and then ≥18m in 2004, ≥15m in 2005 and ≥12m in 2012. Robustness of data is according to vessel length. AFBI provided annual VMS densities for the UK fleet in the Eastern Irish Sea according to fishing density pings per km^2.
(d) Surveillance data	Low	High	Medium	Surveillance of fishing vessels is not continuous and sightings data are therefore only indicative of where fishing activity occurs. Cefas has found that sightings data were not suitable for studies of changes in fishing activity in small areas.
(e) Consultation	Low/High	High	Medium/ Strong	Robustness of oral evidence was categorised as high if responses from fishermen and fishery officers correlated.

The levels of agreement were calculated according to the number of evidence sources of the same category and confidence in the validity of the findings was expressed using five qualifiers: 'very low', 'low', 'medium', 'high' and 'very high'.

2.2 Data source

Two types of data on fishing activity were used in this study:

(i) Secondary data:
- Fish landings and fishing effort (held on the MMO iFISH database);
- Vessel Monitoring System (requirement under EU law for vessels over 12m); and
- Surveillance and enforcement monitoring (carried out by patrol vessels and aircraft).

(ii) Primary data from fishermen, fisheries managers and wind farm companies via a questionnaire and targeted interviews.

Secondary data

Between 2000 and 2014, fish landings at the ICES rectangle level were obtained from the MMO for the Eastern Irish Sea. Processed VMS data on UK vessels operating from 2007 to 2013 in the Eastern Irish Sea were provided by AFBI.

Additional secondary data were obtained in a processed state from OWF reports and a recent strategic appraisal to identify potential areas of wind farm development (Centrica, 2012). Secondary data also came from non-OWF sources, including a study into the potential impact of the proposed Irish Sea Marine Conservation Zones on the Northern Ireland fishing fleet (Cappell *et al*., 2012) and a review of inshore fishing activity off the coast of England and Wales using Government surveillance data (Vanstaen & Breen, 2014).

For official landings and effort data, VMS and surveillance data, a brief description of how the data were collected and recorded and the spatial resolution is provided in Annex B.

Primary data

Questionnaires that included closed and open questions were used to collect quantitative and qualitative information from fishermen, fisheries managers and wind farm developers (Annex C). If changes in fishing behaviour were detected, the consultation investigated why, to what extent, alongside evidence of co-existence between fishing and OWF.

<u>Fishermen's questionnaire</u>

Following advice from fishing port representatives, fisheries liaison officers, NFFO fishermen's representatives, Fishermen's Producer Organisations and MMO fisheries officers, the fishermen chosen for interview were thought to have fished within at least one of the six OWFs in this study (which included the export cable routes to shore). A total of 31 fishermen were interviewed: 19 from North West England; 9 from Northern Ireland; and 3 Welsh fishermen (a scallop dredge operator, a mussel fisherman and a pot / mussel fisherman). The three Welsh fishermen, who acted as a control group, operated in Liverpool Bay, but not within the OWF areas and were used to gauge wider industry perception. Details of the fishermen interviewed, such as their port of registration, size of vessel, fishing gear and species targeted are summarised in Table 4.

The fishermen's questionnaire asked in which OWF areas (areas occupied by wind turbines and / or export cable routes) the fishermen had operated; the type of fishing gear used; the species targeted; and whether the fishermen had reduced or stopped fishing before or after construction. They were asked whether they could provide evidence (e.g. fish plotter data) to show a reduction in fishing activity within the OWF areas and whether they would be prepared to share that evidence. The questionnaire also asked fishermen whether they thought non-wind farm related reasons had caused a reduction in fishing effort before and after construction and included questions on the nature and extent of the reduction in fishing effort. Fishermen were asked about the wider effects of offshore wind farms and whether, and if so how, wind farm developers had helped and / or hindered fishing in any way.

Interviews were carried out over the phone and face-to-face. Fishermen from the Cumbrian ports (Barrow, Whitehaven and Maryport), Fleetwood and the Wirral were interviewed over the phone. Two days were spent in Kilkeel interviewing fishermen face-to-face and meetings were held with the Anglo-Northern Irish Fishermen's Producers Organisation (ANIPO) and the Northern Ireland Fishermen's Producers Organisation (NIFPO).

Fisheries manager's questionnaire

The fisheries manager's questionnaire followed a similar format and asked similar questions (some the same) to those included in the fishermen's questionnaire. Their awareness of fishing activity, gear and species targeted within each of the OWFs before and after construction was important to elicit in order to corroborate the fishermen's response. Fisheries managers were also asked how fishermen were considered in the development of OWFs, whether any forms of compensation, mitigation and / or assistance were offered, whether the wind farm developers had helped or hindered the continuation of fishing, and whether any work opportunities for fishermen had arisen. They were asked the same questions as fishermen on fishing opportunities before and after construction and they were asked whether they had any evidence to show the OWFs had had a positive or negative effect on commercial species.

Telephone interviews were conducted with Fisheries Officers from the local MMO offices (Preston and Whitehaven) and a representative of the NWIFCA.

Offshore wind developer's questionnaire

Questionnaires were sent to each of the lead OWF developers via email (Table 3).

Table 3 Details of wind farms and respective wind farm developers contacted

Offshore Wind farm	**Wind farm developer contacted**
Robin Rigg	E-ON
Ormonde	Vattenfall
Barrow	DONG
Walney 1 & 2	DONG
Burbo Bank	DONG

The wind farm developers were asked similar and in some cases the same questions set for the fishermen and fisheries officer.

Table 4. Details of the fishermen interviewed

Port of Registration	Number of Fishermen	Size Category (m)				Gear Type				Target Species						
		<10	**10-12**	**12-15**	**>15**	**Trawl**	**Nets**	**Pots**	**Dredge**	**Dem**	**Nep**	**Lobs.**	**Bass**	**Ska**	**Sca**	**Mus**
Barrow	7	3	3	-	-	4	1	2	-	4	2	2	2	2	-	-
Belfast	2	-	-	-	2	1	-	-	1	1	1	-	-	-	-	1
Fleetwood	2	-	-	1	1	2	-	-	-	2	1	-	-	1	-	-
Liverpool	1	1	-	-	-	1	1	-	-	1	-	-	-	-	-	-
Maryport	1	-	-	1	-	1	-	-	-	1	-	-	-	1	-	-
Milford Haven	1	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-
Newry	8	-	-	-	8	8	-	-	-	8	8	-	-	-	-	-
Whitehaven	8	3	2	2	-	8	1	1	-	3	6	1	1	1	-	-
No longer registered	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1

Dem	Demersal whitefish	**Lobs**	Lobsters	**Ska**	Skate & ray	**Mus**	Mussel seed
Nep	*Nephrops*	**Bass**	Bass	**Sca**	Scallops		

3. THE LOCATION, NATURE AND EXTENT OF CHANGE IN FISHING ACTIVITY

3.1 The extent of change in fishing activity

3.1.1 The location of fishing activity

Two main groups of UK fishermen were found to have operated in the vicinity of the six OWFs, either before and / or after their construction: (1) visiting fishermen from Northern Ireland, principally Kilkeel, who operated single-rig, twin-rig and pair trawl gear primarily for *Nephrops* with an important by-catch of finfish such as sole, plaice, cod, rays and turbot; and (2) local fishermen along the North West coast of England who operated inshore trawlers for *Nephrops* and finfish and smaller vessels using static fishing gear, such as pots for lobsters and crabs and gill nets for rays, turbot and bass. Confidence in the findings is presented in Annex D and summarised in Table 5.

Table 5. A summary of fishing activity within the vicinity of each wind farm

Wind farm	Fishing activity	Confidence
Robin Rigg	Demersal otter trawl	High
Walney 1 & 2	*Nephrops* and demersal trawl	High
	Beam trawl	Medium
Ormonde	Demersal otter trawl	High
Barrow	Demersal otter trawl	High
	Lobster & crab pot	Medium
Burbo Bank	Demersal otter trawl	High
	Light beam trawl	Medium
	Gill net	Medium

(Demersal trawl covers single-rig, twin-rig and pair otter trawls)

Vessels from the Republic of Ireland and Belgium were found to have operated in the vicinity of the Walney wind farms; Belgian and Irish beam trawlers were found to target Dover sole to the west and south of the Walney wind farms; Irish otter trawlers participated in the *Nephrops* fishery mainly to the north of the Walney wind farms with some fishing activity in the northwest corner of Walney 2. A limited amount of *Nephrops* trawling took place in the south of the Walney wind farms. Around 70% of the 28 fishermen interviewed (not including the control group) had fished inside Walney 1 and 2 wind farms or along the export cable route either before or after the wind farms were constructed. Trawling was the dominant form of fishing activity in all the wind farms, with some static gear reportedly used in Barrow and Burbo Bank (Table 6). This information was corroborated by the fisheries officers. The wind farm developers reported trawling and potting in Robin Rigg and Barrow, and *Nephrops* trawling in Walney 2.

With the exception of Walney 1 & 2, the remaining wind farms lie between 3 and 6nm of the coast where a NWIFCA byelaw prohibits over 15m vessels without a track record from operating.

Table 6. Number of interviewed fishermen who have fished within the wind farms (including the export cable routes) either before or after construction according to fishing gear

Wind farm	Demersal trawl (inc *Nephrops* trawl)	Gill net	Lobster pot	Light beam trawl
Robin Rigg	7			
Walney 1 & 2	22	1	1	
Ormonde	11			
Barrow	11		1	
Burbo Bank	2			1

3.1.2 The change in fishing activity within the offshore wind farms

Existing datasets (VMS, landings and sightings) and information from fishermen and fisheries officers, revealed that fishing activity had declined in the five wind farm sites following their construction, although confidence in the data was between low or medium. For *Nephrops* trawling in Walney 2, the evidence of a decline was much stronger. The confidence assessments are provided in Annex E and summarised in Table 7.

The strongest evidence for a change in fishing activity within the OWFs came from VMS data and consultation with fishermen and fisheries officers. The examination of landings data from ICES rectangles showed a steady decline in annual demersal finfish landings across the Eastern Irish Sea since 2000

Table 7. Confidence in the evidence that showed a reduction in fishing activity in each wind farm

Wind farm	Reduction in Fishing activity	Confidence
Robin Rigg	Demersal trawling	Medium
Walney 1 & 2	Nephrops trawling	High
Ormonde	Demersal trawling	Medium
Barrow	Demersal trawling	Medium
	Lobster potting	Low
Burbo Bank	Demersal trawling	Low
	Gill netting	Low

Fishermen were asked to supply fish plotter data to demonstrate fishing activity before and after the construction of OWFs. Unfortunately, it was not possible to find fish plotter data with an accurate time stamp.

The analysis of the data sources used to assess fishing levels within and around the wind farms is provided in Annex B and summarised below.

VMS (UK vessels)

Analysed and supplied by AFBI, annual VMS intensity for the UK fleet that operated in the Eastern Irish Sea between 2007 and 2013 (Figures 5a to g) showed a fairly constant level of fishing vessel activity in the Walney 2 OWF area before construction (2007-2009). This was followed by a decline in recorded activity in 2010. Negligible levels of activity were subsequently recorded in 2011 (construction commenced April 2011) and 2012, followed by a slight increase in 2013 (the wind farm was commissioned in June 2012).

In the area of Walney 1 and Ormonde, low levels of fishing vessel activity were recorded from 2007 to 2009 (Figure 5a-c), with no activity recorded from 2010 onwards which coincided with the start of construction (March 2010 for Walney 1 and May 2010 for Ormonde).

Since 2007, no UK fleet activity was recorded in the areas of the Robin Rigg, Barrow or Burbo Bank wind farms.

Figure 5a VMS intensity for the UK fleet operating in the Irish Sea in 2007

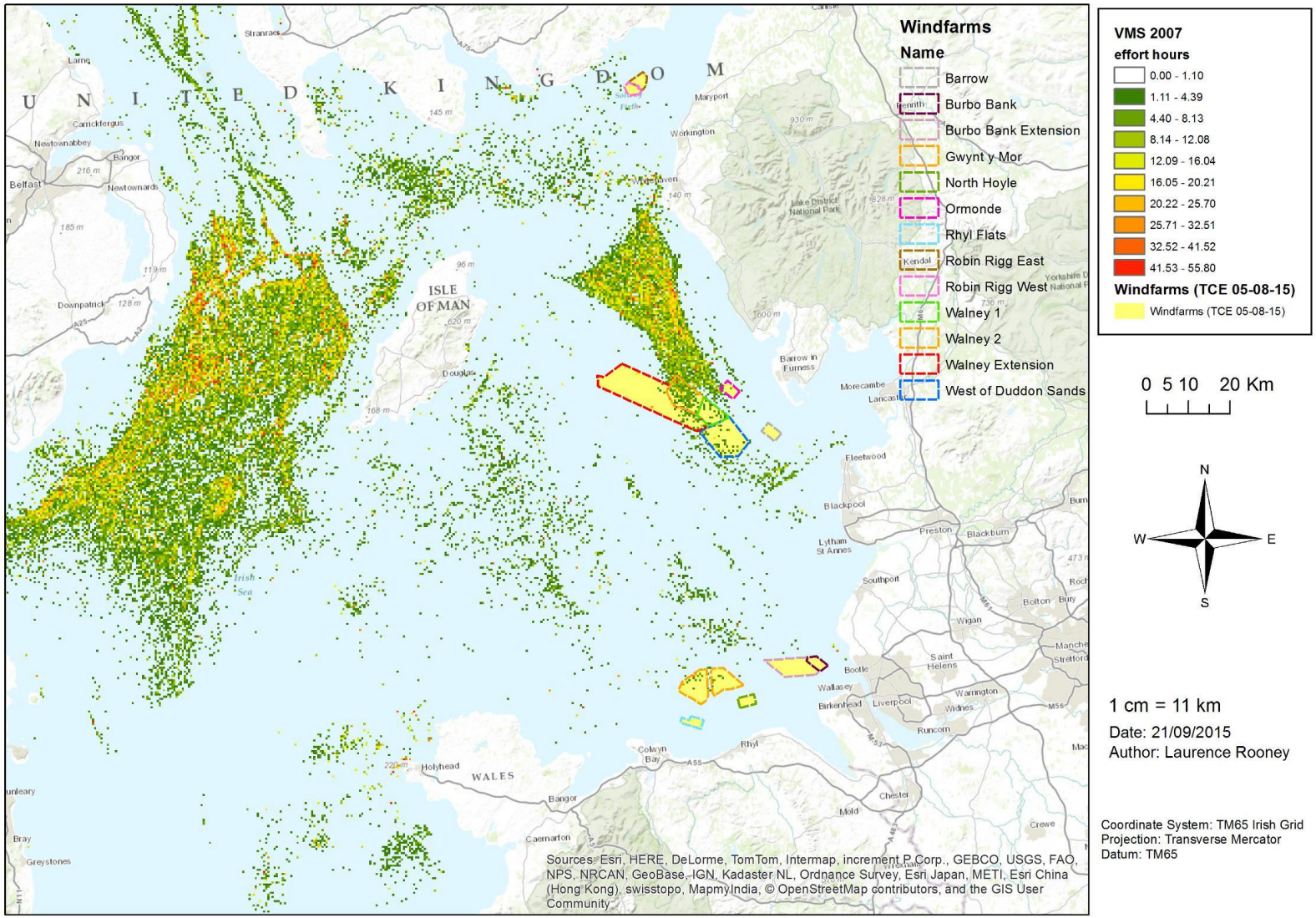


Figure 5b VMS intensity for the UK fleet operating in the Irish Sea in 2008

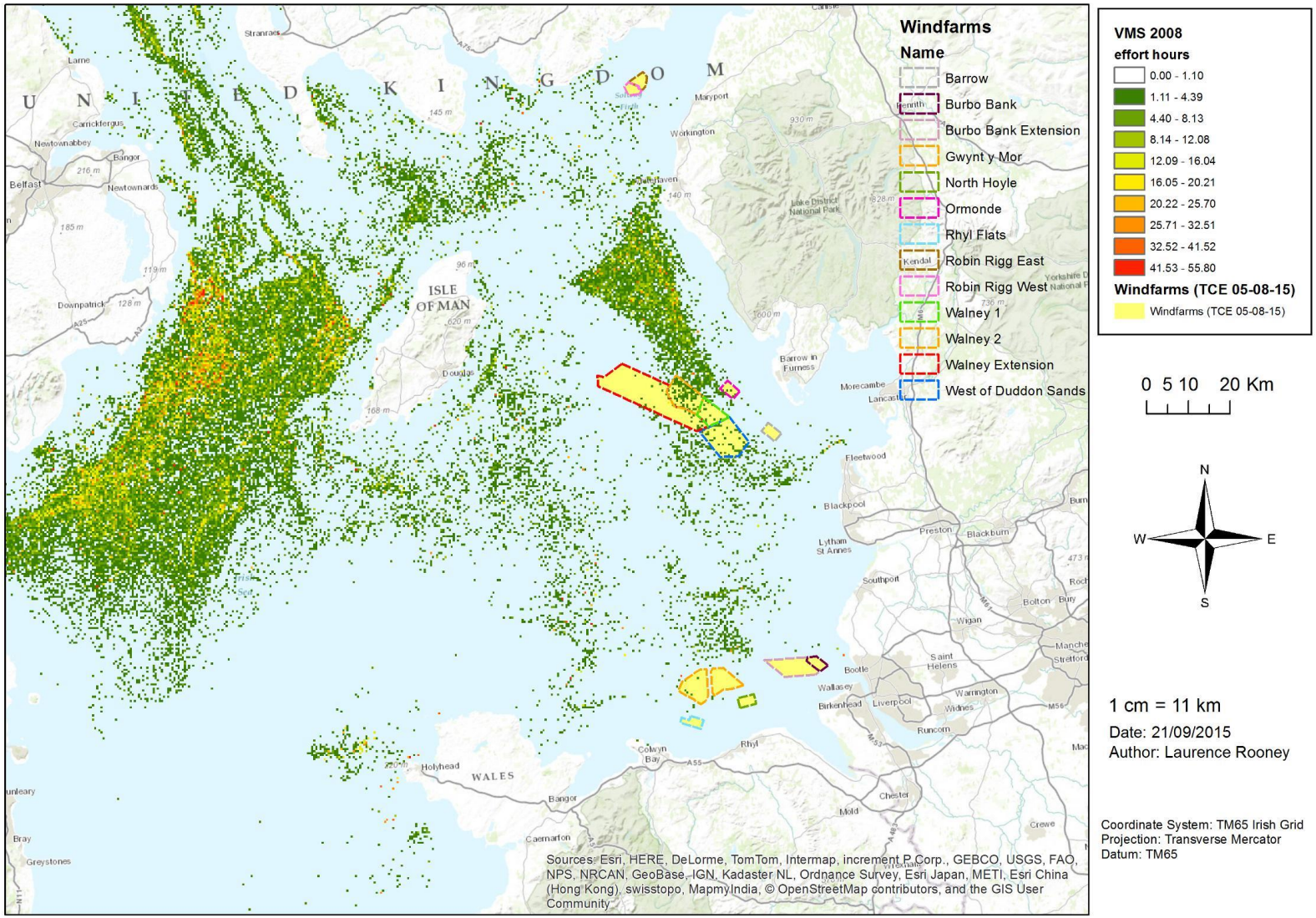


Figure 5c VMS intensity for the UK fleet operating in the Irish Sea in 2009

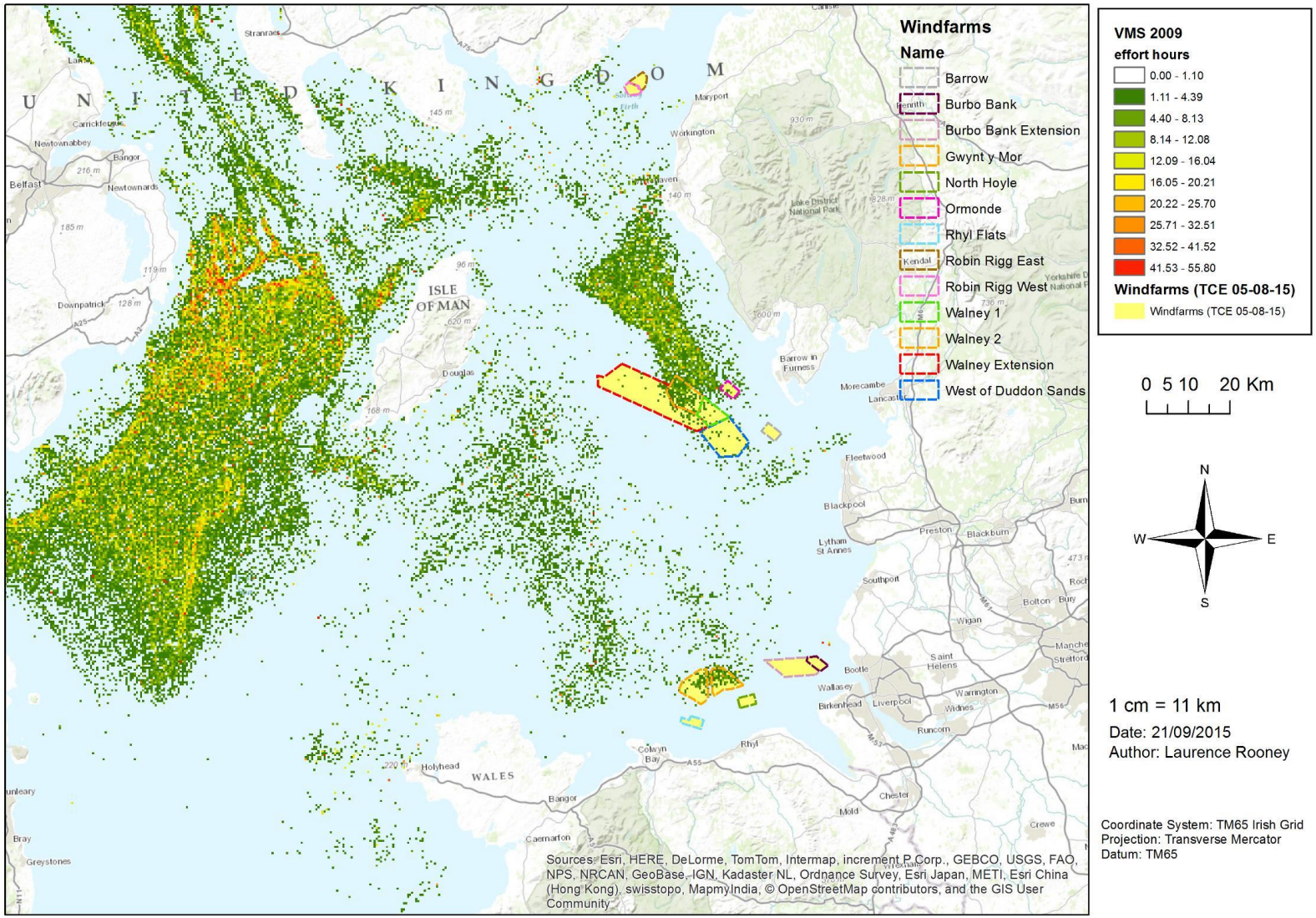


Figure 5d VMS intensity for the UK fleet operating in the Irish Sea in 2010

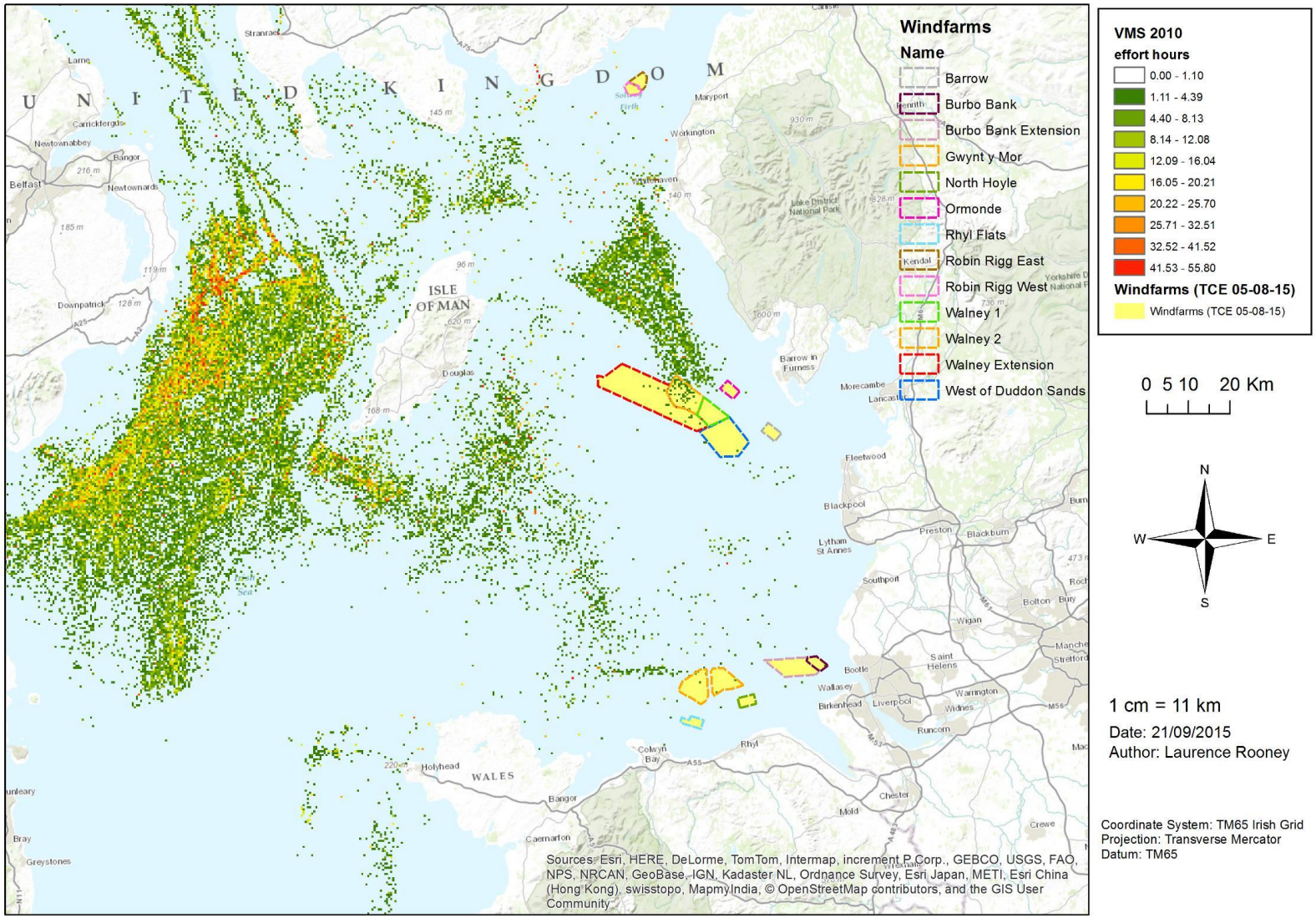


Figure 5e VMS intensity for the UK fleet operating in the Irish Sea in 2011

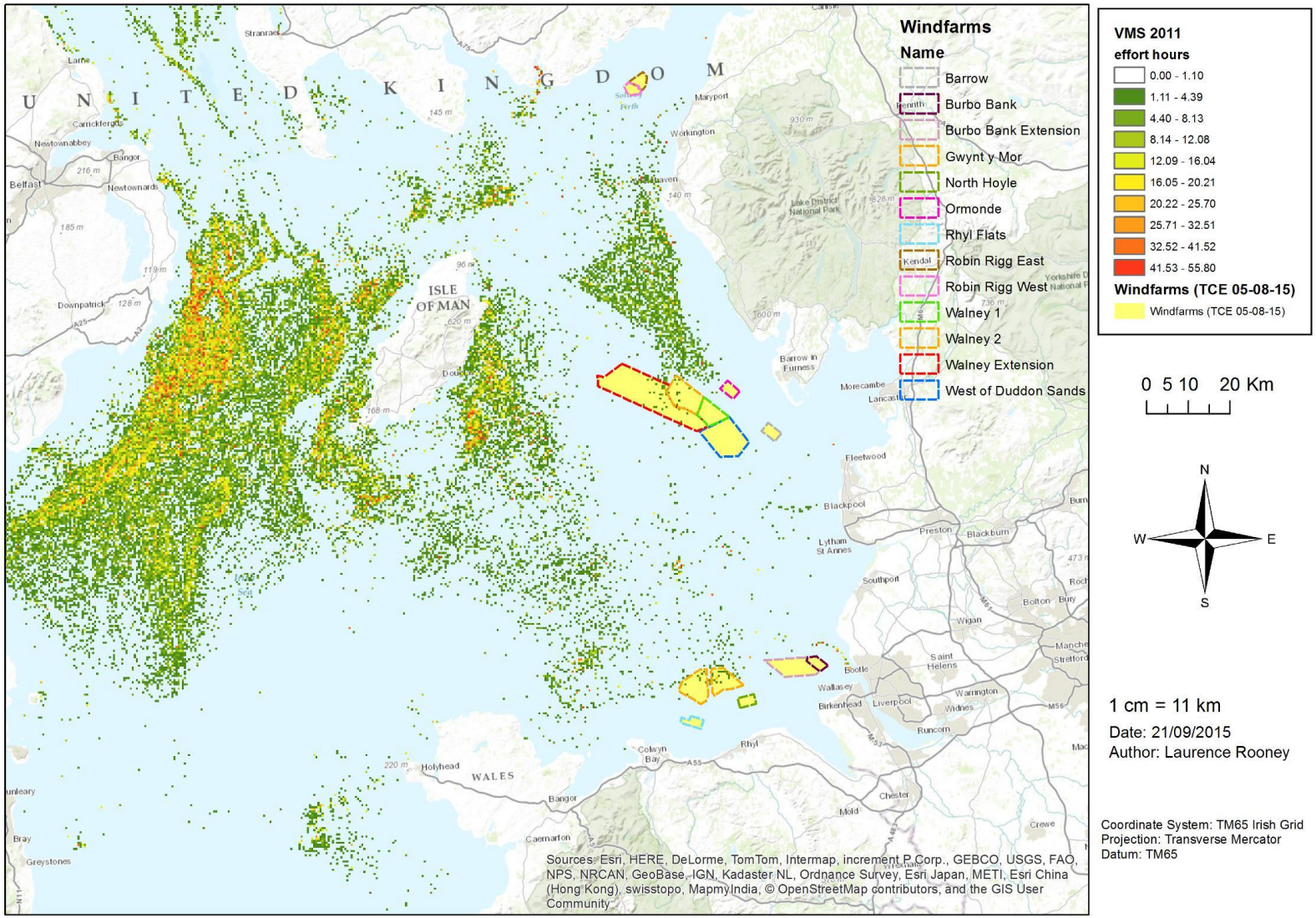


Figure 5f VMS intensity for the UK fleet operating in the Irish Sea in 2012

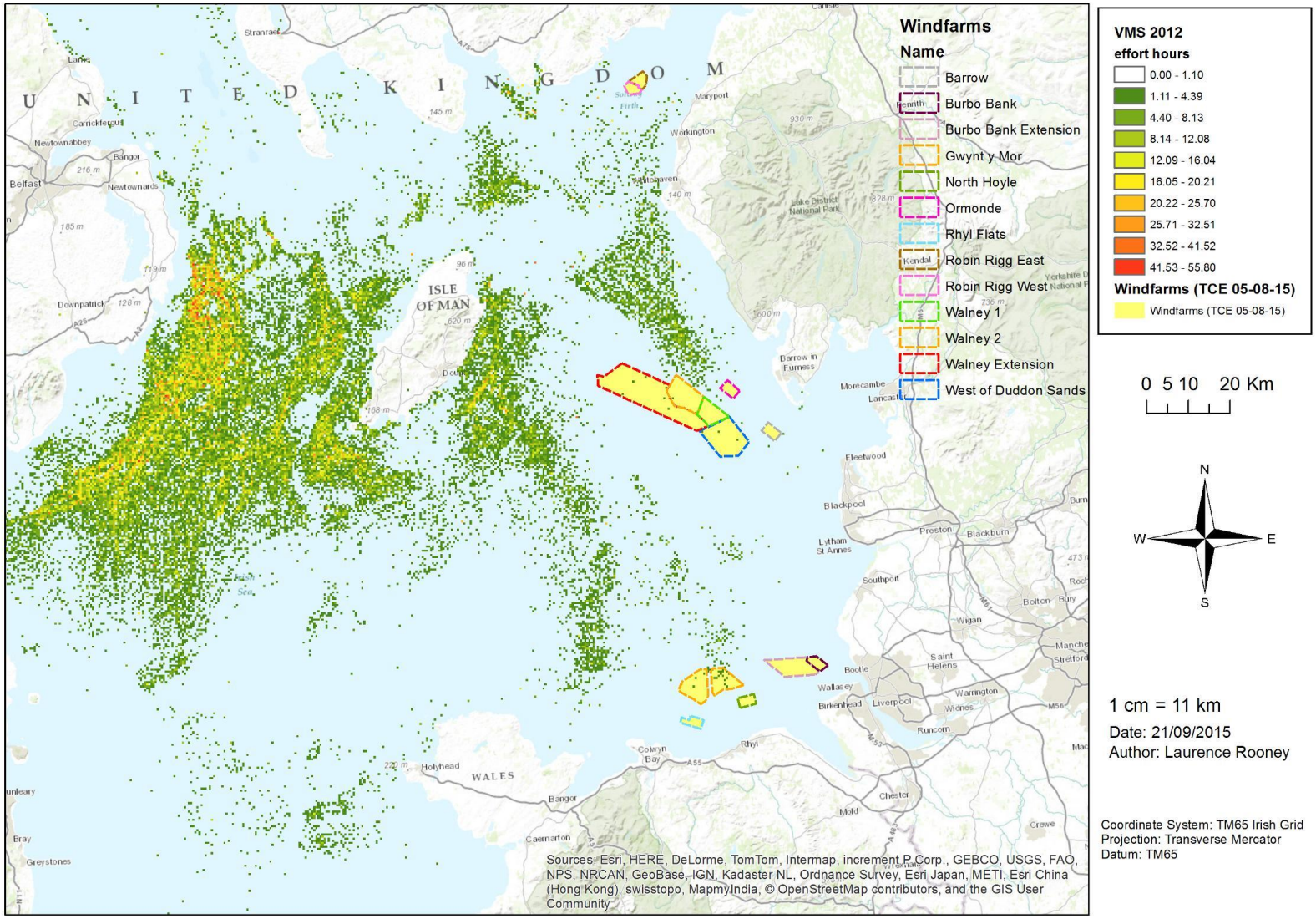
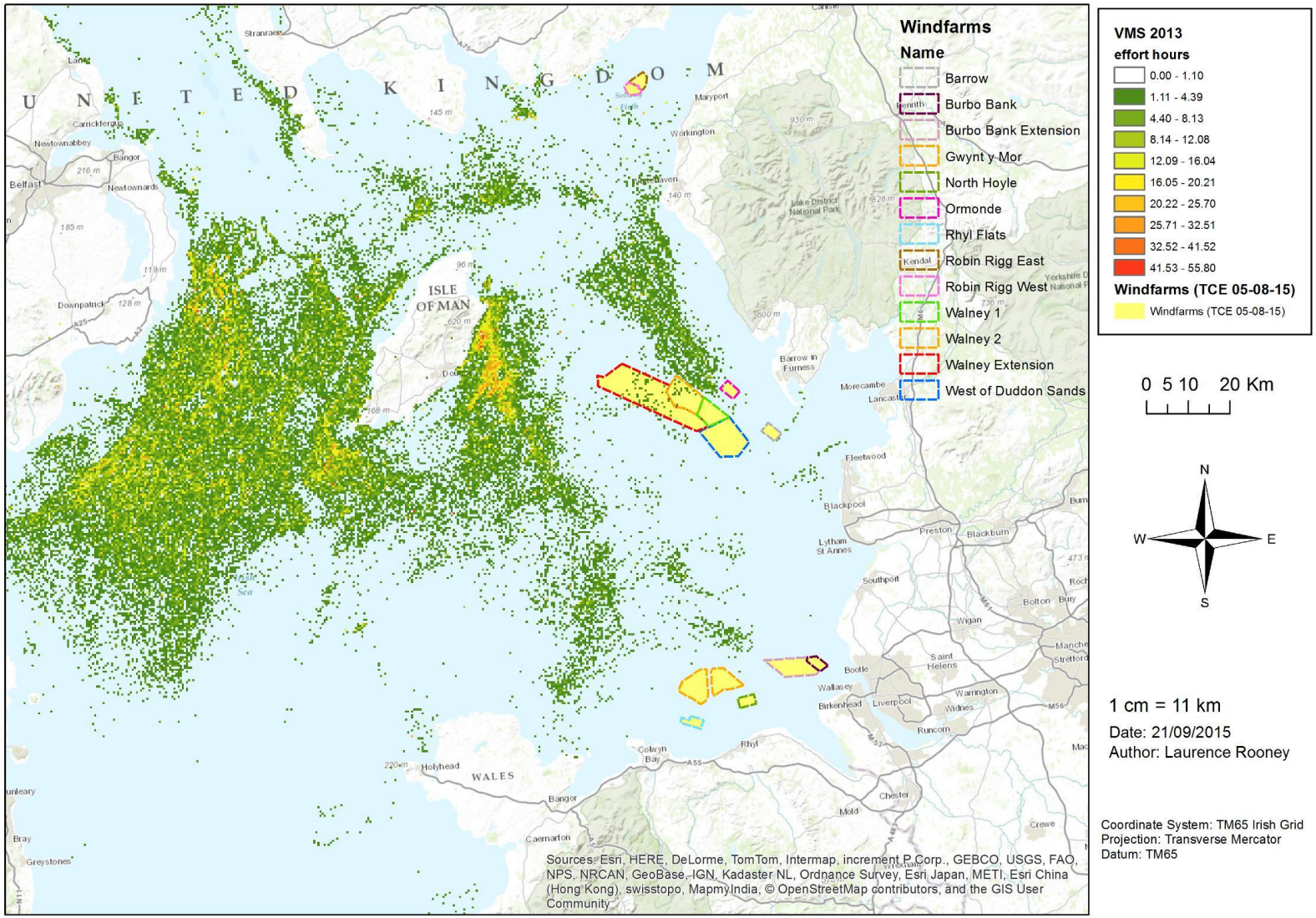


Figure 5g VMS intensity for the UK fleet operating in the Irish Sea in 2013



Landings data

Since 2000, the decline in the total landings of the main commercial finfish from the four ICES sub-rectangles that encompass the 6 wind farms correlated with the reduction in the Total Allocation of Catches (TACs) set for the Irish Sea except for plaice (Table 7 & Annex F). During the same period, the increase in *Nephrops* landings corresponded with the rise in its ICES Subarea VII TAC.

Table 7. Change (%) in the average annual landings and TAC for demersal finfish and Nephrops between two five-year periods: 2000-2004 and 2010-2014 from ICES rectangles 35E6, 36E6, 37E6 and 38E6.

Species	UK landings	Total landings	TAC
Cod	-89%	-91%	-82%
Dover sole	-82%	-82%	-74%
Plaice	-76%	-81%	-21%
Nephrops	+28%	+25%	+18%

A comparison of the average annual UK landings of demersal finfish and *Nephrops* before the construction of each wind farm (up to five preceding years) and after each wind farm was fully commissioned (up to five proceeding years) showed a considerable decline, which in most cases was associated with a decline in the Irish Sea TACs during the same period (Tables 8-11). The rate of decline in plaice landings far exceeded the decline in its TAC in all ICES rectangles reviewed, which according to local fishermen was due to low demand.

A comparison of average annual UK landings within each ICES rectangle before and after the construction of each wind farm and a comparison with average Irish Sea TACs

Table 8. ICES rectangle 38E6 (Robin Rigg)

Species	Average annual landings (tonnes)		Landings difference	TAC difference
	2003 - 2006	2011 - 2014		
Cod	4.35	0.4	-96%	-83%
Dover sole	4.05	0.68	-85%	-75%
Plaice	37.55	14.6	-61%	-2%

Table 9. ICES rectangle 37E6 (Ormonde & Walney 1 & 2)

Species	Average annual landings (tonnes)		Landings difference	TAC difference
	2007 - 2009	2012 - 2014		
Cod	16.6	3.26	-80%	-75%
Dover sole	10.87	4.3	-60%	-73%
Plaice	101.6	26.63	-71%	-13%
Skate & rays	27.4	5.57	-80%	-
Nephrops	693.33	458.57	-34%	-12%

Note Ormonde and Walney 2 were fully commissioned in 2012

Table 10. ICES rectangle 36E6 (Barrow)

Species	Average annual landings (tonnes)		Landings difference	TAC difference
	2000 - 2004	2007 - 2011		
Cod	20.3	0.92	-95%	-59%
Dover sole	23.26	6.28	-73%	-45%
Plaice	105.98	56.58	-53%	-15%

Table 11. ICES rectangle 35E6 (Burbo Bank)

Species	Average annual landings (tonnes)		Landings difference	TAC difference
	2001 - 2005	2008 - 2012		
Cod	10.5	0.24	-98%	-68%
Dover sole	7.38	0.94	-87%	-54%
Plaice	7.3	4.56	-38%	-10%
Skate & rays	29.42	2.43	-92%	-

Consultation

All 28 fishermen claimed to have reduced and / or stopped fishing within the OWFs and / or export cable routes during construction with a small number returning post construction (Table 12) (Refer to Question 2.4, Annex C p53). The fisheries managers also reported a reduction in fishing in all of the OWFs during construction but were only aware of a reduction in fishing after construction in Robin Rigg, Walney 1 & 2 and Burbo Bank. The wind farm developers claimed that a reduction in fishing effort only occurred during the construction of the OWFs.

Nearly 50% of the interviewed skippers from the North West of England fished the export cable routes that led from the wind farms to shore, compared to 25% of the skippers from Northern Ireland. This was expected since all the Northern Ireland vessels exceeded the maximum length of 15m for vessels fishing inside 6nm under the aforementioned NWIFCA byelaw.

Table 12. Number of fishermen stopping or reducing fishing effort within a wind farm and / or export cable route before, during and / or after construction

	2 or more years before construction	0-1 year before construction	During construction	0-1 year after construction	2 or more years after construction
Number of fishermen	1	2	28	23	22
(%)	(4)	(7)	(100)	(82)	(79)

After the construction of the wind farms, 74% of fishermen claimed they considerably reduced their fishing effort within the wind farm area, 19% said they had only slightly reduced their fishing effort and fishing effort didn't change for 7% (Table 13) (Refer to Question 2.5, Annex C p53).

The fisheries officers stated there had been a considerable decrease in effort in the three OWFs (Robin Rigg, Walney 1 & 2 and Burbo Bank) that they felt qualified to comment on. The wind farm

developers claimed there had been no change in effort in Robin Rigg and Ormonde, and were unable to comment on Walney and Barrow due to a lack of evidence.

Table 13. Change in fishing effort within the wind farms post construction

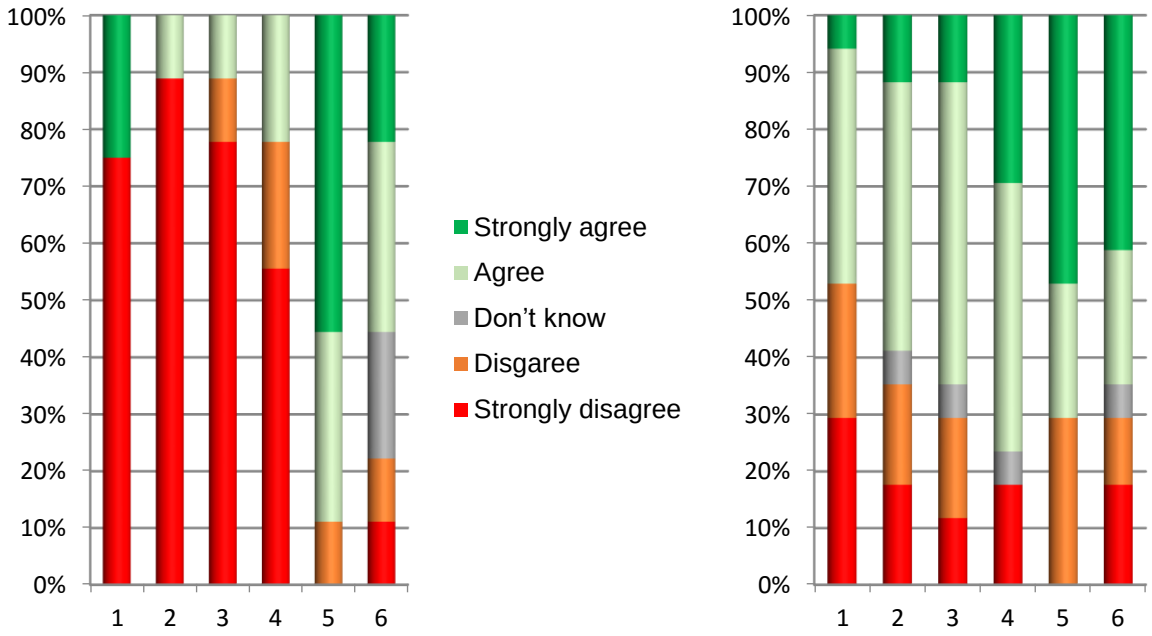
	Considerable decrease	Slight decrease	No change	Slight increase	Considerable increase
Number of fishermen	20	5	2	0	0
(%)	(74)	(19)	(7)	(0)	(0)

3.2 A change in fishing opportunities

The responses to the questionnaires indicate that for most of the Northern Irish skippers (80%), fish quotas, fisheries management and / or the cost of fuel did not cause a reduction in their fishing effort within the wind farms (Figure 6). Conversely, for the North West of England skippers these factors did have a bearing on their fishing effort.

The majority of fishermen (62%) stated that the wind farms had had a greater impact on their fishing opportunities than quota management, although fewer than 50% of Northern Irish fishermen agreed.

Figure 6. Reasons for a reduction in fishing effort within wind farm and export cable areas (N. Ireland fishermen to the left and North West of England fishermen to the right)



Qu 3.1	I have fished along export cable (s)
Qu 3.2	Lack of quota has caused a reduction in effort
Qu 3.3	Management/legislation has caused a reduction in effort
Qu 3.4	The cost of fuel has caused a reduction in effort
Qu 3.5	Risk of potential hazard caused a reduction in effort
Qu 3.6	OWF and export cable maintenance caused a reduction in effort

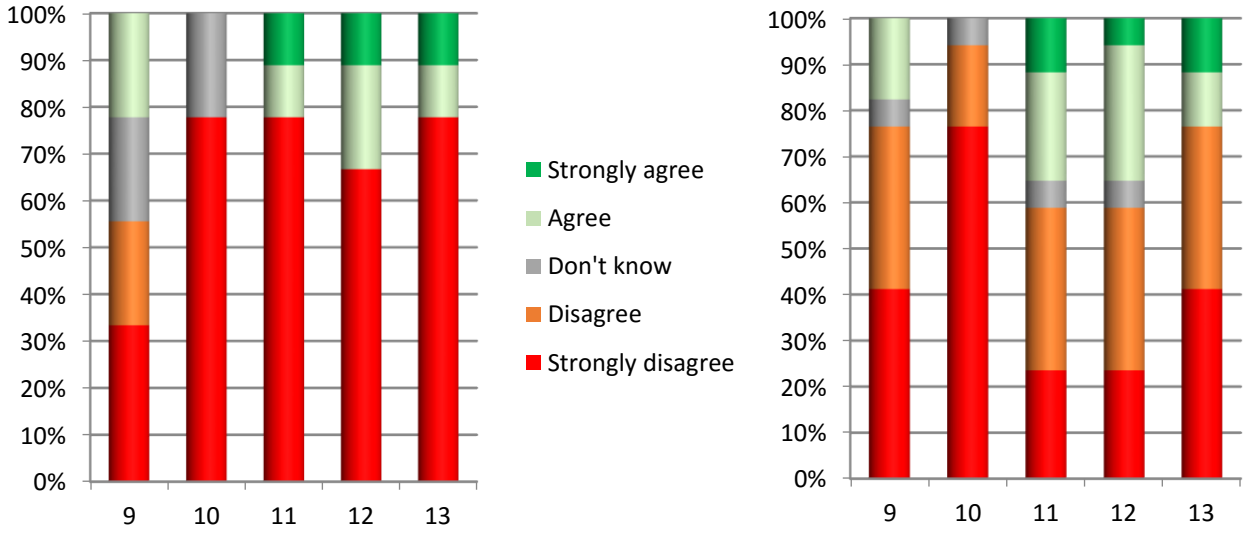
Three of the 4 fisheries officers thought the lack of quota and the cost of fuel would have reduced fishing effort inside the OWFs. All three 'control' fishermen disagreed with the notion that management and the cost of fuel would have reduced effort, although one thought a lack of quota would have reduced effort. Apart from E-ON, the other wind farm developers were unable to comment on the possible reasons for reduced fishing effort. E-ON, who established Robin Rigg, strongly agreed with the assumptions that a lack of quota, fisheries management and the cost of fuel had caused a reduction in effort.

Just less than half the fishermen (45%), one fishery officer and one wind farm developer thought fishing opportunities in the Eastern Irish Sea were in decline before OWFs arrived, which corroborated with the decline in TACs, particularly for whitefish (Tables 7-11). The 3 remaining fisheries officers, 7% of fishermen and two wind farm developers were unsure. Around 90% of fishermen from Northern Ireland and 70% from North West of England claimed the risk of potential hazards caused a reduction in effort with all the fisheries managers in agreement. The discrepancy between the two fishermen's groups may reflect the predominance of trawlers in the Northern Irish fleet and the greater risk of seabed hazards to their bottom trawl gear. The majority of fishermen from England and Northern Ireland (65% and 55% respectively) reported the adverse impact of maintenance work which was backed up by 3 of the 4 fisheries officers.

3.3 A change in fishing behaviour

Whilst the majority of fishermen claimed the wind farms had had a negative / very negative impact on their income, a higher percentage of fishermen from North West England (37%) rated the impact as very negative compared to their Irish counterpart (22%) (Figure 7). One of the Irish fishermen reported the OWFs had had a positive impact as a result of the wind farm guard ship duty work he had received. All the control fishermen thought the wind farms had had a negative effect on fishing.

Figure 7. The effect of wind farms on income and fishing (N. Ireland fishermen to the left and North West of England fishermen to the right)



Qu 3.9	Replacement fishing grounds allowed you to maintain your income
Qu 3.10	Compensation received made up for the loss of income
Qu 3.11	Fishing gear type changed as a result of the OWF
Qu 3.12	Target species changed as a result of the OWF
Qu 3.13	Number of crew on vessel changed as a result of the OWF

Replacement fishing grounds allowed 44% of the Northern Irish fishermen and 18% of local fishermen to maintain their income following displacement from the OWFs. The control group fishermen thought replacement grounds would not allow income to be maintained.

Over 90% of fishermen from England, 78% from Northern Ireland and all 3 control group fishermen thought the compensation for the loss of fishing was inadequate. The remaining fishermen all claimed they did not know whether the compensation made up for the loss, and no fisherman thought it did (Figure 7). Nevertheless, one fisherman said that he "would rather be compensated to avoid areas / stop fishing than forced to decommission on the cheap".

Between 20-30% of all fishermen claimed they had changed their fishing gear, target species and number of crew as a result of the OWFs; the reported impact was slightly higher for the North West of England fishermen, compared to the Northern Ireland skippers (Figure 7). Two of the 3 control group fishermen thought fishermen wouldn't change fishing gear.

The reported impact of the OWFs compared to the export cable route was greater for the vast majority of fishermen (80%).

3.4 Perceived effect of wind farms on commercial species

Nearly 70% of all the fishermen interviewed disagreed with the statement that OWFs had had a positive effect by acting as a nursery ground and nearly 60% believed the wind farms had reduced the overall commercial fish stock size (Annex C). One fisherman claimed that "The quantity and quality of prawns caught close to the wind farms have declined".

Three of the 4 fisheries officers and 2 of the 3 wind farm developers were not aware of any evidence to support the statements in Questions 3.15 and 3.16. For example, one fisheries officer said that "The IFCA haven't received any reports of populations of commercial species within and around the wind farms increasing. They are not aware of any evidence to suggest the wind farms are acting as a refuge (MPA effect) with spill-over into the surrounding area". Two of the three control fishermen thought the OWFs had reduced the overall commercial fish stock size. One fisheries officer and a wind farm developer believed the OWFs had had a positive nursery ground effect; the developer had some survey evidence, but no long term data. They also did not believe OWFs would reduce the size of commercial fish stocks.

As part of their marine licence, each OWF has to meet certain monitoring requirements which include recording any changes to the physical and ecological environment that may have been caused by the construction and operation of the wind farm. The results of each of the six OWF's commercial fish/shellfish population and benthic community monitoring activity was inconclusive, although a slight decrease in the catch rates of *Nephrops* was reported post-construction for Walney 1 (Annex G).

A comprehensive review of environmental data collected at Robin Rigg by Natural Power Consultants Ltd in 2013, concluded that although no significant impacts on fish populations, epibenthic and infaunal communities were found following construction, it was 'too early to tell whether the operation of the wind farm is causing any impacts upon fish and epibenthic communities' (Walls *et al*., 2013). The report also noted that a large number of elasmobranchs were caught along the cable route and over the entire site during the first year of operation, although after just one year of operation, it was difficult to establish a causal relationship between electromagnetic fields and the distribution of elasmobranchs.

In addition to the 6 OWFs in the study, the MMO reviewed the post-consent offshore wind monitoring data collected from a further 16 OWFs around the UK and although stating that 'no robust conclusions have been drawn as a result of the monitoring of fish populations, showing a change to fish numbers, distribution or species composition', the MMO reported that it was likely that although no moderate or major impacts to fish populations had occurred at the sites reviewed, minor effects had been detected (MMO, 2014a). The review also noted the inadequacies in the sampling regimes, such as the lack of a targeted approach, resulting in the inability to distinguish between impacts and natural variation of fish and shellfish populations.

3.5 Comparative effects of wind farms

The majority of the fishermen (66%), fisheries officers and all the control fishermen believed some OWFs had had a greater impact than others on the fishing industry (Annex C) with over 78% of Northern Ireland fishermen believing that to be the case.

Most of the Northern Ireland fishermen, all of the fisheries officers and DONG were unsure whether OWFs were having a larger impact on fishing opportunities than marine protected areas (67%) contrasting with the majority of fishermen from North West England (76%) who thought they were. The uncertainty amongst Northern Ireland fishermen, fisheries officers and DONG could be caused by the lack of information on how fishing will be managed in the Irish Sea Marine Conservation Zones which are currently being designated.

4. CO-EXISTENCE

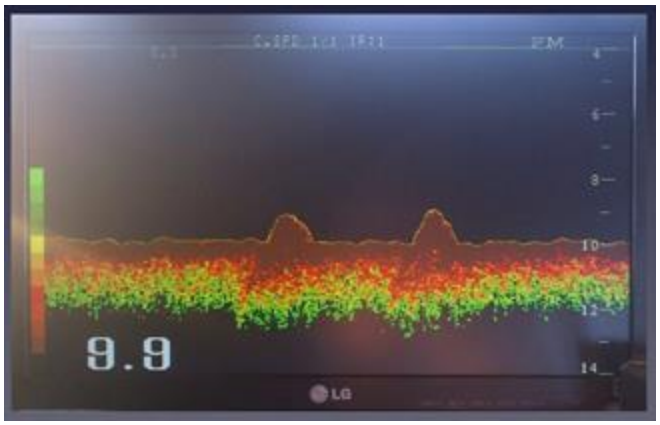
4.1 Factors limiting co-existence

In response to the questionnaire, fishermen, fisheries officers and wind farm developers identified the difficulties for fishermen and fishing inside wind farm sites and suggested how cooperation and co-existence could be improved (Annex H).

As described in section 3.2, the majority of fishermen stated that potential hazards inside OWFs caused a reduction in fishing effort and many fishermen identified specific hazards, such as snagging trawl gear on cables, rock armouring of cables and general seabed debris, together with the risk of collision with turbines in the event of engine failure. Typical comments were: “although there is no exclusion it would be unsafe to fish in OWF areas”; “Fishing within OWF is…too risky due to the combination of tides and weather should a vessel breakdown”; “The risk of snagging cables, losing fishing gear and the risk of collision with turbines in the event of engine failure deters fishing within the OWF”. The risks to trawling dissuaded or reduced the amount of trawling undertaken by the majority of Northern Irish skippers in and around the wind farms once they had been constructed. One skipper claimed he “fishes no closer than 1/4 mile from the wind farm”, another skipper said there is a lack of information on some rock armouring’ and a third skipper said that while he fished within certain parts of a wind farm which was free of obstructions, he did not fish within the OWF at night.

Another reason to avoid OWFs and cable routes was the financial risk of damage to nets. One fisherman pointed out that “rock armouring is a significant hazard to prawn nets, worth up to £20k which discourages fishing within OWFs”. Another fisherman provided evidence from his on-board Acoustic Ground Discrimination System (AGDS) (Figure 8.) of two close piles of rocks that had apparently been dumped to protect a cable and one pile was thought to have missed its target.

Figure 8. A skipper’s AGDS evidence of potential inaccurate rock armouring



There were also reports of poor catches close to and inside the OWFs: one fishermen stated “the quantity and quality of prawns caught close to the wind farms have declined. The summer prawn fishery would start in May until August fishing for 2 weeks at a time”. According to a couple of Irish fishermen, prawns were renowned to be better in the south.

Another theme was the feeling among fishermen that “Experience of dealing with wind farms has been frustrating, there is little interest in developing co-location opportunities”, and that “Wind developers have little interest or consideration for fishing interests”. Related to this feeling was the claim from fishermen that “communication between the developers and the fishing industry is

generally poor". This leads to the broader issue of longer term co-existence. One fisheries officer thought the remnants of decommissioned OWFs (e.g. turbine foundations and cable rock armouring) that would restrict fishing would have the greatest impact on the fishing industry in the longer term, whilst another officer stated the increased steaming distance to fishing grounds beyond the OWFs had the greatest negative impact.

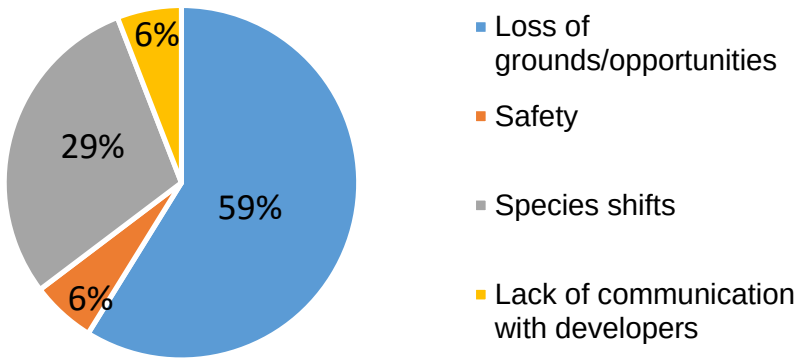
As part of the questionnaire, fishermen were asked whether, and if so how, wind farm operators had hindered fishing. In response, all of the Northern Ireland fishermen did not think or were not sure whether the wind farm developers had hindered the continuation of fishing (Table 14) (Refer to Question 4.8, Annex C p62). Only 13% of fishermen from the North West of England thought that was the case and claimed that inadequate compensation and excessive restrictions on fishing during and after construction were the main types of hindrance. The control fishermen thought survey work and poor communication hindered the continuation of fishing.

Table 14. How wind farm developers have hindered the continuation of fishing

Type of hindrance	Response from fishermen (%)		
	All	NW England	N. Ireland
Vessel insurance is invalidated	1 (4%)	1 (4%)	0
In-adequate compensation	4 (17%)	4 (17%)	0
Restrictions on fishing inside & outside wind farms during and after construction including surveying work and rock armouring of cables	5 (21%)	4 (17%)	0
Lack of communication	2 (8%)	1 (4%)	0
Impact on commercial species fish	1 (4%)	1 (4%)	0
Don't know	3 (13%)	0	2 (25%)
No	9 (38%)	3 (13%)	6 (75%)

All the Northern Ireland and control fishermen and half of the fisheries officers said the loss of fishing ground was the main negative effect of wind farms on the fishing industry, with 59% of fishermen from the North West of England in agreement (Figure 9) (Refer to Question 4.5, Annex C p59). The majority of the remaining fishermen thought that the impact on commercial species was the main negative effect of wind farms.

Figure 9. Fishermen's views of the negative impacts of offshore wind farms



4.2 Potential for co-existence

A limited amount of trawling was reported to have taken place inside some of the OWFs in areas free of interconnecting (array) cables. The build-up of knowledge and experience could attract more fishermen, as noted by one Northern Irish fishermen: 'More information about potential seabed hazards within offshore wind farms may improve confidence to fish inside the farms. Over time, experience of those operating close to the wind farms and within may instil others to follow suit'. The reporting of seabed hazards with spatial precision and regular communication was mentioned by many fishermen as a prerequisite before they would consider returning to the wind farm areas.

Fishermen recommended a greater use of concrete mattresses, such as the type shown in Figure 10 rather than rock armouring to protect cables. Another fisherman said that "More accurate seabed maps of cables, cable crossing points, rock armouring, seabed debris etc may encourage fishing closer to the turbines and within the wind farm".

Figure 10 Demonstration of a concrete mattress being deployed over a pipe section (Source: BERR 2008)

Measures respondents raised that could help to increase the level of co-existence between the fishing and offshore wind farm industries included:

- Improved mapping of potential seabed hazards;
- Timely provision of seabed maps showing precise location of potential hazards;
- Proactive identification of clean and cable-free corridors between the turbines that could be suitable for mobile gear;
- More effective cable burial beneath the seabed;
- Fishing friendly methods of cable protection, such as the use of concrete mattresses as an alternative to rock dumping;
- Where rock dumping is required, more accurate deposition of rocks over the cables;
- Clearing debris left on the seabed following the construction of wind turbines;
- Better communication and working relationships between fishermen and wind farm service vessel operators;
- More regular monitoring and reporting of cable exposure; and
- The removal of all seabed structures, material and debris following the decommissioning of wind farms.

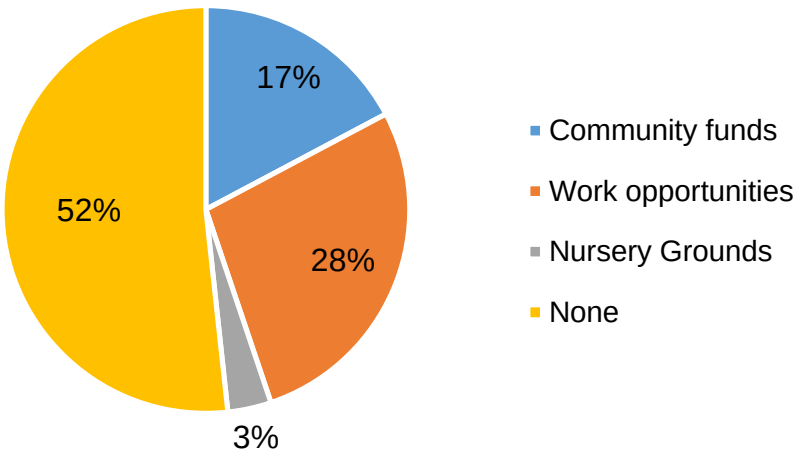
In terms of wind farm developers helping fishermen to continue fishing, the majority of Northern Irish fishermen and all 3 control fishermen thought the developers did not offer any assistance; 15% of all fishermen stated that good communication with the developers helped; and 15% of fishermen from North West England cited work opportunities and the West of Morecambe Bay Fisheries Fund's (WofMFF) assistance (Table 15) (Refer to Question 4.7, Annex C p61).

Table 15. How wind farm developers have helped the continuation of fishing

Type of assistance	Response from fishermen (%)		
	All	NW England	N. Ireland
Work opportunities	4 (15%)	3 (21%)	0
Established a fisheries fund	2 (7%)	3 (21%)	0
Good communication	4 (15%)	2 (14%)	1 (11%)
Don't know	2 (7%)	0	2 (22%)
None	15 (56%)	6 (43%)	6 (67%)

Although just over half of all fishermen, 2 of the 3 control fishermen and one fisheries officer believed there were no positive impacts of OWFs on the fishing industry, 33% of Northern Ireland fishermen, 1 control fisherman and two fisheries officers identified work opportunities as the main benefit, which was unsurprising given the wind farm guard ship duty awarded to the Northern Ireland fleet over that last few years (Figure 11) (Refer to Question 4.6, Annex C p60).

Figure 11. Fishermen's views of the positive impacts of offshore wind farms



Fishermen from North West of England stated that community funds were the main benefit as did one fisheries officer. The WofMFF was identified as a significant help by many fishermen.

5. DISCUSSION

The project set out to answer the following questions:

i. Has there been a change in fishing activity within wind farms and export cable routes?
ii. If so, what were the reasons for the change and how can the change be addressed?

Has there been a change in fishing activity within wind farms and along export cable routes?

Since 2000, the continual decline in landings of demersal finfish (cod, Dover sole, plaice, skate and rays) from the Eastern Irish Sea largely correlated with the decline in their respective TACs, except for plaice landings that fell at a far greater rate than its Irish Sea TAC (which was probably due to the relatively greater reduction in cod and Dover sole TACs which would have lowered the overall effort in the predominant mixed demersal trawl fishery). The decline in landings also corresponded with the considerable decline in otter trawling (≥100mm mesh size, TR1) and beam trawling (≥80-119mm mesh size, BT2) between 2003 and 2007; since 2007 effort in both *metiers* have declined at a slower rate (STECF, 2014).

Conversely, landings of Eastern Irish Sea *Nephrops* have remained fairly stable since 2000, which correlated with the ICES Subarea VII TAC and fishing effort (≥70-99mm mesh size, TR2) which remained stable between 2003 and 2008, followed by a reduction in 2009 with the introduction of the current cod recovery plan (STECF, 2014).

In most cases, the low resolution of official data restricted the ability to associate a reduction in fishing effort with any particular OWF. However, higher resolution VMS data showed a reduction in the spatial extent of UK vessels (thought to be principally Irish trawlers targeting *Nephrops)* between 2007 and 2013 following the construction of Walney 2 OWF, with a limited amount of activity recorded in 2013. Alternative *Nephrops* grounds could have helped those fishermen who were displaced to maintain their landings, although it was not known how much more effort, if any, was required to do so.

Fishermen reported a reduction in fishing effort in all OWFs following construction and along some export cable routes, where, for example, rock armouring had prevented the continued use of otter trawls. One fisherman claimed he had been informed by a wind farm worker that he was not allowed to use anchors and grapples for static gear inside Burbo Bank wind farm. The local MMO officers also reported a reduction in fishing effort post-construction in the OWFs they were familiar with, namely Robin Rigg, Walney 1 & 2 and Burbo Bank.

The majority of fishermen from North West England, fishery officers and the wind farm companies thought a reduction in fishing activity in the Eastern Irish Sea could be attributed to falling TACs, fisheries management (Irish Sea Cod Recovery Plan), and the rising cost of fuel. However, these were not seen as limiting factors by the Northern Irish fishermen nor by the three control fishermen, although one thought the cost of fuel had restricted activity.

More fishermen from North West England than from N. Ireland claimed that OWF maintenance work had affected their fishing, especially where export and array cables had been fortified with rock armour. This contrast was not surprising given that many local fishermen operated small trawlers landward of the OWFs, whereas the Northern Irish fleet were restricted from operating within 6nm of the coast.

What were the reasons for the change and how can they be addressed?

The consultees' reasons for the limited levels of fishing co-existing in the vicinity of the wind farm operations can be categorised under five headings; the first three applied to the post-construction period whilst the latter two were relevant to the pre-construction stage:

- Prevention of fishing
- Disruption to fishing
- Environmental Impact
- Inadequate protection of fishing grounds
- Inadequate compensation

Post-construction

Pre-construction

Most of the actions listed below that might help to address the issues could be initiated by FLOWW working with the wind farm developers and the fishing industry. It may be appropriate in some instances to amend licence conditions or develop procedures that address the issues identified when dispensing with licence condition requirements.

PREVENTION OF FISHING

Issues: The most common issue raised by fishermen, which was acknowledged by local fisheries officers was the risk associated with turbines stanchions, exposed cables, rock armouring, cable crossing points and waste material (debris) to fishing. These risks were cited as the major deterrent to fishing inside OWFs.

Referring to the period following decommissioning, fishermen and a fisheries officer expressed concern over the remnants of wind farm infrastructure and materials and the potential impact it could have on future fishing opportunities. Concern was also raised about the potential effect of removing OWF infrastructure.

Possible action: *(and initiators)* The potential risks to fishing inside OWFs could be reduced by involving the industry in the development of cable plans, the provision of comprehensive, up-to-date and readily available maps of potential seabed hazards to fishing; use of fishing-friendly cable armouring structures; more effective cable burial techniques, particularly where the nature of the seabed can significantly change; durable cable armouring; removal of waste material; post-installation surveys to verify that fishing actives can safely resume and communication of findings to the fishing industry, and regular monitoring for cable exposure and other unmapped seabed hazards and communication to the Kingfisher Information Service *(wind farm developers & FLOWW).*

Agreement on what and how OWF infrastructures and materials are removed following the decommissioning of OWFs needs to be communicated to the fishing industry *(wind farm regulators and developers).*

DISRUPTION TO FISHING

Issues: Wind farm maintenance work was cited as causing disruption to fishing operations within and around wind farms. Conflict with OWF maintenance vessels, excessive area closures for maintenance work, and poor communication between fishermen and maintenance vessel operators was reported by fishermen. Fishermen complained about the increased steaming distance and time to fishing grounds beyond the OWFs.

Possible action: *(and initiators)* Appointing a fisheries liaison officer is a typical licence condition requirement. Improved communication between fishermen, wind farm developers and their maintenance companies could be supported through an upfront mutual agreement of operational protocols. This could lead to a greater understanding and accommodation of each other's needs and help to minimise disruption, loss of fishing gear and delays in maintenance work. Wind farm developers could work with fishermen to identify safe routes through OWFs *(wind farm developers, fishermen's representatives & FLOWW).*

ENVIRONMENTAL IMPACT

Issues: Based on their experience and the results of wind farm monitoring, fishermen and fisheries officers raised concerns over the potential adverse environmental effect of OWFs. Fishermen reported reduced quantity and quality of *Nephrops* and lower quantities of commercial demersal fish when approaching and within OWFs. Some North West of England fishermen were concerned over the apparent use of limestone to protect cables and attributed the local mortality of marine life to the use of this rock.

Possible action: *(and initiators)* The developers monitor the physical and ecological condition of their OWF sites as part of their licence condition requirements. Periodic research into the status of commercial species within OWF sites is also known to take place. MMO (2014a) recommended that generic fishing monitoring conditions be removed and replaced with targeted monitoring associated with identified significant impacts or uncertainties identified in the EIA. Where this is the case the communication of findings and the design and involvement of fishermen in monitoring of commercial finfish and shellfish could improve understanding of how OWFs could affect a particular species. Before after surveys of *Nephrops* stocks at wind farm sites may also yield evidence on potential impacts on stocks and post impact recovery. Clarification on the use and implications of using limestone for rock armouring cables should be sought *(wind farm regulators, developers and fishermen).*

INADEQUATE PROTECTION OF FISHING GROUNDS

Issues: *(and initiators)* Fishermen expressed concern over the cumulative spatial encroachment of OWFs and marine conservation requirements on fishing grounds, compounded by restrictions imposed by EU, national and regional fisheries management. Fishermen and fisheries officers thought the financial and economic value of fisheries was probably underestimated, partly due to the difficulty of obtaining data on vessels under 10m, especially those targeting

non-pressure stock species. This could limit the evidence base available to help underpin any compensation agreements.

Possible Action: Due consideration of the importance of fishing grounds should be addressed when preparing marine plans and in the early planning phases for OWFs, during strategic planning (for example the zonal process for the Irish Sea) and at the early planning stage of individual wind farms.

Improving the spatial evidence base for fisheries, including interpreting importance and developing associated spatial fisheries marine plan policies for English plan areas would help to identify and consider the importance of fishing areas at an early stage. This may build upon preliminary work undertaken by the MMO (MMO, 2014b). Beyond project siting decision-making, further monitoring and assessment of fisheries operating within the vicinity of wind farms will strengthen understanding of the levels of co-existence that may be achieved.

The onus is on the fishing industry to supply appropriate evidence on the financial, economic and social consequences of OWF at the individual wind farm level, particularly in the context of agreeing any suitable compensation arrangements. *(MMO, wind farm developers and fishermen).*

INEQUITABLE COMPENSATION

Issues: Many fishermen claimed compensation arrangements were inequitable, alleging that some fishermen eligible for compensation did not receive any, while others received too little, as fisheries were undervalued and compensation was not based on vessel size and allocated fishing time (days at sea). It was not possible to confirm these allegations as compensation details were not requested or provided.

Possible action: *(and initiators)* Compensation should be arranged before construction, once the value of fishing grounds and the identification of those fishermen affected was established, although unforeseen environmental effects could influence future compensation arrangements. FLOWW has developed guidelines on disruption settlements and community funds that could help prevent eligible fishermen not receiving compensation and others receiving too little *(wind farm developers, fishermen and FLOWW).*

Increasing profitability, by for example, reducing fuel costs, improving the quality of the catch to reduce waste and generating a higher first sale value could be achieved through better portside infrastructure and services such as fuel depots and ice machines, which have been assisted by WofMFF in some of the Cumbrian ports *(wind farm developers, fishermen and FLOWW).*

A 2006 study on the potential impact that Round 2 wind farms could have on fishing and fishermen in three areas (The Greater Wash, Thames estuary and North West England) reported very similar concerns to those raised in this study, including displacement effect of wind farms; damage to gear from construction debris on the seabed; distrust of the wind farm approval process; insufficient formal information; environmental habitat effect; and alteration of fish behaviour (Cefas, 2006).

Safety was such a concern in the Cefas study that fishermen said they would avoid OWFs even if they were permitted to fish inside them.

The claim by the majority of fishermen in the present study that replacement fishing grounds did not maintain their income; that, displacement had increased conflict outside the OWFs; and that OWFs had had a negative impact on income was predicted by fishermen in the 2006 Cefas study who thought the overall impact of OWFs would be 'strongly negative' with few opportunities other than the possibility of using static gear. There was no evidence in this study to suggest an increase in the use of static gear within OWFs, which may be due to the limited range of the local static gear fleet as reported by the North West IFCA.

Many of the suggestions to improve co-existence were also made in a COWRIE (Collaborative Offshore Wind Research into the Environment) commissioned report (Blythe-Skyrme, 2010) into the options and opportunities for mitigation which aimed to identify ways to keep fishermen fishing. The report recommended how impacts on fishing could be minimised through careful planning of wind turbine and cable routes to allow fishing to take place along cable-free corridors, as well as initiatives to increase profitability when faced with a loss of fishing opportunities, such as stock enhancement, improvement of port side facilities, and assistance with vessel maintenance and equipment.

In addition to sharing ground (cohabitation), co-existence could include two activities taking place in the same area, but not occupying the exact same space. Fishing will undoubtedly be restricted by OWFs, not only preventing trawling taking place in close proximity to the turbines, but also prohibiting the use of relatively light trawl gear and beam trawls close to rock armouring. Provision for the loss of fishing opportunities, particularly for vessels with limited or no ability to fish elsewhere could help local fisheries remain profitable and in addition to the fishermen's livelihoods, safeguard shore side and supply chain businesses. The WofMFF, which administers funds from the offshore wind sector to finance community projects of direct benefit to the fishing industry, such as the installation of ice plants at Maryport and Barrow-in-Furness and a self-managed fuel facility at Whitehaven in 2014, is an excellent example of how this could be achieved (a description of WofMFF can be found in Annex I).

Assigning guardship duty and contracting fishing vessels with local experience to undertake seabed survey and ecological monitoring work within OWFs would also help to offset loss of fishing, maintain employment and utilise local maritime skills and knowledge. In collaboration with Natural England, the NFFO has helped organise the deployment of fishermen to collect seabed video footage to confirm seabed habitats and inform marine protected area boundaries (Woolmer, 2013). This cost effective and efficient method of obtaining marine data had improved relations between fishermen and scientists, and led to a greater level of information flow and understanding of the needs of Natural England and the fishermen.

Recommendations and next steps to improving co-existence

There is a commitment to enable the co-existence of compatible activities in the UK Marine Policy Statement (MPS), a key principle of which is to reduce conflict between marine sectors (UK Government, 2011).

FLOWW's 'Best Practice Guidelines for Offshore Renewables Developments: Recommendation for Fisheries Liaison' 2014 report supports the group's intention to encourage co-existence between the two industries by: identifying mitigation measures at the earliest opportunity (planning process);

establishing clear lines of communication with the industry (e.g. through the appointment of company liaison officers, fishing industry representatives and the production of a fisheries liaison plan); planning for mitigation and co-existence during the wind farm planning cycle; and compensating for disruption and displacement.

The initiatives to improve the co-existence of fishing and offshore wind energy generation were suggested by fishermen and fisheries officers during the consultation phase and supplemented by the authors' own analysis. Further consideration could be given to them, perhaps through a workshop facilitated by FLOWW.

6. CONCLUSION

- Since 2000, there has been a large reduction in fishing effort and landings of demersal finfish throughout the Eastern Irish Sea, which is probably a result of reduced TACs and not the installation of OWFs.
- Although landings of *Nephrops* from the Eastern Irish Sea remained fairly stable during the period before and after OWF construction, VMS data clearly showed a decline in *Nephrops* trawling in Walney 2. Confidence in the evidence that suggested a decline in fishing activity in the other wind farms was low to medium.
- The stability of landings would suggest effort was displaced to alternative *Nephrops* grounds, although it was not known how much more effort, if any, was required to maintain landings.
- For those fishermen who claimed to have operated on fishing grounds now occupied by wind turbines, the majority stated they had not returned or had reduced their fishing effort within the OWFs two or more years after construction.
- Although there was evidence of a small number of fishermen operating inside OWFs, the key reason why fishermen had not returned was heightened risk, perceived and actual, rather than changes to the ecosystem.
- Concerns were raised over the potential impact of the operation of turbines on commercial species, such as vibration, visual turbine blade flashing, electromagnetic emission from cables and chemical pollution from the material used for cable armouring (limestone). Recent reviews of wind farm ecological monitoring data were inconclusive.
- The fishermen's responses to the questionnaires indicated that the main obstacles that limited the co-existence of fishing and offshore wind energy generation in the Eastern Irish Sea were:
    - The risks associated with turbines, cables, cable armouring and seabed construction debris to fishing inside OWFs;
    - Excessive disruption to fishing, loss of fishing gear and increasing steaming distances to fishing grounds caused by wind farm maintenance work;
    - A poor relationship and inadequate communication between fishermen and wind farm developers and their maintenance service companies; and
    - The cumulative spatial encroachment of wind farms and MPAs on traditional fishing grounds.
- Most of the suggestions on how fishers and wind farm developers could better engage to improve their working relationship would probably be applicable to other UK OWF sites. The recommendations centred on communication, information and knowledge exchange, a better understanding of each other’s needs and the utilisation of fishermen in wind farm work.
- The co-existence of two or more activities does not necessarily mean that they have to occupy the same space. Some of the recommendations could compensate for the loss of fishing opportunities by maintaining the viability and profitability of fishing businesses. The WofMFF was a good example of how this could occur.

- Greater co-existence could be achieved by: collaborative planning for cables, the communication of up-to-date seabed data to reveal potential hazards to fishing, safe fishing corridors and transit routes; the removal of waste construction material from the seabed; more effective cable burial and fishing-friendly cable armouring; post installation seabed surveys and communication of results; monitoring for cable exposure; the agreement of operational protocols for work activities, utilisation of fishermen for guardship duty, seabed surveys and ecological monitoring; applying mutually agreed approaches to determining any disruption settlements; and measures aimed at offsetting any potential losses by enhancing the profitability of fishing through, for example, improvements to portside facilities.
- A workshop, perhaps facilitated by FLOWW, could consider the suggestions made in this and past studies on how to improve the co-existence of fishing and the offshore wind energy sector.

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ACRONYMS

Term	Description
AFBI	Agri-Food and Biosciences Institute
AGDS	Acoustic Ground Discrimination System
ANIFPO	Anglo North Irish Fish Producers' Organisation
CE	Crown Estate
Cefas	Centre for Environment, Fisheries and Aquaculture Science
COWRIE	Collaborative Offshore Wind Research into the Environment
DARD	Department of Agriculture and Rural Development Northern Ireland
DEFRA	Department for Environment, Food and Rural Affairs
FEPA	Food and Environment Protection Act
FLOWW	The Fishing Liaison with Offshore Wind and Wet Renewables Group
FLO	Fisheries Liaison Officer
FPV	Fisheries Protection Vessels
GIS	Geographic Information Systems
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authority
iFISH	MMO database of reported activity, including all logbook entries for UK registered fishing vessels
IPCC	Intergovernmental Panel on Climate Change
ILVO	Institute for Agricultural and Fisheries Research, Belgium
MaRS	Marine Resource System – Decision support system based on GIS
MMO	Marine Management Organisation
MPS	Marine Policy Statement
NIFPO	Northern Irish Fishermen's Producers Organisation
NFFO	National Federation of Fishermen's Organisations
NWIFCA	North Western Inshore Fisheries and Conservation Authority
OWF	Offshore Wind Farm
POs	Producer Organisations
TAC	Total Allowable Catch
UKFEN	UK Fisheries Economics Network
VMS	Vessel Monitoring System - Satellite tracking system used to monitor the location and movement of fishing vessels
WofMFF	West of Morecambe Fisheries Fund

ANNEXES

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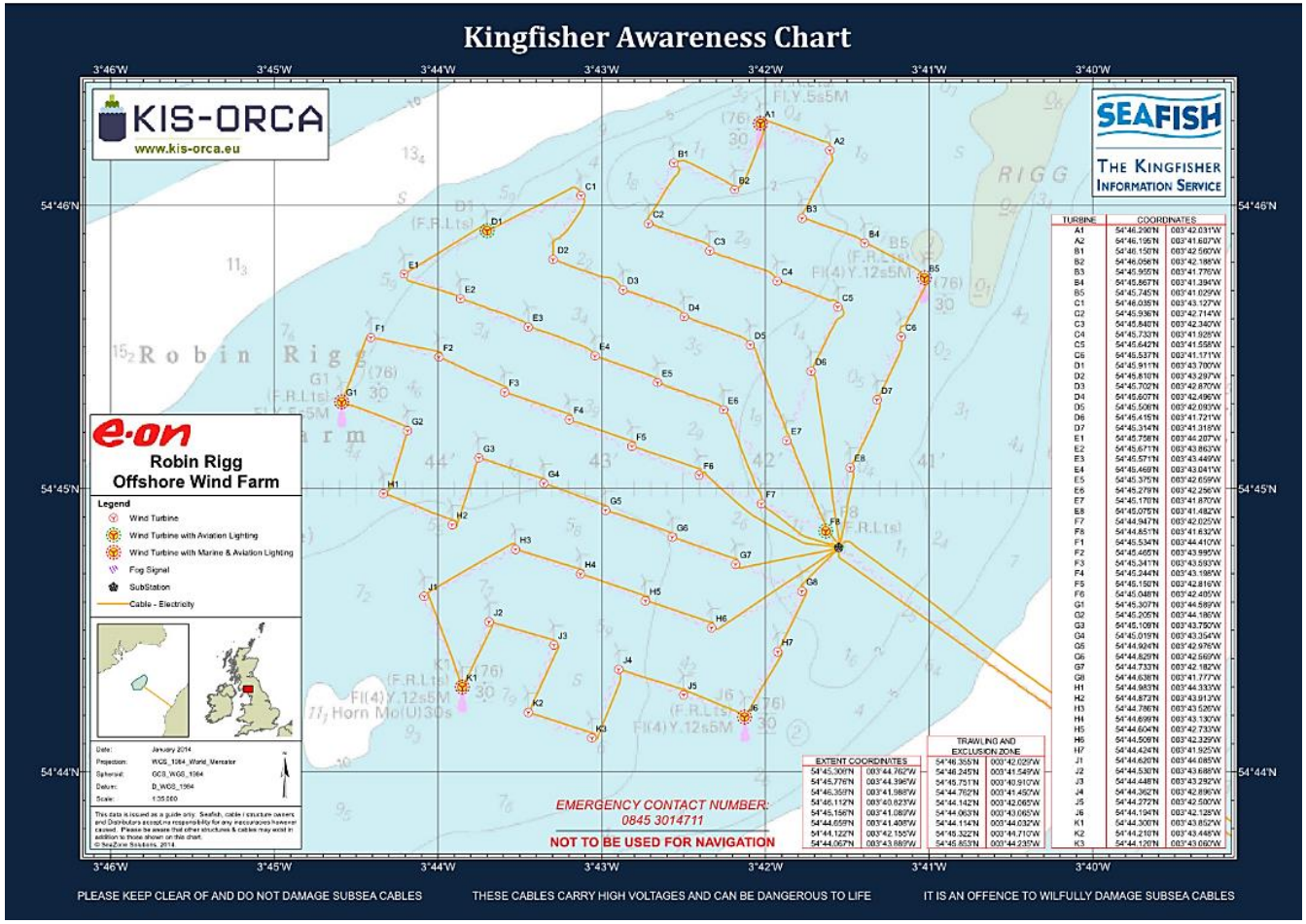
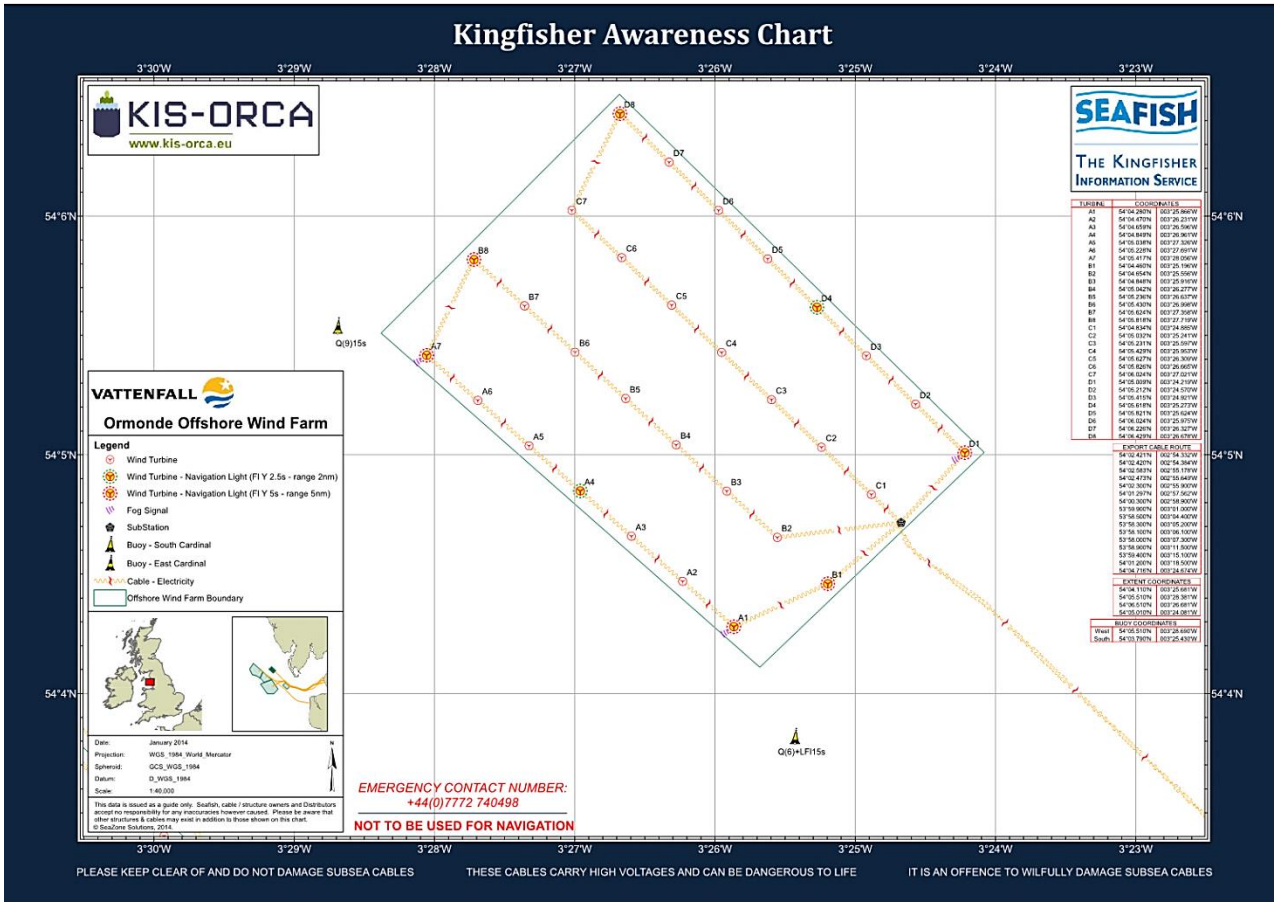
ANNEX A CONFIGURATION OF TURBINES AND CABLES FOR THE SIX OFFSHORE WIND FARMS

Figure A.1
The configuration of Robin Rigg offshore wind farm in the Solway Firth



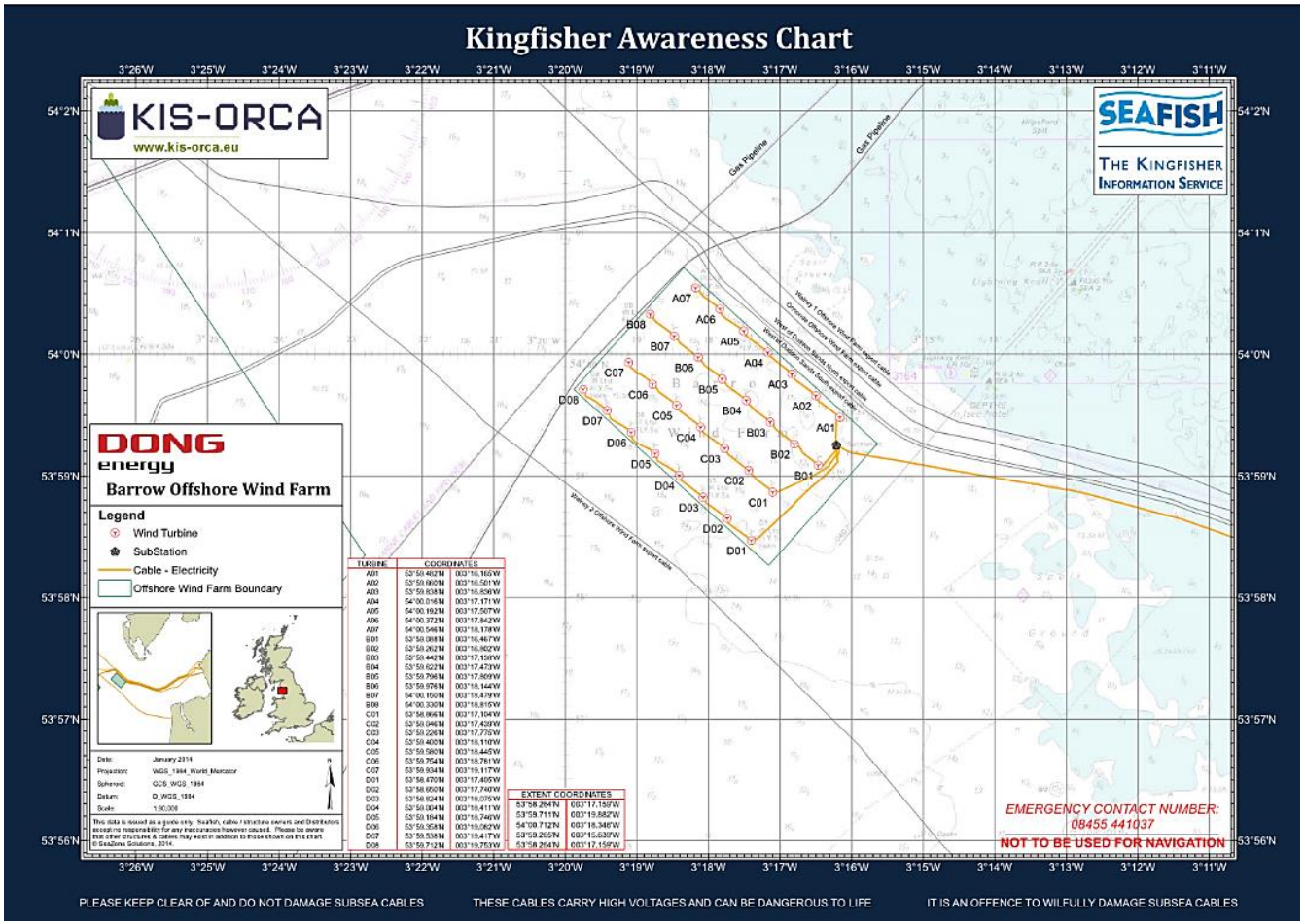
Wind Farm	Owner	Location	Coverage	Construction	First power generated	Date of full commission	Turbines
Robin Rigg	E-ON	Solway Firth, 11 km from shore	18 km²	September 2007	September 2009	September 2010	60

Figure A.2
The configuration of Ormonde offshore wind farm off the Cumbrian coast



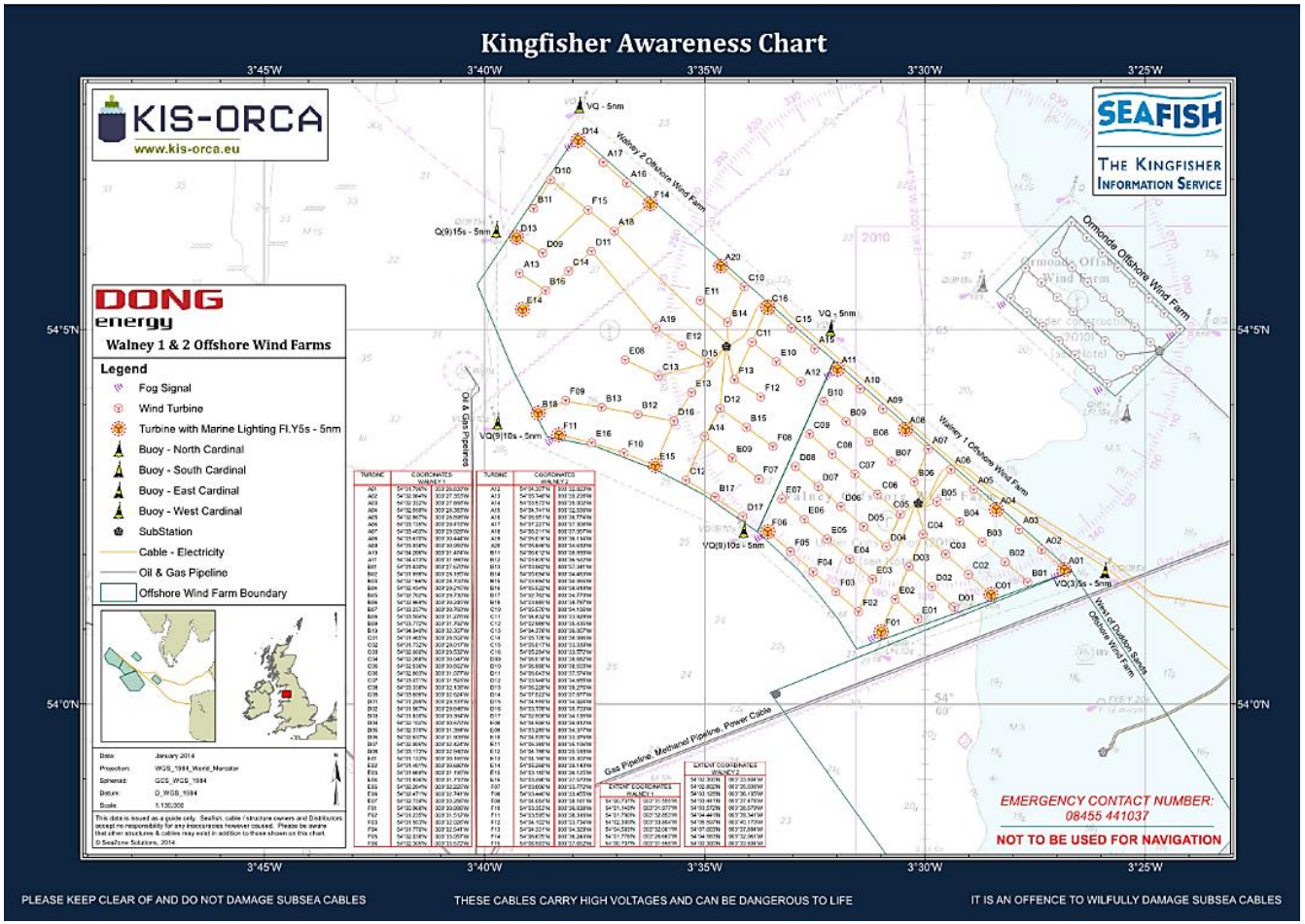
Wind Farm	Owner	Location	Coverage	Construction	First power generated	Date of full commission	Turbines
Ormonde	Vattenfall	9.5 km off Barrow-in-Furness	10 km²	May 2010	August 2011	February 2012	30

Figure A.3
The configuration of Barrow offshore wind farm off the Cumbrian coast



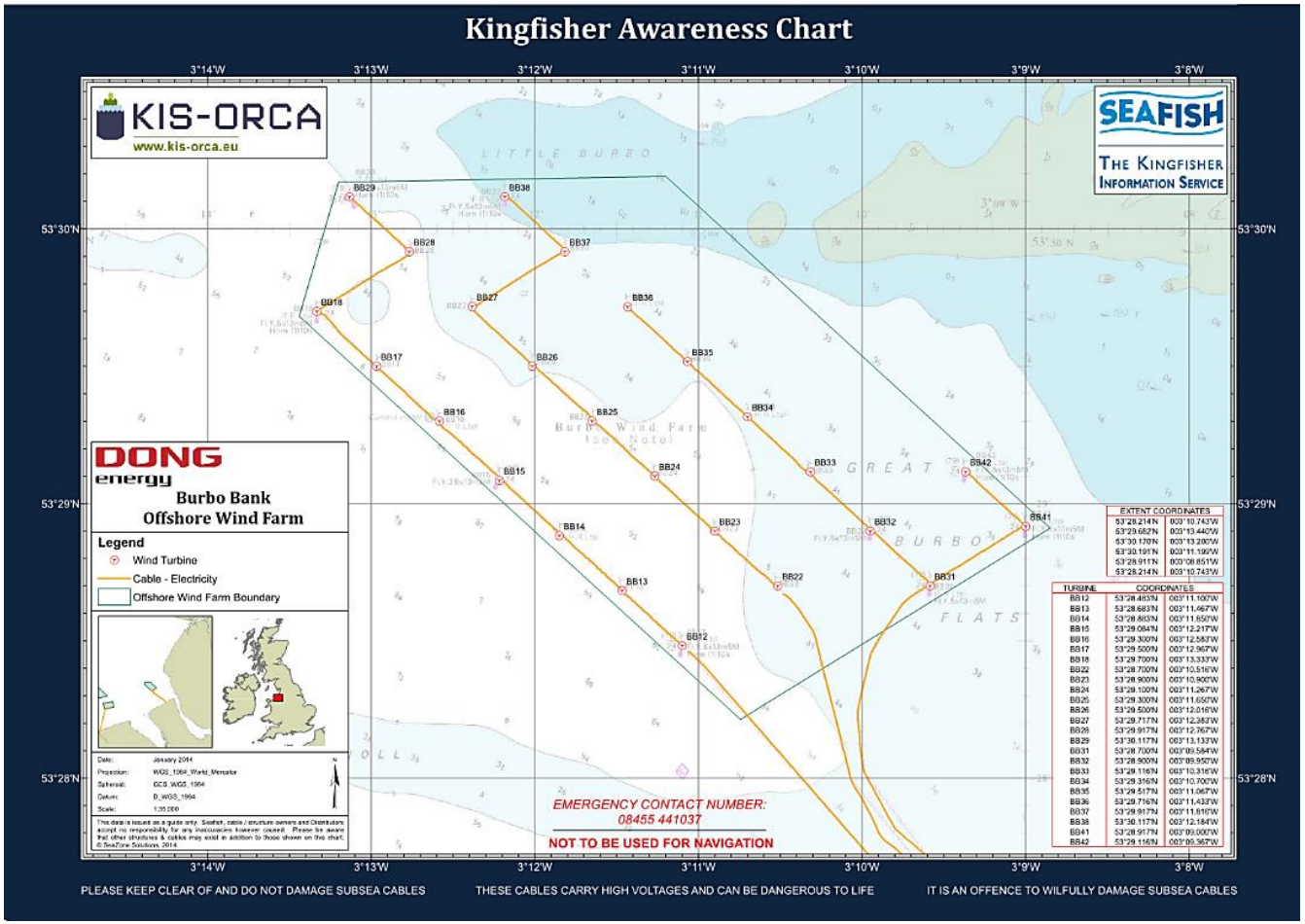
Wind Farm	Owner	Location	Coverage	Construction	First power generated	Date of full commission	Turbines
Barrow	DONG & Centrica	7.5 km SW off Walney Island	10 km²	May 2005	March 2006	September 2006	30

Figure A.4
The configuration of Walney Phase 1 and Phase 2 offshore wind farms off the Cumbrian coast



Wind Farm	Owner	Location	Coverage	Construction	First power generated	Date of full commission	Turbines
Walney 1 & 2	DONG & SPR	14 km off Walney Island	73 km²	March 2010	January 2011	June 2012	102

Figure A.5
The configuration of Burbo Bank offshore wind farms in Liverpool Bay



Wind Farm	Owner	Location	Coverage	Construction	First power generated	Date of full commission	Turbines
Burbo Bank	DONG	Liverpool Bay, 6.4 km from the coast	10 km²	June 2006	July 2007	October 2007	25

ANNEX B A SYNOPSIS OF GOVERNMENT FISHERIES DATA

Landings and effort data

Fishing effort and landing statistics are calculated using data collected and processed by fisheries administrations in the UK, namely the MMO, Marine Scotland, Department of Agriculture and Rural Development Northern Ireland (DARD), Welsh Government and Departments in Jersey, Guernsey and Isle of Man, and held centrally (MMO iFISH database). The method of data collection depends on the length of the fishing vessel.

Over 10m fishing vessels

Data collected on landings and fishing effort by over 10m vessels come primarily from the fishing logbook, but also from landings declarations and sales notes. The fishing logbook records details of the catch, fishing gear and the ICES division and rectangle for the activity. An ICES rectangle is 0.5 degree of latitude by 1 degree of longitude - at UK latitudes they measure approximately 30 x 30 nautical miles. Supply of logbook data is mandatory for all vessels over 10m and must be submitted within 48 hours of landing to UK authorities. Effort statistics for the UK are calculated using trip data from the fishing logbook to determine the time spent at sea with each gear in each ICES sub-division and rectangle.

Under 10m fishing vessels

For vessels under 10m, there is no statutory requirement for fishermen to declare their catches. According to the MMO, past information for this sector was collected with the co-operation of the industry: it comprised log sheets and landing declarations voluntarily supplied by fishermen as well as sales notes and assessments of landings collected from market sources and by correspondents located in the ports (MMO 2014a). This collection of data was replaced after the introduction in September 2005 of a scheme of registration for buyers and sellers of first sale fish. Compulsory sales notes are now used in addition to the voluntary information from fishermen.

Vessel Monitoring System

Under EU legislation, a satellite-based Vessel Monitoring System (VMS) is used to provide data on the location, course and speed of all EU fishing vessels over 12m in length operating in EU waters. It has been gradually introduced since 2000 when it first applied to fishing vessels ≥24m and then extended to vessels ≥18m in 2004, ≥15m in 2005 and ≥12m in 2012. Positional data is provided every 2 hours and the MMO categorises the VMS data according to fishing gear type (including trawl, dredge, gill nets and pots etc). Vessel speed is used to determine whether a vessel is fishing or not. The MMO's data protocol assume a vessel travelling at between 1-6 knots is actively fishing (UKFEN 2012).

VMS can be used to identify the location and important of fishing grounds, in terms of fishing effort. The MMO and Marine Scotland provide VMS data to a resolution of 0.05 degree rectangles (approximately 3 x 1.75 nautical miles or 200th of an ICES rectangle) (UKFEN 2012). Combined with logbook data, VMS can provide spatial landings weight and value.

Surveillance (sightings)

The IFCAs undertake surveillance and enforcement of local and national fisheries regulations out to the six nautical mile limit, while the MMO operates an at-sea surveillance programme using Royal Navy Fisheries Protection Vessels (FPV) and aerial surveillance carried out by Directflight Ltd (MMO, 2014b). Information on the fishing vessel (including vessel type, fishing activity and nationality) is typically collected alongside its position and ICES statistical rectangle.

Vanstaen & Breen (2014) noted that the geographic extent and intensity of surveillance and enforcement varies greatly depending on local fisheries management requirements: for example, areas with fewer fisheries enforcement issues are likely to be visited less often. As there is no continuous monitoring, sightings data is limited to indicating where fishing activity takes place and not quantifying the degree of activity.

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ANNEX C QUESTIONNAIRE RESULTS

Fishermen's Questionnaire Results

Section 2 Record of fishing within Offshore Wind Farms (OWF) which includes export cable areas

Qu. 2.1. Have you fished within any OWF either before or after construction?

	Robin Rigg	Walney 1	Walney 2	Ormonde	Barrow	Burbo Bank
Total number of fishermen	7	22	21	11	12	4
Percentage (%)	22.6	71.0	67.7	35.5	38.7	12.9
English vessels	6	14	13	5	10	3
Percentage (%)	32	74	68	26	53	16
Northern Ireland vessels	1	8	8	6	2	0
Percentage (%)	11	89	89	67	22	0

Qu. 2.2. What type of fishing gear did you use? & Qu. 2.3. What species were you targeting?

Port of Registration	Number of Fishermen	Size Category (m)				Gear Type				Target Species						
		<10	**10-12**	**12-15**	**>15**	**Trawl**	**Nets**	**Pots**	**Dredge**	**Dem**	**Nep**	**Lobs.**	**Bass**	**Ska**	**Sca**	**Mus**
Barrow	7	3	3	-	-	4	1	2	-	4	2	2	2	2	-	-
Belfast	2	-	-	-	2	1	-	-	1	1	1	-	-	-	-	1
Fleetwood	2	-	-	1	1	2	-	-	-	2	1	-	-	1	-	-
Liverpool	1	1	-	-	-	1	1	-	-	1	-	-	-	-	-	-
Maryport	1	-	-	1	-	1	-	-	-	1	-	-	-	1	-	-
Milford Haven	1	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-
Newry	8	-	-	-	8	8	-	-	-	8	8	-	-	-	-	-
Whitehaven	8	3	2	2	-	8	1	1	-	3	6	1	1	1	-	-
No longer registered	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1

Dem	Demersal whitefish	**Lobs**	Lobsters	**Ska**	Skate & ray	**Mus**	Mussel seed
Nep	*Nephrops*	**Bass**	Bass	**Sca**	Scallops		

Qu. 2.4. Did you stop or reduce fishing effort within OWF and/or export cable areas during the following times?

	2 or more years before construction	0-1 year before construction	During construction	0-1 year after construction	2 or more years after construction
Total no. of fishermen	1	2	28	23	22
Percentage (%)	4	7	100	82	79
English vessels	1	1	19	14	14
Percentage (%)	5	5	100	74	74
Northern Ireland vessels	1	2	9	9	9
Percentage (%)	11	22	100	100	100

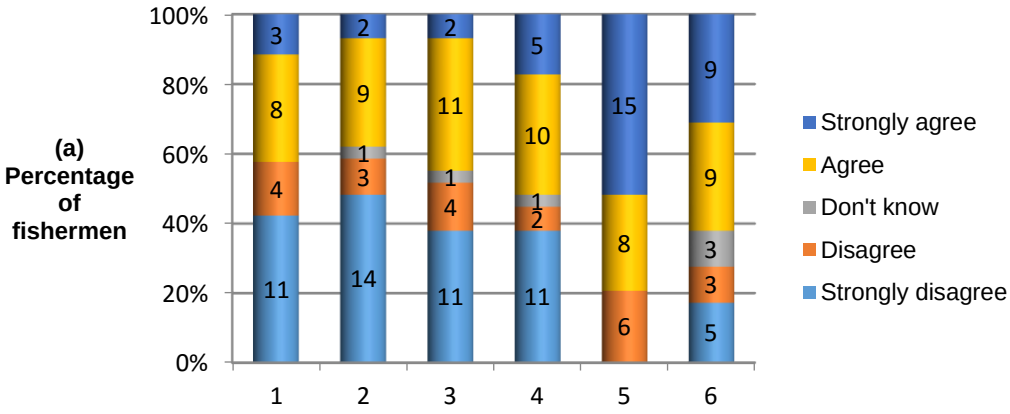
Qu. 2.5. How much did your fishing effort within the OWF change post construction?

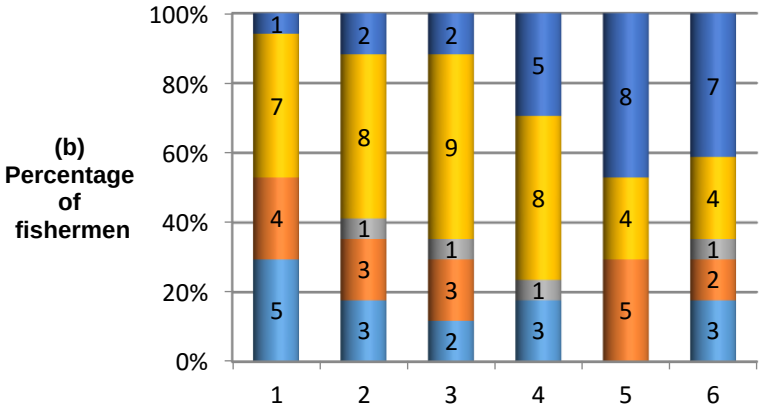
	Considerable decrease	Slight decrease	No change	Slight increase	Considerable increase
Total no. of fishermen	20	5	2	0	0
Percentage (%)	74	19	7	0	0
English vessels	14	3	2	0	0
Percentage (%)	74	16	11	0	0
Northern Ireland vessels	6	2	0	0	0
Percentage (%)	67	22	0	0	0

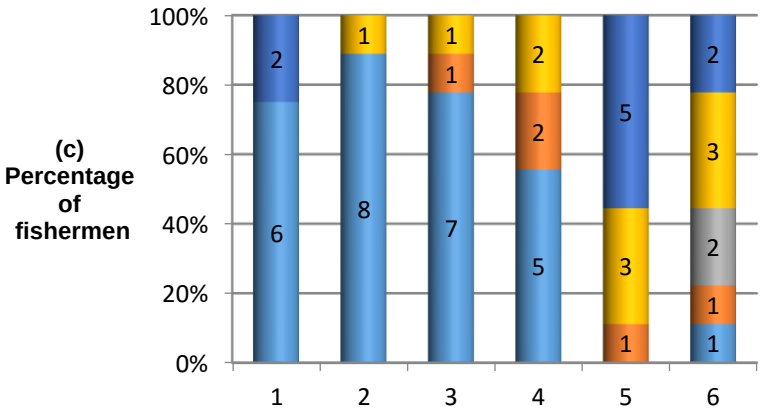
Section 3 Reduction in fishing within OWF and export cable areas

Qu. 3.1 to 3.6 *Total (a), English (b) and Northern Irish fishermen's (c) response to the following statements (number of fishermen shown in the bars)*

1.	I have fished along export cable(s)	4.	The cost of fuel has caused a reduction in effort
2.	Lack of quota has caused a reduction in effort	5.	Risk of potential hazards caused a reduction in effort
3.	Management/legislation has caused a reduction in effort	6.	OWF and export cable maintenance caused a reduction in effort







Qu. 3.7. The impact of the OWF on my fishing opportunities has been greater than the lack of quota and fisheries management

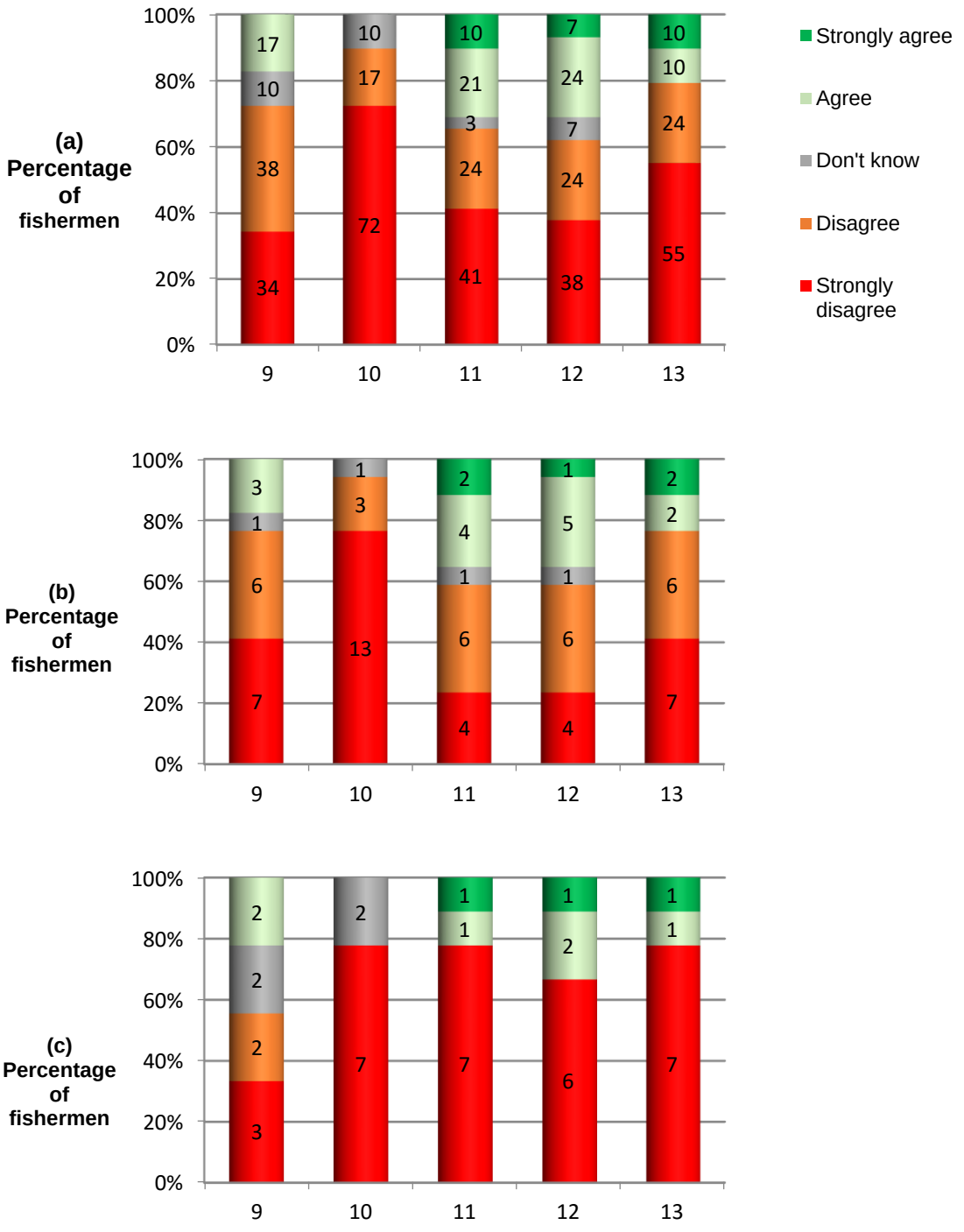
	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Total no. of fishermen	4	6	1	3	15
Percentage (%)	13.8	20.7	3.4	10.3	51.7
English vessels	0	5	0	1	11
Percentage (%)	0	26	0	5	58
Northern Ireland vessels	3	1	1	1	3
Percentage (%)	33	11	11	11	33

Qu. 3.8. How have wind farm developments impacted your income?

	Very negatively	Negatively	Neutral	Positively	Very positively
Total no. of fishermen	9	18	1	1	0
Percentage (%)	31.0	62.1	3.4	3.4	0
	Very negatively	Negatively	Neutral	Positively	Very positively
English vessels	7	9	1	0	0
Percentage (%)	37	47	5	0	0
Northern Ireland vessels	2	6	0	1	0
Percentage (%)	22	67	0	11	0

Qu. 3.9 to 3.13 *Total (a), English (b) and Northern Irish fishermen's (c) response to the following statements (number of fishermen shown in the bars)*

9.	Replacement fishing grounds allowed you to maintain your income	12.	Target species changed as a result of the OWF
10.	Compensation received made up for the loss of income	13.	Number of crew on vessel changed as a result of the OWF
11.	Fishing gear type changed as a result of the OWF		

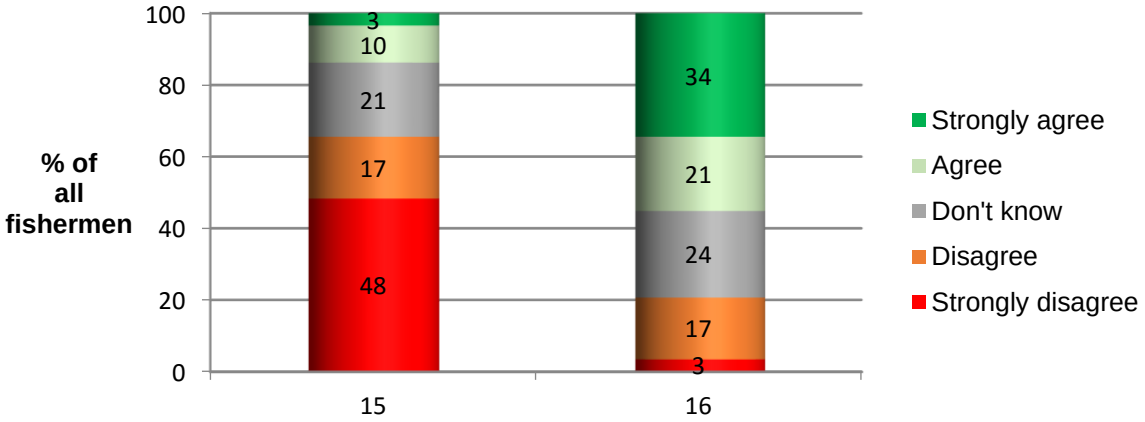


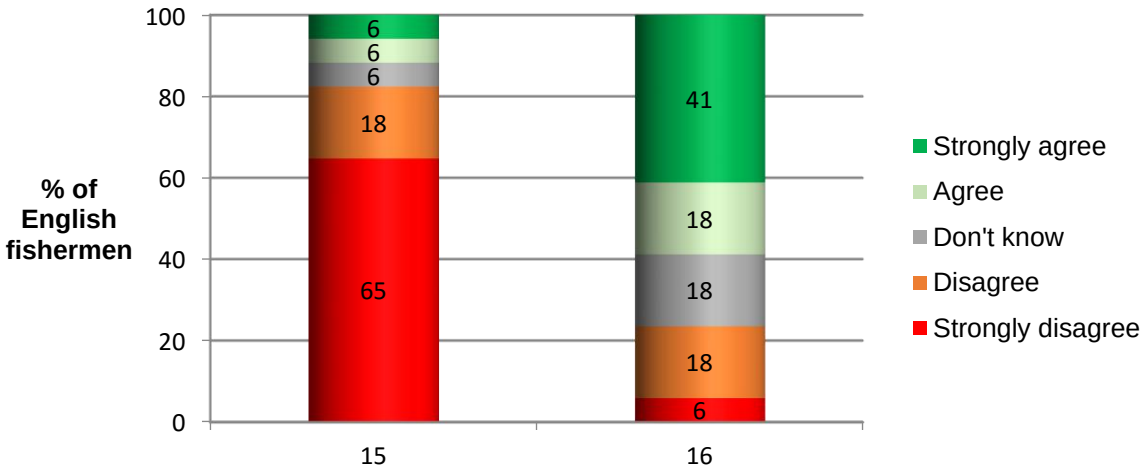
Qu. 3.14. The impact on my fishing activities was stronger in the OWF than the cable route

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Total no. of fishermen	1	0	5	10	14
Percentage (%)	3	0	17	33	47
English vessels	1	0	3	8	5
Percentage (%)	6	0	18	47	29
Northern Ireland vessels	0	0	1	2	7
Percentage (%)	0	0	10	20	70

Qu. 3.15 & 3.16 Total (top) and English (bottom) fishermen's response to the following statements (number of fishermen shown in the bars)

Qu. 15	I believe the OWF has had a positive effect on the fish stock by acting as a nursery ground
Qu. 16	I believe the OWF has reduced the overall commercial fish stock size

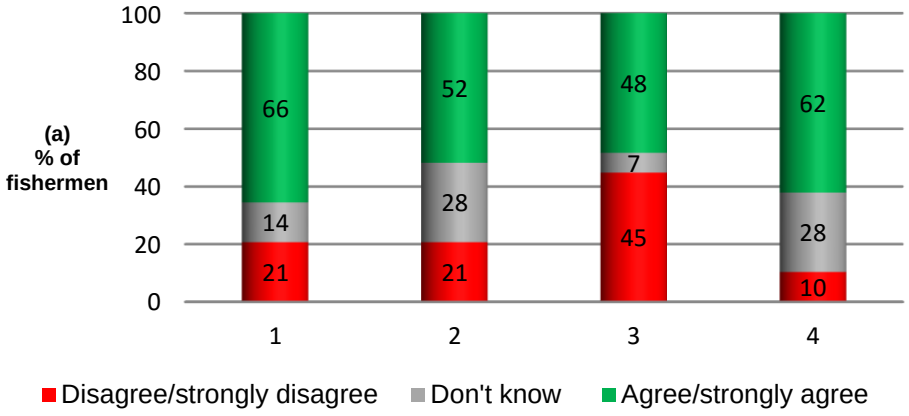


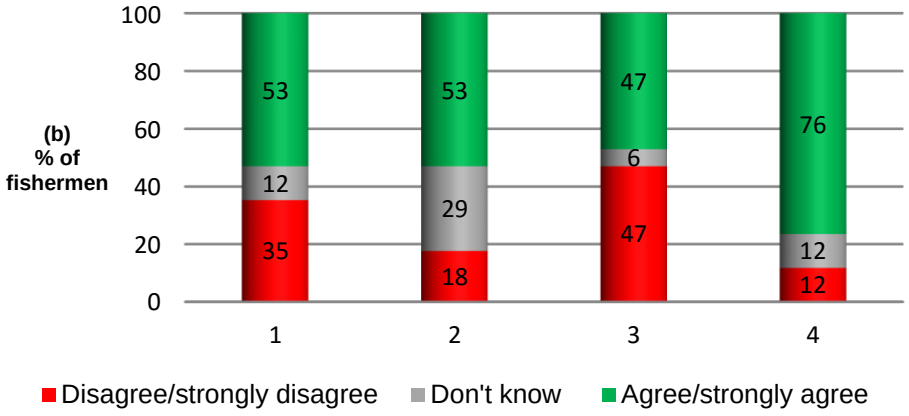


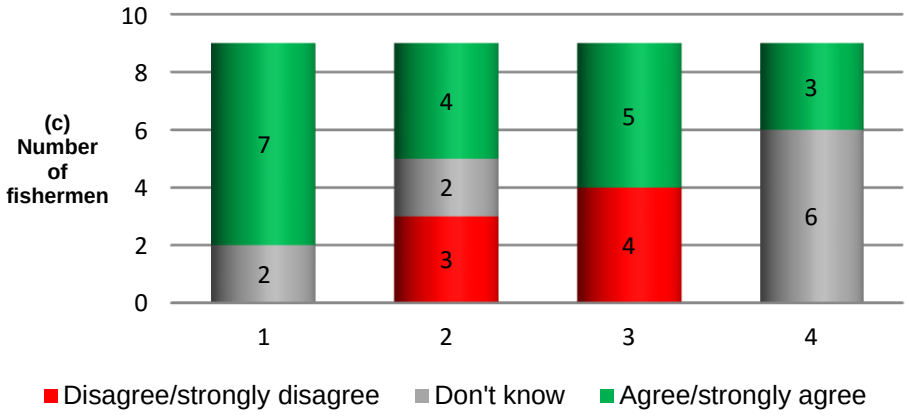
Section 4 Wider Effects of OWF

Qu. 4.1 to 4.4 Total (a), English (b) and Northern Irish fishermen's (c) response to the following statements (number of fishermen shown in the bars)

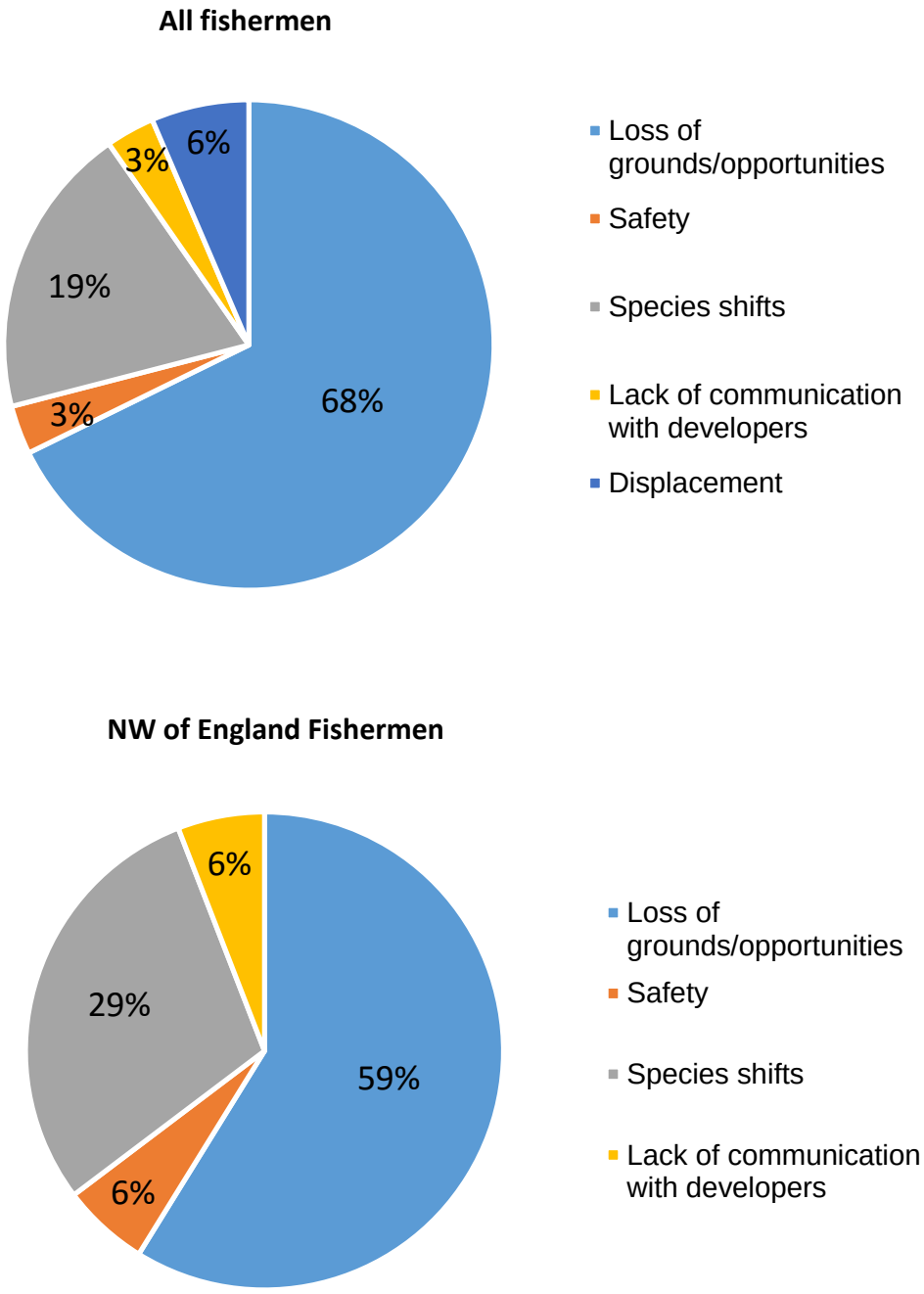
Qu 1	I believe some OWFs have had a greater impact on the fishing industry than others
Qu 2	Displacement away from the OWF has increased conflict outside of the OWF
Qu 3	Fishing opportunities in the Eastern Irish Sea have been in decline before OWFs arrived
Qu 4	OWFs have a larger impact on fishing opportunities than marine protected areas (SACs/MCZs)







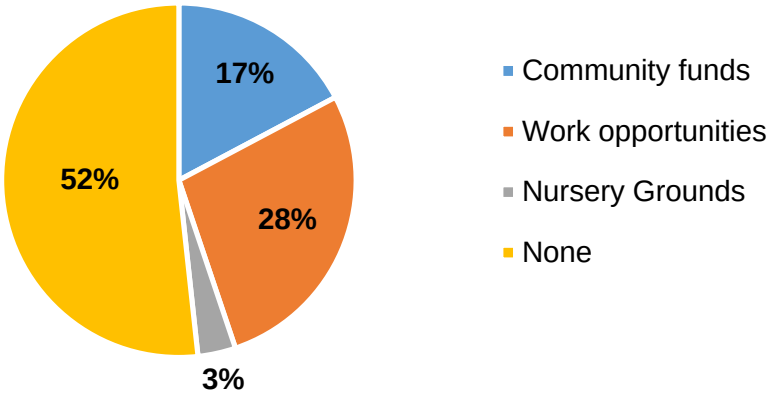
Qu. 4.5. What is the main negative impact of the OWF on the fishing industry?



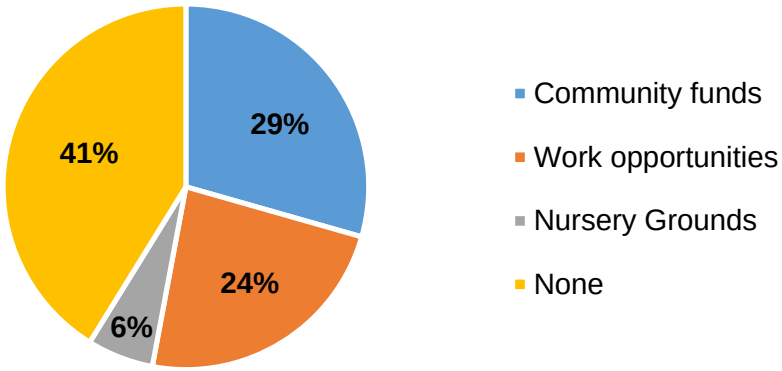
All Northern Irish fishermen stated that the loss of fishing grounds was the main negative effect of offshore wind farms

Qu. 4.6. What has been the main positive impact of the OWF on the fishing industry?

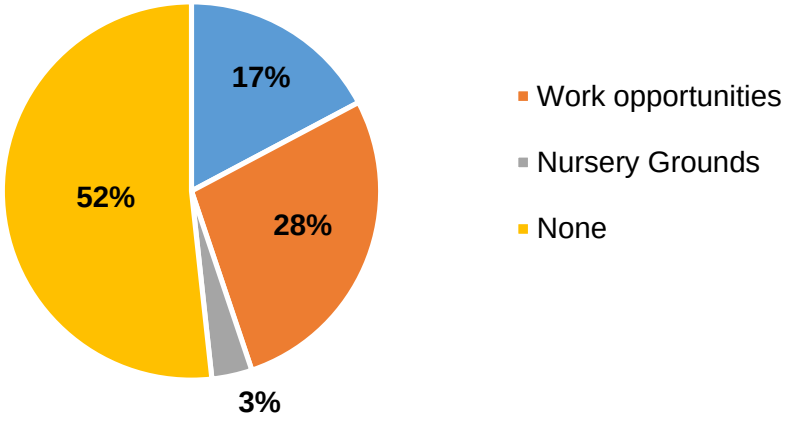
All fishermen



NW of England fishermen



N. Irish fishermen



Qu 4.7. Has the developer helped you to continue fishing in any way? If so how?

All fishermen

Type of assistance	No of responses	%
Work opportunities	4	15
Established a fisheries fund	2	7
Good communication	4	15
Don't know	2	7
None	15	53

English fishermen

Type of assistance	No of responses	%
Work opportunities	3	21
Established a fisheries fund	3	21
Good communication	2	14
Don't know	0	0
None	6	43

N. Ire fishermen

Type of assistance	No of responses	%
Work opportunities	0	0
Established a fisheries fund	0	0
Good communication	1	11
Don't know	2	22
None	6	67

Qu 4.8. Has the developer hindered the continuation of fishing in any way? If so how?

All fishermen

Type of hindrance	No of responses	%
Vessel insurance is invalidated	1	4
In adequate compensation	4	17
Restrictions on fishing inside & outside wind farms during and after construction including surveying work and rock armouring of cables	5	21
Lack of communication	2	8
Impact on commercial species fish	1	4
Don't know	3	13
No	9	38

English fishermen

Type of hindrance	No of responses	%
Vessel insurance is invalidated	1	4
In adequate compensation	4	17
Restrictions on fishing inside & outside wind farms during and after construction including surveying work and rock armouring of cables	4	17
Lack of communication	1	4
Impact on commercial species fish	1	4
Don't know	0	0
No	3	13

N. Irish fishermen

Type of hindrance	No of responses	%
Vessel insurance is invalidated	0	0
In adequate compensation	0	0
Restrictions on fishing inside & outside wind farms during and after construction including surveying work and rock armouring of cables	0	0
Lack of communication	0	0
Impact on commercial species fish	0	0
Don't know	2	25
No	6	75

Additional comments from all fishermen

- Feel as though fishermen are being pushed out by various sectors including IFCAs, OWFs and MMO. Always restricted areas due to maintenance works. Would rather be compensated to avoid areas/stop fishing than forced to decommission on the cheap.
- Safety is key and although there is no exclusion it would be unsafe to fish in OWF areas. Compensation is often the same irrespective of vessel length and days at sea.
- Noise from piling and pingers scares fish. Leave pingers on throughout the duration of construction.
- Not given enough time to move lobster pots. Claimed for 60 pots damaged by vessels that had been working grounds that they were not supposed to.
- Think that there should not be an exclusion zone at Barrow and fishermen should be able to fish there at their own risk.
- Should have some form of compensation. Ongoing conflict between fishing vessels and vessels associated with the OWF
- Safety is a major concern when fishing within OWF. Industry is faced with increasing spatial pressure from not only OWF, but also MCZs.
- Should have an adequate survey method which identifies fishermen that are fishing within the OWF areas before construction. Dumping limestone has brought sea kill to the beach. Need a grid system that will keep cables buried.
- Prawn catches decline when approaching and entering the OWF. Research needs to be carried out to determine whether the OWF have a negative effect on prawns. Fishing within OWF is viewed as unsafe, too risky due to the combination of tides and weather should a vessel breakdown.
- More boats are having to fish in smaller areas. Changes to the migratory patterns of fish, no sole, turbot or brill coming into Whitehaven.
- The risk of snagging cables, losing fishing gear and the risk of collision with turbines in the event of engine failure deters fishing within the OWF. Operate no closer than 1/4 mile from the wind farm. More accurate seabed maps of cables, cable crossing points, rock armouring, seabed debris etc may encourage fishing closer to the turbines and within the wind farm.
- The vessel undertook OWF guard ship duty, employed for 3 months during 2013 for three week periods. There are many potential seabed hazards within wind farms such as concrete, steel and other materials that are thought to have been dumped following construction and maintenance work. This vessel used to fish throughout the Walney site and occasionally the Solway Firth and further south if fishing within the Walney area was poor.
- Safety is the main concern when considering fishing within OWFs, especially the risk of snagging fishing gear on cables and rock armouring. There is a lack of information on some rock armouring but Kingfisher information is deemed to be accurate enough. The spread of gear is around 50 fathom (300ft) which doesn't provide much room to manoeuvre inside a wind farm. Turbine vibration may affect prawns as they are known to be less active during thunder for example.
- The quantity and quality of prawns caught close to the wind farms have declined. The summer prawn fishery would traditionally start in May until August with boats fishing for 2 weeks at a time. Prawns were known to be better in the south. Concern over the

potential effect of vibration caused by the rotating turbines. Avoids fishing the OWF areas for fear of snagging gear on cables and risks associated with a vessel breakdown.

- The skipper fishes within certain parts of the Walney OWFs which are free of obstructions. The skipper does not fish within the OWFs at night. Catches within the OWFs are noticeably lower compared to pre-construction. A DoE report shows a decline in some commercial species within the OWFs.
- Avoids fishing within OWFs due to safety concerns. The vessel is contracted to undertake monitoring in the Walney OWF. It is critical to ensure OWFs are sited away from prime fishing grounds.
- Rock armouring is a significant hazard to prawn nets, worth up to £20k which discourages fishing within OWFs. Rock armouring is an obstacle and occurs where cables cross. Fishermen have evidence of rock dumping that has missed its target. The loss of traditional fishing grounds has resulted in more fishing in the North Sea, off North Shields which takes 4 days passage. This vessel has been employed for guardship duty, one of 5 boats operating at the West of Duddon Sands, operating for 12 weeks in 2013, for a period of 3 - 6 weeks. Vessels are now employed for 3 weeks at a time. Guard ship duty provides some compensation for the winter fishery.
- Up until 2008, the Eastern Irish Sea fishing grounds were very important and accounted for up 80-90% of annual fishing effort for some vessels, targeting prawns, plaice, brill, turbot, sole, monkfish etc. There were better fishing opportunities to the east of the Irish Sea than locally (west). Quality of fish didn't change over the last 10 years of fishing (1998 - 2008). Different fishing grounds exist off Whitehaven (different ground type and species) 6 - 20nm offshore. There is a long history of Irish boats fishing the E. Irish Sea grounds, principally from Kilkeel. The fisherman left the industry due to increasing landing restrictions (cod recovery programme) as did two of his sons, both skippers, one currently works on a pelagic boat and the other for an OWF company.
- More information about potential seabed hazards within offshore wind farms may improve confidence to fish inside the farms. Over time, experience of those operating close to the wind farms and within may encourage others to follow suit. There is a lack of knowledge of the effects of wind farms on shellfish/fish stocks.
- Wind developers have little interest or consideration for fishing interests.
- There is a lack of information and evidence about the effects of wind turbines on fish and the seabed. Better monitoring is required. Developing aquaculture inside wind farms could help mitigate the loss of fishing opportunities. Experience of dealing with wind farms has been frustrating: there is little interest in developing co-location opportunities.
- All the different types of disturbance need to be assessed accumulatively, for example pile driving, sedimentation, maintenance work (e.g. rock dumping) and electromagnetic effects. There are some effective compensation-type mechanisms such as the West of Morecambe Fisheries Fund and the fuel purchase agreement adopted by the Thanet Fishermen's Association in the Thames. The wind farm developers are not interested in helping fishermen to continue to operate on traditional fishing grounds now occupied by wind turbines. Communication between the developers and the fishing industry is generally poor.

- Initially was informed of the development and didn't receive any compensation despite the wind farm being built on my fishing grounds. The wind farm has significantly affected my drift net fishery (in the past drifting would begin 2 hr after HW and over around 2 miles offshore, whereas now drifting covers 1.25 miles and begins 4 hr after HW. The service vessel skippers (catamarans) warned against the use of anchors and grapples inside the wind farm. A Fleetwood trawler (Cygnus 33) used to fish on Burbo Bank April/May for a few weeks probably targeting sole. After the construction of the wind farm, it was seen fishing in surrounding areas.

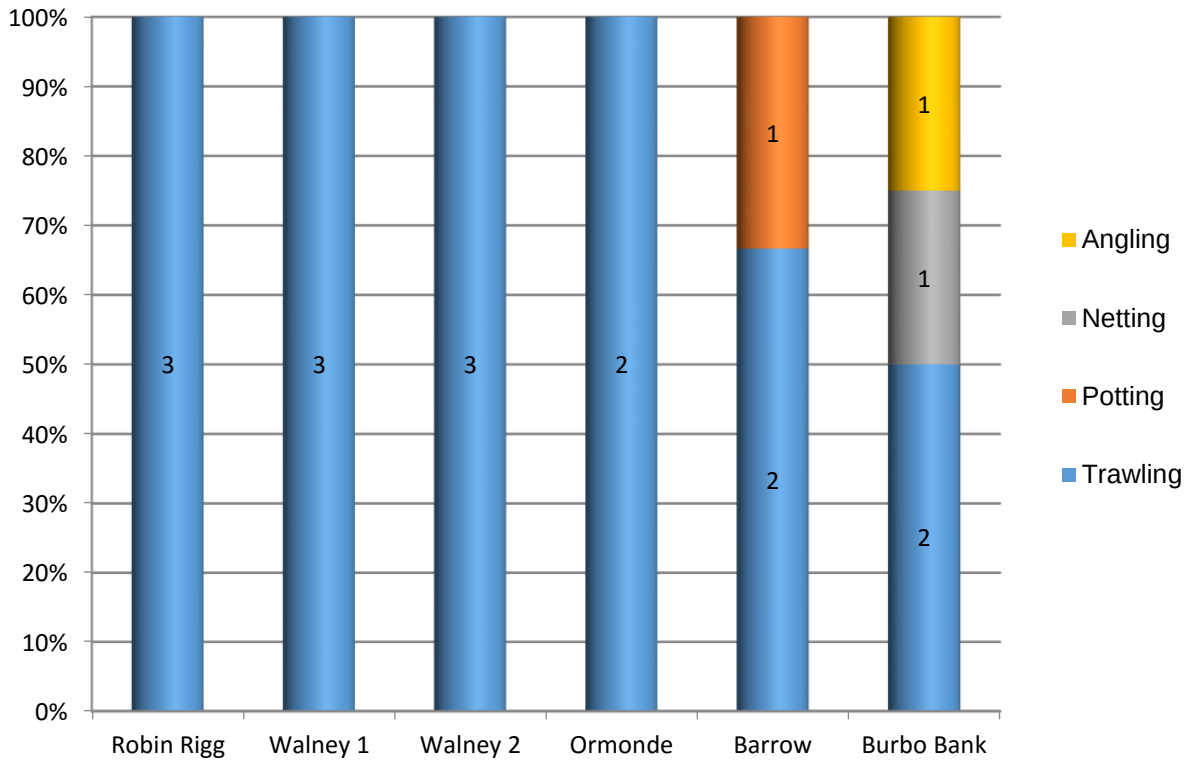
Fisheries Manager's Questionnaire Results

Section 2: Record of fishing within Offshore Wind Farms (OWF) which includes export cable areas

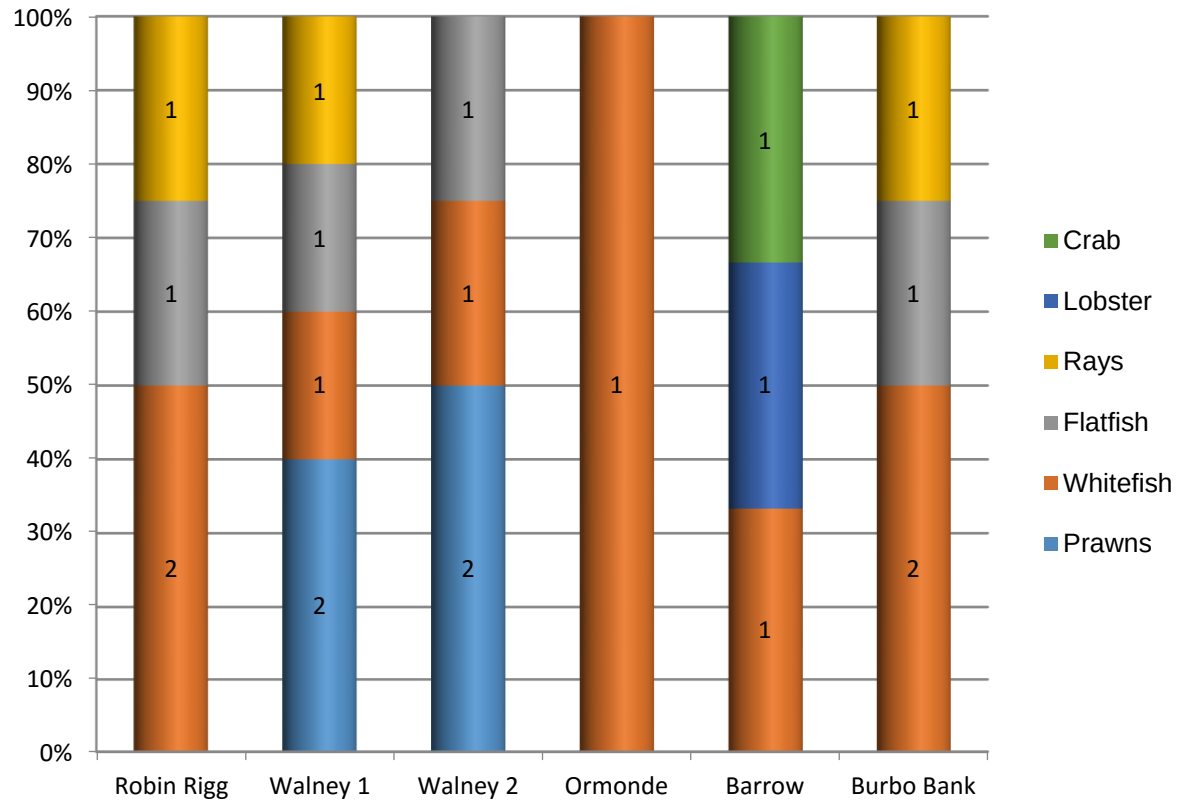
Qu 2.1. Are you aware of any commercial fishing activity in Eastern Irish Sea OWFs before or after construction?

	Robin Rigg	Walney 1	Walney 2	Ormonde	Barrow	Burbo Bank
Number of individuals	3	4	4	3	3	2
Percentage (%)	75	100	100	75	75	50

Qu. 2.2. What type of gear was used? (number of fisheries officers shown in bars)



Qu 2.3. Which species were targeted? (number of fisheries officers shown in bars)



Question 2.4. For each OWF and / or export cable routes:

(a) Are you aware of a reduction in fishing effort before, during and / or after construction? (no. of fisheries officers)

	2 or more years before construction	0-1 year before construction	During construction	0-1 year after construction	2 or more years after construction
Robin Rigg	-	-	3	2	2
Walney 1	-	-	2	1	1
Walney 2	-	-	2	1	1
Ormonde	-	-	1	-	-
Barrow	-	-	1	-	-
Burbo Bank	-	-	2	1	1

(b) Do you believe fishing effort within your OWF changed post construction? (no. of fisheries officers)

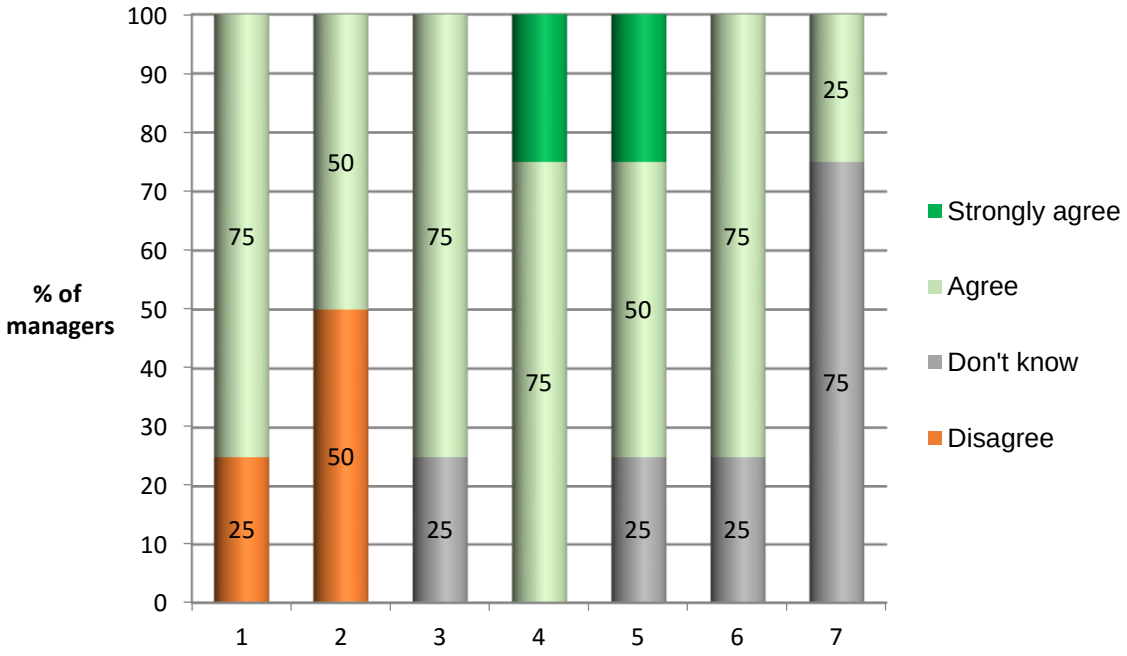
	Considerable decrease	Slight decrease	No change	Slight increase	Considerable increase
Robin Rigg	2	-	-	-	-
Walney 1	1	-	-	-	-
Walney 2	1	-	-	-	-
Ormonde	-	-	-	-	-
Barrow	-	-	-	-	-
Burbo Bank	1	-	-	-	-

Section 3 Fishing within OWF and export cable areas

Reasons and extent of reduction in fishing

Qu. 3.1 to 3.7 *Fisheries officers' response to the following statements*

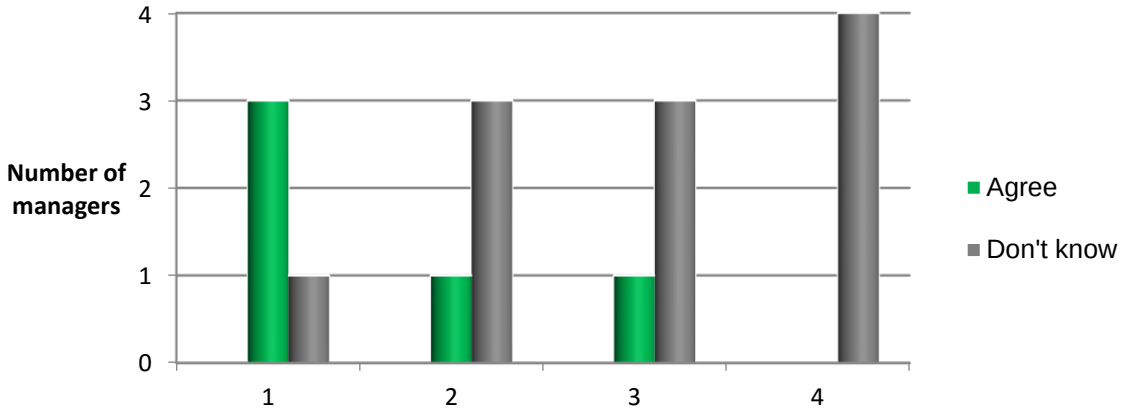
1	Lack of quota has caused a reduction in fishing effort
2	Management/legislation has caused a reduction in fishing effort
3	The cost of fuel has caused a reduction if fishing effort
4	Risk of potential hazard caused a reduction in fishing effort
5	Measures to protect export cable routes has caused a reduction in fishing effort
6	OWF and export cable maintenance caused a reduction in fishing effort
7	The impact of the OWF on fishing opportunities has been greater than the lack of quota and fisheries management?



Section 4 Wider Effects of OWF

Qu 4.1 to 4.4 Fisheries officers' response to the following statements:

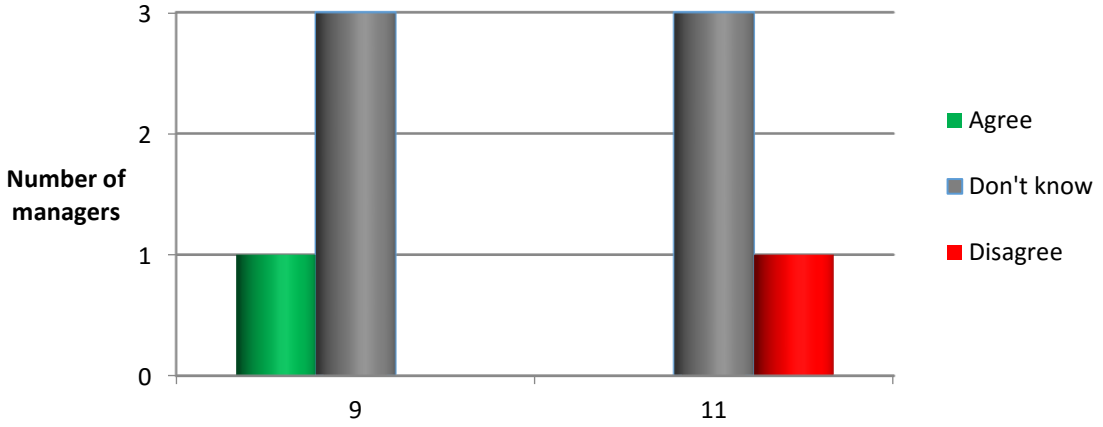
1	I believe some OWFs have had a greater impact on the fishing industry than have others?
2	Displacement away from the OWF has increased conflict between fishermen outside the OWF
3	Fishing opportunities in the Eastern Irish Sea have been in decline before OWFs arrived
4	OWFs have a larger impact on fishing opportunities than have marine protected areas (SACs/MCZs)



Effect of OWF on commercial fish stocks

Qu 4.9 to 4.11 Fisheries officers' response to the following statements:

9	I believe the OWF has had a positive effect on the fish stock by acting as a nursery ground?
11	I believe the OWF has reduced the overall commercial fish stock size?



The four fisheries officers' responses to Qu 4.5 to 4.8:

Qu. 4.5. What is the main negative impact of the OWF on the fishing industry?			
Loss of fishing grounds	Increasing steaming to fishing grounds beyond the OWF	Potential impact on future fishing activity, particularly post decommissioning	Spatial impact - loss of fishing grounds
Qu. 4.6. What has been the main positive impact of the OWF on the fishing industry?			
None	Guardship duty	Some financial gain through work for the WF companies	Providing a potential habitat for lobsters and possibly crabs
Qu. 4.7. Has the developer helped fishermen to continue fishing in any way? If so, how?			
No	Good & regular communication via the Mariner's Notice and Fisheries Liaison Officer	Fisheries fund (eg WofMFF)	Communication of fishing restrictions and safety (ie Mariner's Notices) is good and provision of fisheries liaison officers
Qu. 4.8. Has the developer hindered the continuation of fishing in any way? If so, how?			
Don't know	Don't know	No	No

Additional comments from Fisheries Officers

- Data on where vessels under 10 m operate is not routinely collected. Landings data doesn't reveal the precise location of catches and neither does information recorded under the buyers and sellers regulation. MMO collate landings data which is processed at a low resolution.
- The potting fleet, particularly around Barrow has fluctuated considerably over the years. The lack of local processing has been a limiting a factor. At the moment the potting fleet is fairly healthy. The officer had heard of pots being set around turbines, but wasn't sure whether local fishermen were involved. The wind farms are a

considerable distance offshore (6 - 10 miles for the local fleet) and probably too far for most local potting boats.

- The wind farms in the Eastern Irish Sea are not sited on renowned fishing grounds and the impact on the fishing industry is probably not that significant.
- The IFCA is concerned about the burial of the export cables and has suggested the cables should be regularly monitored.
- Rock armouring the cables could impact the mobile gear fleet.
- The IFCA haven't received any reports of populations of commercial spp within and around wind farms increasing. They are not aware of any evidence to suggest the wind farms are acting as a refuge (MPA effect) with spill over into the surrounding area.
- During the planning stage, there was a lot of speculation about the potential for wind farms to create MPA type benefits. More evidence probably needs to be collected and current monitoring is probably limited.
- There is a variety of potential disturbance including noise, vibration, visual (flashing turbines) and electro-magnetic emission from cables, the effect of which is not well understood.
- Two issues commonly raised by the fishermen are (a) will the infrastructure be removed following decommissioning and the seabed be returned to its natural state? and (b) what will be the effect of removing the infrastructure?
- The demersal trawl fishery in the Robin Rigg area is a relatively small but stable fishery almost exclusively prosecuted by Maryport boats. The Robin Rigg wind farm has had a significant effect on the steaming distance and time now taken to reach fishing grounds beyond the wind farm.
- Uncertainty over the effect of electo-magnetic currents on electro-sensitive species such as rays. Fishermen have raised the issue of decommissioning and the removal of rock armouring and metal work that has been sunk into the seabed.
- There is commercial and recreational fishing activity on Burbo Bank, A couple of small beamers moored in the Mersey have operated in this area targeting flatfish, rays, cod and bass in season.
- There may be some gill netting and commercial hand lining on Burbo Bank by vessels working from slip ways and marinas around the Wirral (eg Hoylake, New Brighton, Formby, First Aston (slipway between Heswall and West Kirby).
- There are many part-time fishermen that aren't captured by official data on landings and fishing effort.
- The area supports recreational and charter fishing. Many of these boats have to circumvent the Burbo WF to access grounds further offshore.
- The MMO database has very little information on fishing activity on Burbo Bank as the local vessels are under 10 m and therefore do not have complete fish log books. Data from RBS is limited as fishermen supply local pubs and restaurants that aren't registered. Data from the monthly shellfish returns is limited as the fisheries on and around Burbo Bank target whitefish.

Offshore Wind Farm Developer's Questionnaire Results

Section 2: Record of fishing within Offshore Wind Farms (OWF) which includes export cable areas

	Walney 1 & 2	Robin Rigg	Barrow	Ormonde
Qu. 2.1. Are you aware of any commercial fishing activity in your OWF before or after construction?	Yes	Yes	Yes	-
Qu. 2.2. What type of fishing gear was used?	Trawls, dredges and seine nets The ICES37E6 triangle which covers the WOW1&2 farms (hereafter referred to as WOW) reported the following fisheries as dominant in terms of landing value for both foreign and national vessels for the triangle: unspecified trawler, TW nephrops otter, nephrops otter trawl, unspecified dredge, TW in otter trawl, Scottish fly seine. The Environmental Statement for WOW concluded that there was very little fishing activity within the WOW site boundary.	Pots and trawls	Trawls The Environmental Statement for BOW stated that the wind farm area had been reported by local fishermen as 'being rough ground, which is likely to damage nets, and given the proximity to the existing gas pipelines, is unlikely to be widely used'. However, up to seven vessels reported fishing activity in the vicinity of the wind farm using trawls. This activity was reported as mainly being focused in the summer months. (Warwick Energy, 2002)	-

	Source: Environmental Statement Walney Offshore Wind Farm, DONG Energy, 2006.			
Qu. 2.3. Which species were targeted?	Nephrops The ICES37E6 triangle which covers the WOW1&2 farms reported the following fisheries as dominant in the triangle in terms of landing value for both foreign and national vessels Nephrops, sole, plaice, skates and rays, cod, brill, spurdog and turbot. Nephrops were reported to be targeted in the northern boundary of the WOW site. The Environmental Statement for WOW concluded that there was very little fishing activity within the WOW site boundary. Source: Environmental Statement Walney Offshore Wind Farm, DONG Energy, 2006.	Demersal	Nephrops and sole were the highest value species in the area The ICEs rectangle data for the Morecambe Bay Area was analysed as part of the Environmental Statement for BOW. This analysis found that Nephrops was the highest value species landed in the northern part of Morecambe Bay with sole and plaice bringing in high revenues in the inshore waters and Nephrops, scallops and herring in the offshore waters. In the Southern part of the Bay, sole were the highest value species followed by queen scallops and scallops in both the inshore and offshore waters. (Warwick Energy, 2002)	-

Qu. 2.4. ***Are you aware of a reduction in fishing effort within your OWF and / or export cable areas?***	We have not undertaken any formal or quantitative monitoring of formal commercial fishing activity within the WOW site since the original ES. As such, it is not possible to answer this question in full. Access to the wind farm was limited for the duration of the construction period as such it could be inferred that there would have been a reduction in fishing effort during the construction period.	No	We have not undertaken any formal or quantitative monitoring or formal commercial fishing activity within the BOW site since the original ES. As such, it is not possible to answer this question in full.	-
Qu. 2.5. ***How much do you believe fishing effort within your OWF changed post construction?***	We have not undertaken any formal or quantitative monitoring of formal commercial fishing activity within the WOW site since the original ES. As such, it is not possible to answer this question in full.	No change	We have not undertaken any formal or quantitative monitoring of commercial fishing activity within the wind farm post construction. As such, it is not possible to answer this question.	No change
Qu. 2.6. ***Do you have any evidence of a change in fishing effort within the OWF post construction?***	We have not undertaken any formal or quantitative monitoring of formal commercial fishing activity within the WOW site since the original ES. As such, it is not possible to answer this question in full.	No	We have not undertaken any formal or quantitative monitoring of commercial fishing activity within the wind farm post construction. As such, it is not possible to answer this question.	No

Qu. 2.7. Would you be prepared to provide this evidence of change in fishing effort within OWF areas?	We have not undertaken any formal or quantitative monitoring of formal commercial fishing activity within the WOW site since the original ES. As such, it is not possible to answer this question in full.	No	We have not undertaken any formal or quantitative monitoring of commercial fishing activity within the wind farm post construction. As such, it is not possible to answer this question.	Yes, all reports from our surveys are with the MMO
Qu. 2.8. Did the proposed protection measures for the export cable route consider the continuation of fishing by all gear type users?	Where the cable could not be buried to sufficient depth to provide adequate protection, rock protection has been used to provide additional protection to the cable. Rock protection was considered to offer the best available solution for a number of different environmental receptors including scour, fishing and impact on benthic habitats as well as offering the best technical solution.	No	Where the cable could not be buried to sufficient depth to provide adequate protection, rock protection has been used to provide additional protection to the cable. Rock protection was considered to offer the best available solution for a number of different environmental receptors including scour, fishing and impact on benthic habitats as well as offering the best technical solution.	Not sure. I have seen the licence applications explaining the need for rock dumping, but I'm unaware of consultation. However, we do have a continuous dialogue with the fishermen. I would assume a risk assessment to ensure activities could continue was undertaken. On the other sites I have worked on this has been done, taking into account spawning, migration etc
Qu. 2.9. Have you offered financial compensation to fishermen for the loss of fishing grounds during construction?	DONG Energy is a member of the Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) and as such seeks to adhere to the best practice as defined in the document 'FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison JANUARY 2014'. The guidance in this document states that if co-existence is not possible,	No	As the commercial compensations are confidential I am not able to comment on the nature of any compensation that may have been paid with respect to BOW.	Yes

	mitigation for disruption and displacement of fishing activity as a result of an OREI should be considered as the first priority, and commercial compensation should only be used as a last resort when there are significant residual impacts that cannot otherwise be mitigated. However, compensation should only be paid on the basis of factually accurate and justifiable claims. There is therefore an obligation upon affected fishermen to provide evidence (such as three years' worth of catch records) to corroborate any claims. As the commercial compensations are confidential I am not able to comment on the nature of any compensation that may have been paid with respect to WOW.			
Qu 2.10. Have any other forms of compensation, mitigation and / or assistance been offered?	The WOW is represented in the West of Morecambe Fisheries Fund which is a fund provided by the owners of several offshore wind farms. The fund is used to set up and support appropriate Community Projects would be of direct benefit to the fishing industry operating in the same areas as the wind farms. The West of Morecambe Fisheries Fund	Community Fund	Not to my knowledge	Yes

	always work with the full support of the fishing industry on the funded projects			
Qu 2.11. Did you help to identify work opportunities for fishing vessels and fishermen pre-construction, during construction and post construction?	Fisheries Industry Representatives, where possible use of fishing vessels for use in surveys. There may be other examples but I do not have full information from the construction phase ie on the use of fishermen/fishing vessels as guard vessels.	Fishermen never applied	Fisheries Industry Representatives, where possible use of fishing vessels for use in surveys. There may be other examples but I do not have full information from the construction phase ie on the use of fishermen/fishing vessels as guard vessels.	

Section 3 Fishing within OWF and export cable areas

Reasons and extent of reduction in fishing

	Walney 1 & 2	Robin Rigg	Barrow	Ormonde
Question 3.1. A lack of quota has caused a reduction in effort	(a)	Strongly agree	(b)	-
Question 3.2. Fisheries management/legislation has caused a reduction in effort	(a)	Strongly agree	(b)	-
Question 3.3. The cost of fuel has caused a reduction in effort	(a)	Strongly agree	(b)	-
Question 3.4. The risk of potential hazards (eg turbines, rock armouring of cables) has caused a reduction in fishing effort	(a)	Strongly disagree	(b)	-

Question 3.5. Measures to protect export cable routes has caused a reduction in fishing effort	(a)	Strongly disagree	(b)	**-**
Question 3.6. OWF and export cable maintenance caused a reduction in fishing effort	(a)	Strongly disagree	(b)	-
Question 3.7. The impact of the OWF on fishing opportunities has been greater than the lack of quota and fisheries management?	(a)	Strongly disagree	(b)	-

(a) I am not able to comment on whether fishing effort has been reduced within WOW export as we have not undertaken any formal or quantitative monitoring of commercial fishing activity within WOW post construction.

(b) I am not able to comment on whether fishing effort has been reduced within BOW export as we have not undertaken any formal or quantitative monitoring of commercial fishing activity within BOW post construction.

Section 4: Wider Effects of OWF

	Walney 1 & 2	Robin Rigg	Barrow	Ormonde
Qu. 4.1. I believe some OWFs have had a greater impact on the fishing industry than have others?	Don't know	Strongly disagree	Don't know	-
Qu. 4.2. Displacement away from the OWF has increased conflict between fishermen outside the OWF	Don't know	Strongly disagree	Don't know	-
Qu. 4.3. Fishing opportunities in the Eastern Irish Sea have been in decline before OWFs arrived	Don't know	Strongly agree	Don't know	-
Qu. 4.4. OWFs have a larger impact on fishing opportunities than have marine protected areas (SACs/MCZs)	Don't know	Strongly disagree	Don't know	-
Qu. 4.5. What is the main negative impact of the OWF on the fishing industry?	The main negative impact relates to temporary displacement during construction where mandatory safety zones are required around construction vessels.	None	No study undertaken	-

Qu. 4.6. What has been the main positive impact of the OWF on the fishing industry?	The wind farm has provided funding through WOMFF which has provided support to a number of projects in the East Irish Sea ie Barrow, Maryport, Whitehaven ie ice machines, fuel facilities. There may be other positive impacts associated with the WOW but without undertaking a full and formal study into these benefits it would not be appropriate to identify them in this questionnaire.	Don't know – ask the fishermen	No study undertaken	-
Qu. 4.7. Has the developer helped fishermen to continue fishing in any way? If so, how?	See answer to question 4.6 and 2.10	Very little contact	No study undertaken	There are no restrictions within the site
Qu. 4.8. Has the developer hindered the continuation of fishing in any way? If so, how?	Not that we are aware of. The presence of the assets naturally restricts the access to the sea/sea bed in the same way that it may have been accessed prior to construction. However, post construction fish surveys undertaken by Brown and May Marine (BMM 2008 to 2013) using commercial vessels deploying demersal otter and beam trawls have demonstrated that it is feasible to tow the gears between the turbines of	No	Not that we are aware of. The presence of the assets naturally restricts the access to the sea/sea bed in the same way that it may have been accessed prior to construction. However, post construction fish surveys undertaken by Brown and May Marine (BMM 2008 to 2013) using commercial vessels deploying demersal otter and beam trawls have demonstrated that it is feasible to tow the	Not aware of any hindrance

	operational wind farms including WOW which have a minimum turbine spacing of 749m.		gears between the turbines of operational wind farms.	
Qu. 4.9. I believe the OWF has had a positive effect on the fish stock by acting as a nursery ground? We have not undertaken any studies into the effects of the wind farm as a nursery ground for commercial fish stocks at BOW.	Don't know	Don't know	We have not undertaken any studies into the effects of the wind farm as a nursery ground for commercial fish stocks at BOW.	Don't know
Qu. 4.10. Do you have any evidence to show a positive effect? And if so what?	N/A		N/A	This has been shown in surveys, but we do not have enough long term data to show evidence
Qu. 4.11. I believe the OWF has reduced the overall commercial fish stock size?	Don't know	Strongly disagree	We have not undertaken any studies into the effects of the wind farm on commercial fish stock size.	Disagree
Qu. 4.12. Do you have any evidence to show either a reduction or increase? And if so what?	Taking the information provided above in the post construction monitoring for fish ecology at WOW, it is not considered that the introduction of the WOW has resulted in a major difference in the fish community of the area. Whilst some differences have been noted during pre- and post-construction	No	Taking the information provided above in the post construction monitoring for fish ecology at BOW, assessments of the fishery results conclude that no rare, unusual or protected fish species have been recorded during the otter and beam trawling performed, and no statistically significant	-

	surveys, these have been consistently recorded both within the wind farm and at control stations. It is therefore likely that any changes observed are a result of natural variability in the area rather than caused by the presence of the wind farms.		differences in fish abundance and population composition have been measured during operation of BOW compared to the baseline situation before construction.	

Further comments:

We have not undertaken any formal or quantitative monitoring of commercial fishing effort within the wind farm post construction as such it has been very difficult to answer a large proportion of this questionnaire using objective information within the timescales allowed. DONG Energy seeks to develop positive relationships with our commercial fisheries stakeholders and we are pleased to see that the Crown Estate is undertaking a study on commercial fishing activity in operational wind farms. However, it is our view that this questionnaire has not maximized the opportunity to fully engage with operational offshore wind developers. A robust and quantitative study is required to fully understand how operational wind farms may influence fishing practices in the UK. We would welcome the opportunity to engage with the Crown Estate, through a suitable forum such as FLOWW, on the potential for such a study

ANNEX D CONFIDENCE OF THE LOCATION OF FISHING ACTIVITY

Evidence of UK and non-UK fishing vessel activity in the vicinity of the six Eastern Irish Sea wind farms either before and / or following their construction was obtained from the MMO, AFBI, consultation with fishermen, fisheries officers and wind farm developers, and the five reports listed below.

- Centrica & DONG (2014). Rhiannon Wind Farm. Preliminary Environmental Information (Stage 2) Volume 1. Main Technical Report. Chapter 13 Commercial Fisheries. 81pp.
- Centrica (2012). Irish Sea Zone: Zonal Appraisal and Planning (ZAP) report. A strategic approach to the identification of Potential Areas of Development within the Irish Sea. 56pp.
- Brown & May Marine Ltd (2013). Commercial Fisheries Technical Report. Walney Offshore Wind Farm Extension Development. DONG Energy 130pp.
- Finding Sanctuary, Irish Sea Conservation Zones, Net Gain and Balanced Seas (2012). Annex I3. Impact Assessments materials in support of the Regional Marine Conservation Zone Projects' Recommendations. 254pp.
- Cappell, R., Nimmo, F. Rooney, L. (2012). The value of Irish Sea Marine Conservation Zones to the Northern Irish fishing industry. Poseidon Report to the Seafish Northern Ireland Advisory Committee 51pp.

In EU waters, historic fishing rights allow Member State's fishing fleets to operate up to the 6nm limit of another Member State's territorial waters. In the Eastern Irish Sea, the Republic of Ireland, Belgium and France have historical rights to fish inside the 6nm limit of UK waters.

The evidence used to identify the specific fishing activities in the vicinity of each wind farm is presented in the table below with reference to the source of the data. Confidence in the findings was evaluated using the IPCC 'degree of certainty' matrix (see section 2.1 for a full explanation).

Table A.1 The strength and confidence in the evidence that identified fishing activity in the vicinity of the OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Robin Rigg	Demersal trawl fishery	VMS (MMO) A low level of mobile gear vessel activity was recorded in the south west corner of the wind farm for vessels over 15m in length.	2	High	High	Strong	**HIGH**
		Consultation One Northern Ireland fishermen and 6 Cumbrian fishermen stated they had trawled within the Robin Rigg area either before and / or after construction. This was corroborated by 3 fisheries officers.	Annex C	High	High	Strong	
		Landings (MMO) Mixed demersal fish were landed from ICES rectangle 38E6.	Annex F	High	Low	Medium	**MEDIUM**
		Sightings (MMO) Demersal (otter and beam) trawlers were sighted in the vicinity of Robin Rigg wind farm between 2001 and 2011.	3 & 4	Low	High	Medium	

Table A.1 The strength and confidence in the evidence that identified fishing activity in the vicinity of the OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Walney 1 & 2	*Nephrops* and demersal trawl fishery	VMS (AFBI, MMO & Marine Institute) UK vessel activity recorded in most of Walney 2 between 2007 & 2009. A small amount of activity between 2011 and 2013.	AFBI	High	High	Strong	**HIGH**
		Consultation In this study, 8 Northern Ireland and 11 Cumbrian fishermen stated they had trawled for *Nephrops* within Walney 1 and/ or Walney 2 wind farms either before and / or after construction. This was corroborated by 4 fisheries officers. Fishermen marked *Nephrops* fishing grounds covering Walney 1 & 2 as part of a wind farm assessment study. The Irish Sea Conservation Zone Fishermap project identified at least 20 vessels using bottom demersal trawls principally for *Nephrops* within the wind farm site up until 2010.	Annex C	High	High	Strong	
		Landings (MMO) *Nephrops* & demersal were landed in ICES rectangle 37E6	Annex F	High	Low	Medium	**MEDIUM**
		Sightings (MMO) Between 2007 & 2011, demersal and unspecified trawlers were more frequently observed in Walney 2 than 1, although there were relatively few recorded. Between 2002 and 2011, Irish vessels were seen to the north and south of Walney wind farms.	2	Low	High	Medium	

Table A.1 The strength and confidence in the evidence that identified fishing activity in the vicinity of the OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Walney 1 & 2	Beam trawl fishery	VMS (ILVO & Marine Institute) Between 2006 & 2010, VMS recorded Belgium vessels operating to the west and south of the Walney wind farms.	1 & 3	High	High	Strong	**MEDIUM**
		Landings (ILVO & Marine Institute) Predominance of Dover sole with significant landings of plaice, rays, turbot and brill by the Belgium beam trawl fleet in the Eastern Irish Sea between 2006 & 2010	1 & 3	High	Low	Medium	**MEDIUM**
		Sightings (MMO) Between 2002 & 2011, sightings of Belgium vessels in the Eastern Irish Sea were most frequently made to the west and south of the Walney wind farms.	1 & 3	Low	High	Medium	

Table A.1 The strength and confidence in the evidence that identified fishing activity in the vicinity of the OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Ormonde	Demersal trawl fishery	VMS (MMO) A low level of mobile gear vessel activity was recorded for vessels over 15m in length	2	High	High	Strong	**HIGH**
		Consultation Six Northern Ireland fishermen and 5 Cumbrian fishermen stated they had trawled within the Ormonde wind farm area either before and / or after construction. This was corroborated by 3 fisheries officers.	Annex C	High	High	Strong	
		Sightings (MMO) Demersal trawlers were sighted within Ormonde wind farm between 2001 and 2011	3 & 4	Low	High	Medium	**MEDIUM**
		Landings (MMO) Mixed demersal fish were landed from ICES rectangle 36E6.	Annex F	High	Low	Medium	

Table A.1 The strength and confidence in the evidence that identified fishing activity in the vicinity of the OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Barrow	Demersal trawl fishery	Consultation Eight Cumbrian fishermen stated they had trawled within the Barrow wind farm area either before and / or after construction. This was corroborated by 3 fisheries officers.	Annex C	High	High	Strong	**HIGH**
		VMS (MMO) A low level of mobile gear vessel activity was recorded in the north west corner of the wind farm for vessels over 15m in length	2	High	High	Strong	
		Sightings (MMO) Demersal trawlers were sighted within the wind farm between 2001 and 2011.	3 & 4	Low	High	Medium	**MEDIUM**
		Landings (MMO) Mixed demersal fish were landed from ICES rectangle 37E6 & 36E6.	Annex F	High	Low	Medium	
	Lobster & crab pot fishery	Consultation Two Cumbrian fishermen stated they had set pots within the Barrow wind farm area either before and / or after construction. This was corroborated by 3 fisheries officers.	Annex C	High	High	Strong	**MEDIUM**
		Landings (MMO) Lobsters (the annual values reached over £200k in 2007 & 2008) and edible crabs (annual value over £100k in 2007) were landed from ICES rectangle 36E6.	1	High	Low	Medium	
		Sightings (MMO) Pot fishing vessels were sighted in the vicinity of Barrow wind farm between 2001 and 2011.	3 & 4	Low	High	Medium	

Table A.1 The strength and confidence in the evidence that identified fishing activity in the vicinity of the OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Burbo Bank	Demersal trawl fishery	VMS (MMO) A low level of mobile gear vessel activity was recorded in the north west corner of the wind farm for vessels over 15m in length	2	High	High	Strong	**HIGH**
		Consultation A couple of trawlers over 15 m were reported to have fished within Burbo Bank wind farm area either before and / or after construction. A Birkenhead fishermen had used a light beam trawl to target. This was corroborated by 2 fisheries officers	Annex C	High	High	Strong	
		Sightings (MMO) Demersal trawler & scallop dredger were sighted in the vicinity of the wind farm between 2001 and 2011.	3 & 4	Low	High	Medium	**MEDIUM**
		Landings (MMO) Mixed demersal fish were landed from ICES rectangle 35E6.	Annex F	High	Low	Medium	
	Gill net fishery	Consultation A Birkenhead fishermen was reported to drift gill nets through the wind farm site. This was corroborated by a local fisheries officer	Annex C	High	High	Strong	**MEDIUM**
		Landings (MMO) Mixed demersal fish were landed from ICES rectangle 35E6.	Annex F	High	Low	Medium	**LOW**

References

1. Centrica & DONG (2014). Preliminary Environmental Information (Stage 2) Volume 1. Main Technical Report. Chapter 13 Commercial Fisheries.
2. Centrica (2012). Irish Sea Zone: Zonal Appraisal and Planning (ZAP) Report. A Strategic Approach to the Identification of Potential Areas of Development within the Irish Sea.
3. Brown & May Marine Ltd (2013). Commercial Fisheries Technical Report. Walney Offshore Wind Farm Extension Development. DONG Energy. 130pp.
4. Cappell, R., Nimmo, F. Rooney, L. (2012). The value of Irish Sea Marine Conservation Zones to the Northern Irish Fishing Industry. Poseidon Report to the Seafish Northern Ireland Advisory Committee. 51pp.

Consultation response

Trawling was the dominant form of fishing activity in all the wind farms, with some static gear reportedly used in Barrow and Burbo Bank. This information was corroborated by the fisheries officers. The wind farm developers reported trawling and potting in Robin Rigg and Barrow, and *Nephrops* trawling in Walney 2.

Table A.2 Number of fishermen who have fished in the 6 wind farm areas (including the export cable routes) either before or after construction

	Demersal trawl (inc *Nephrops* trawl)	**Gill net**	**Lobster pot**	**Light beam trawl**
Robin Rigg	7			
Walney 1 & 2	22	1	1	
Ormonde	11			
Barrow	11		1	
Burbo Bank	2			1

England Marine Conservation Zone project

The following description of commercial fishing activity within Walney 1 & 2 wind farms was taken from the Impact Assessment report (Annex I3) that accompanied the MCZ recommendations made by the regional MCZ groups (Finding Sanctuary, Irish Sea Conservation Zones, Net Gain and Balanced Seas, 2012) for the proposed co-location of an MCZ (to protect subtidal mud) within Walney 1 & 2 wind farm farms.

'At least 20 vessels are known to use bottom trawls in the site, targeting primarily nephrops in mainly March to September (ISCZ, 2010). They comprise single-rig, twin-rig and pair otter trawlers. These vessels are associated with the home ports of Ardglass, Barrow, Fleetwood, Kilkeel, Maryport, Portavogie and Whitehaven (ISCZ, 2010). There are also fewer than 5 UK beam trawlers working the site for mixed whitefish from September to May. Stakeholder meetings suggest that nearer to 50 vessels use bottom trawls in the site (ANIFPO, 2011; NIFPO, 2011 Whitehaven Fishermen's Association & NWIFCA, 2011). VMS data indicate the use of bottom trawls by over 15 metre UK vessels in the site (MMO, 2011a).

Irish vessels have historic rights to bottom trawl for nephrops within the portion of the site that lies between 6nm and 12nm offshore. French vessels have historic rights to fish for any species within a part of the 6nm to 12nm area but are not known to fish there. Irish vessels (bottom trawlers) are known to fish in the site (MMO, 2011a).'

References

ANIFPO. 2011. *Qualitative assessment of the impact of MCZs upon the ANIFPO fleet meeting,* 3 August 2011

ISCZ. 2010. *FisherMap project.*

MMO. 2011a. *Vessel monitoring system spatial attribute data 2006–2010.* Newcastle upon tyne: Marine Management Organisation.

NIFPO. 2011. *Qualitative assessment of the impact of MCZs upon the NIFPO fleet meeting,* 2 August 2011.

Whitehaven Fishermen's Association & NWIFCA. 2011. *Qualitative assessment of the impact of MCZs upon the Cumbrian fleet meeting,* 3 August 2011.

ANNEX E CONFIDENCE OF THE EXTENT OF CHANGE IN FISHING ACTIVITY

Using the information that identified fishing activity in the vicinity of the six Eastern Irish Sea wind farm the level of fishing activity before the construction of the wind farms was compared with the level afterwards to determine the extent of change.

The evidence is presented in the table below with reference to the source of the data. Confidence in the findings was evaluated using the IPCC ‘degree of certainty’ matrix (see section 2.1 for a full explanation).

Table A.3 The strength and confidence in the evidence that showed a change in fishing activity within OWFs

Offshore wind farm	Historical fishing activity	Evidence of a change in fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Robin Rigg	Demersal trawling	<u>Consultation</u> The 3 fishermen who had trawled the Robin Rigg wind farm area before the turbines and cables were installed stated they had either reduced or stopped fishing the area following its construction. Two local MMO fisheries officers were aware of a reduction in fishing effort during construction and 1 reported a reduction following construction.	Annex C	High	High	Strong	**MEDIUM**
		<u>Landings</u> Landings of demersal fish declined within ICES rectangle 38E6 following the construction of the wind farm. Compared to 2003-2006 the average annual UK landings of cod, Dover sole and plaice during 2011-2014 declined by 91%, 83% and 61% respectively.	Annex F	High	Low	Medium	**LOW**

Table A.3 The strength and confidence in the evidence that showed a change in fishing activity within OWFs

Offshore wind farm	Historical fishing activity	Evidence of a change in fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Walney 1 & 2	*Nephrops* trawling	VMS (AFBI) VMS data showed negligible UK fishing activity in Walney 2 wind farm in 2011 and 2012 compared to previous years. A slight increase is recorded in 2013. UK VMS data showed no activity recorded in Walney 1 from 2010 onwards compared to low levels in previous years.	AFBI	High	High	Strong	**HIGH**
		Consultation All 8 of the Northern Ireland fishermen interviewed reduced or stopped fishing inside Walney 1 & 2 wind farms during and following construction. Two local MMO fisheries officers were aware of a reduction in fishing effort during construction and 1 reported a reduction following construction.	Annex C	High	High	Strong	
		Landings (MMO) Compared to 2007-2009 the average annual UK landing of *Nephrops* during 2012-2014 declined by 34%.	Annex F	High	Low	Medium	**MEDIUM**
		Sightings (MMO) Surveillance data show a reduction in mobile gear fishing intensity from 2007-09 to 2010-12 in the Walney area	3	Low	High	Medium	

Table A.3 The strength and confidence in the evidence that showed a change in fishing activity within OWFs

Offshore wind farm	Historical fishing activity	Evidence of a change in fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Ormonde	Demersal trawling	VMS (AFBI) UK VMS data showed no activity recorded from 2010 onwards compared to low levels in previous years.	AFBI	High	High	Strong	**MEDIUM**
		Consultation The 6 Northern Ireland fishermen and 5 Cumbrian fishermen who had trawled the Ormonde wind farm area before the turbines and cables were installed stated they had either reduced or stopped trawling the area following its construction. The local MMO fisheries officers were not aware of a reduction in fishing effort following construction.	Annex C	Low	High	Medium	
		Landings Landings of demersal fish declined within ICES rectangle 37E6 following the construction of the wind farm. Compared to 2007-2009 the average annual UK landings of cod, Dover sole, plaice and skate & rays during 2012-2014 declined by 80%, 60%, 71% and 80% respectively.	Annex F	High	Low	Medium	

Table A.3 The strength and confidence in the evidence that showed a change in fishing activity within OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Barrow	Demersal trawling	Landings Landings of demersal fish declined within ICES rectangle 36E6 following the construction of the wind farm. Compared to 2000-2004 the average annual UK landings of cod, Dover sole and plaice during 2007-2011 declined by 95%, 73% and 53% respectively.	Annex F	High	Low	Medium	**MEDIUM**
		Consultation The 8 Cumbrian fishermen who trawled the Barrow wind farm area before the turbines were installed stated they had either reduced or stopped trawling the area following its construction. The local MMO fisheries officers were not aware of a reduction in fishing effort following construction.	Annex C	Low	High	Medium	
Barrow	Lobster potting	Consultation The 2 Cumbrian fishermen who set pots in the Barrow wind farm area before the turbines and cables were installed stated they had either reduced or stopped potting in the area following its construction. The local MMO fisheries officers were not aware of a reduction in fishing effort following construction.	Annex C	Low	High	Medium	**LOW**

Table A.3 The strength and confidence in the evidence that showed a change in fishing activity within OWFs

Offshore wind farm	Historical fishing activity	Evidence of fishing activity	References	Robustness	Resolution	Strength of evidence	Confidence
Burbo Bank	Gill netting	Consultation The Wirral fisherman who drifted nets over the Burbo Bank area before the turbines and cables were installed stated he had stopped drift netting in the area occupied by the turbines following its construction. This was corroborated by a local MMO fisheries officer.	Annex C	High	High	Medium	**LOW**
Burbo Bank	Demersal trawling	Landings Landings of demersal fish declined within ICES rectangle 35E6 following the construction of the wind farm. Compared to 2001-2005 the average annual UK landings of cod, Dover sole, plaice and skate & rays during 2008-2012 declined by 98%, 87% and 38% and 92% respectively.	Annex F	High	Low	Medium	**MEDIUM**
		Consultation A local fisherman observed trawling in the Burbo Bank area during the spring sole fishery before the turbines and cables were installed. Since the installation of the wind farm visiting trawlers have not been seen inside the wind farm.	Annex C	Low	High	Medium	

1. ANIFPO (2013). VMS maps obtained from ANIFPO and created by AFBI
2. Brown & May Marine Ltd (2013). Commercial Fisheries Technical Report. Walney Offshore Wind Farm Extension Development. DONG Energy 130pp.
3. Vanstaen, K., & Breen, P. (2014). Understanding the distribution and trends in inshore fishing activities and the link to coastal communities, CEFAS Report MB0117.

ANNEX F. ANALYSIS OF MMO LANDINGS DATA

Table A.4 Irish Sea (Division VIIa) TAC for the main demersal finfish (tonnes)

	Irish Sea (Division VIIa) TAC (tonnes)				
Year	**Cod**	**Dover sole**	**Nephrops***	**Plaice**	**Skates and Rays****
2000	2100	1080	21 000	2400	
2001	2100	1100	18 900	2000	
2002	3200	1100	17 790	2400	
2003	1950	1010	17 790	1675	
2004	2150	800	17 450	1340	
2005	2150	960	19 544	1608	
2006	1828	960	21 498	1608	
2007	1462	820	25 153	1849	
2008	1199	669	25 153	1849	
2009	899	502	24 650	1430	15 700
2010	674	402	22 432	1630	13 400
2011	506	390	21 759	1627	11 400
2012	380	300	21 759	1627	9 900
2013	285	140	23 065	1627	8 900
2014	228	95	20 989	1220	8 000

*TAC for Nephrops is for entire Subarea VII

**TAC for common skates and rays includes Subareas VI and VII

Table A.5 UK landings of the main demersal finfish from ICES Rectangles 35E6, 36E6, 37E6, 38E6 (tonnes)

	UK Landings from ICES Rectangles 35E6, 36E6, 37E6, 38E6 (tonnes)				
Year	**Cod**	**Dover sole**	**Nephrops**	**Plaice**	**Skates and Rays**
2000	69.2	54.2	448.5	363.8	201.8
2001	80.7	72.7	490.6	363.6	180.0
2002	78.4	43.3	362.8	320.8	161.7
2003	56.8	54.1	300.8	264.9	324.6
2004	38.3	21.7	369.9	257.2	183.9
2005	53.4	58.9	528.3	324.4	201.4
2006	27.1	48.1	574.6	289.3	81.0
2007	28.1	32.8	859.3	333.5	132.6
2008	21.3	21.5	637.1	220.9	58.9
2009	9.3	8.2	684.8	143.4	8.9
2010	9.7	6.8	531.0	95.2	8.9
2011	6.7	19.4	509.7	79.0	3.1
2012	7.2	8.4	448.3	96.0	58.9
2013	3.9	6.0	431.0	64.3	8.9
2014	8.2	4.9	610.3	35.0	0.1

Table A.6 UK landings of the main demersal finfish from ICES Rectangles 35E6, 36E6, 37E6, 38E6 from 2000 to 2014 (tonnes)

	Total Landings from ICES Rectangles 35E6, 36E6, 37E6, 38E6 (tonnes)				
Year	**Cod**	**Dover sole**	**Nephrops**	**Plaice**	**Skates and Rays**
2000	85.0	348.8	452.4	601.3	257.7
2001	149.0	384.4	493.0	596.4	234.0
2002	152.6	420.3	393.3	644.2	242.8
2003	120.8	323.2	303.6	520.4	428.2
2004	71.7	245.7	397.0	472.9	229.4
2005	95.7	404.5	545.3	634.6	369.9
2006	46.1	265.4	578.5	492.1	166.5
2007	36.4	127.8	861.7	398.6	181.7
2008	26.0	157.4	642.8	311.3	120.6
2009	12.2	172.4	684.8	247.0	18.1
2010	13.5	91.8	531.0	142.0	9.4
2011	10.9	89.8	509.7	127.7	9.4
2012	12.0	88.8	452.9	149.2	7.8
2013	5.1	40.8	436.9	93.4	12.2
2014	8.3	4.9	612.0	35.0	0.1

Figure A.6 Total & UK landings and TAC for cod from ICES Rectangles 35E6, 36E6, 37E6, 38E6 from 2000 to 2014 (tonnes)

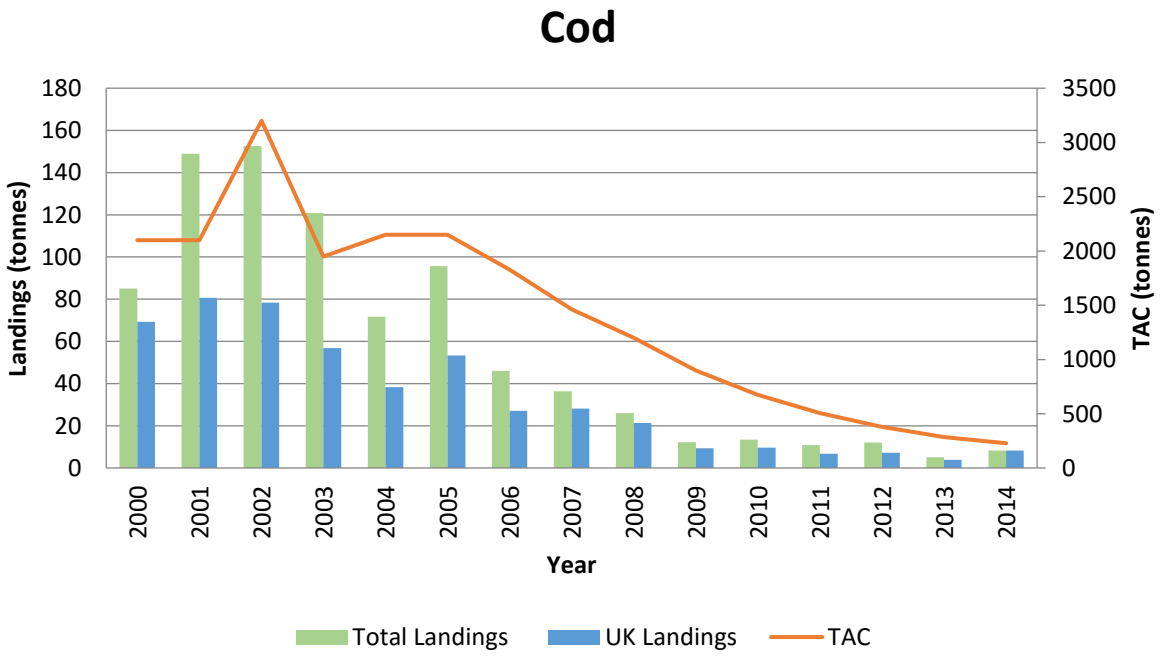


Figure A.7 *Total & UK landings and TAC for Dover sole from ICES Rectangles 35E6, 36E6, 37E6, 38E6 from 2000 to 2014 (tonnes)*

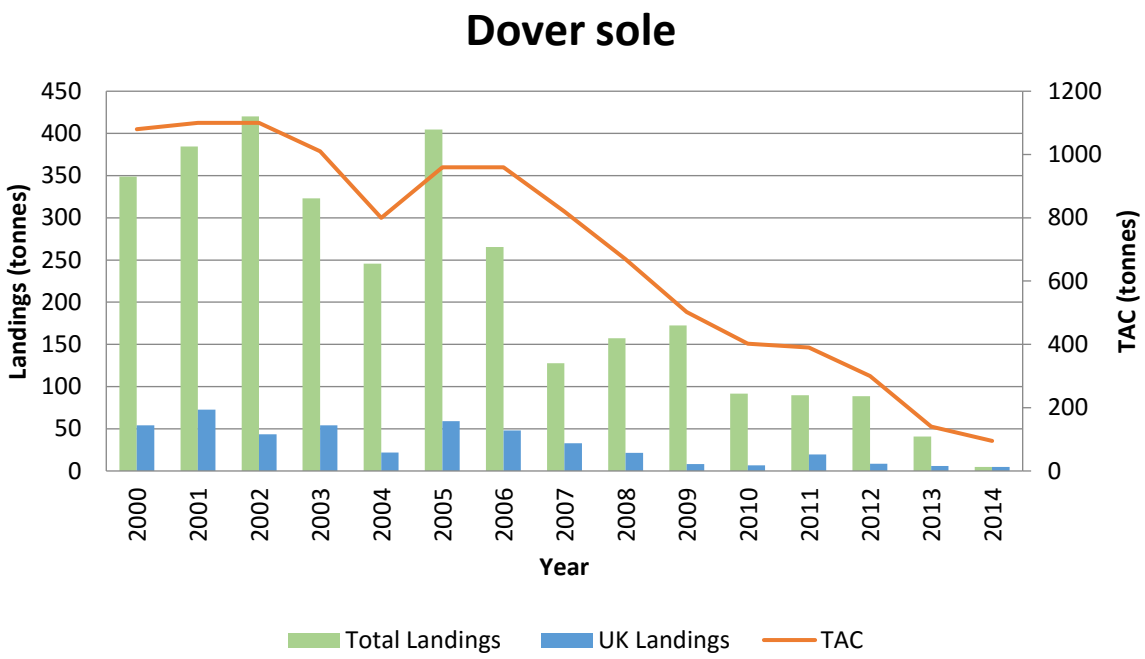


Figure A.8 *Total & UK landings and TAC for Nephrops from ICES Rectangles 35E6, 36E6, 37E6, 38E6 from 2000 to 2014 (tonnes)*

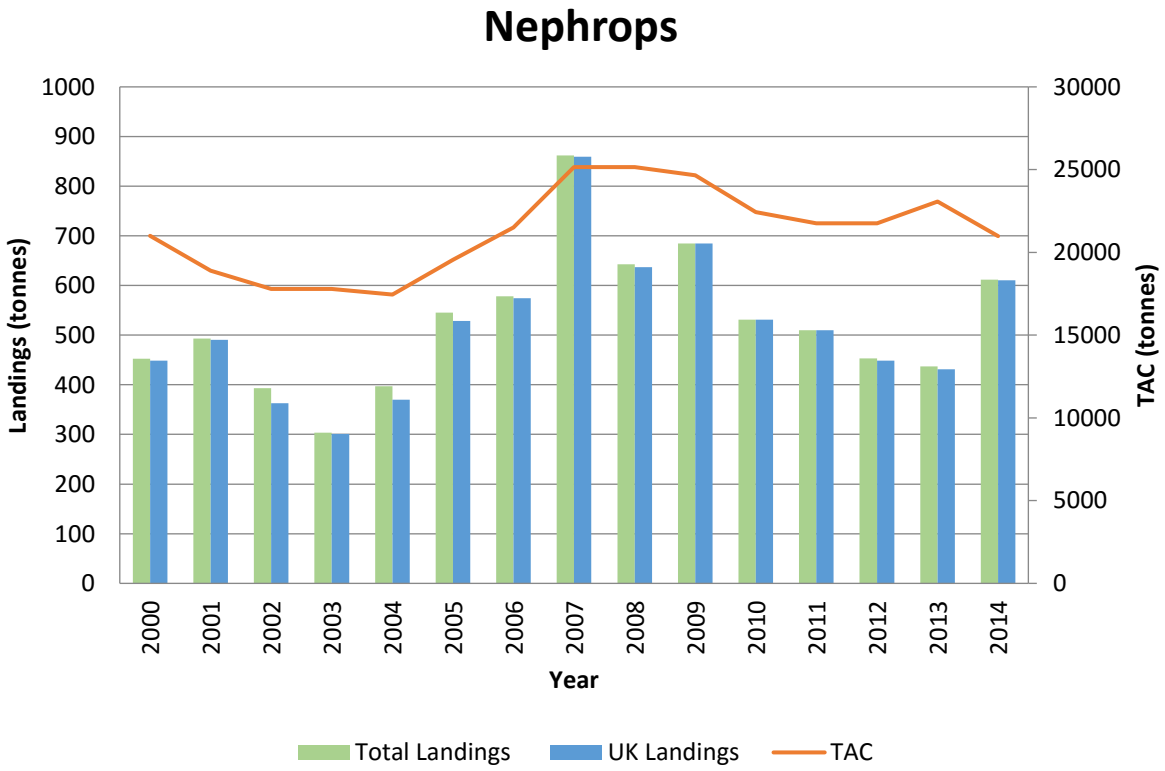


Figure A.9 *Total & UK landings and TAC for Nephrops from ICES Rectangles 35E6, 36E6, 37E6, 38E6 from 2000 to 2014 (tonnes)*

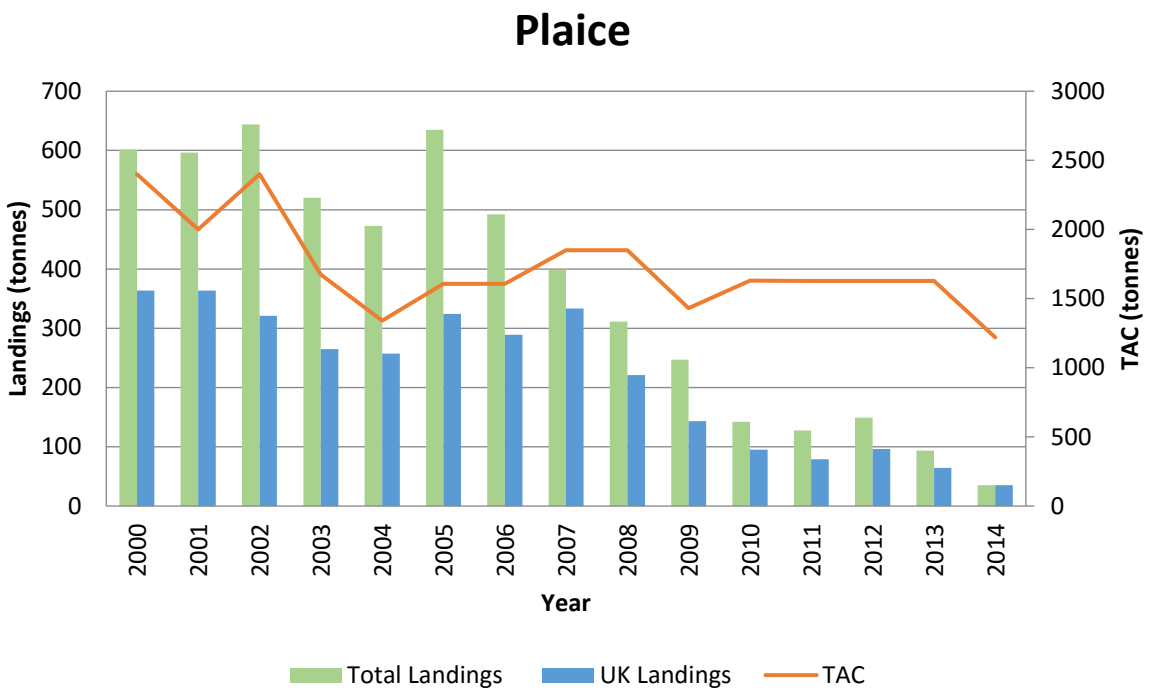


Figure A.10 *Total & UK landings and TAC for Nephrops from ICES Rectangles 35E6, 36E6, 37E6, 38E6 from 2000 to 2014 (tonnes)*

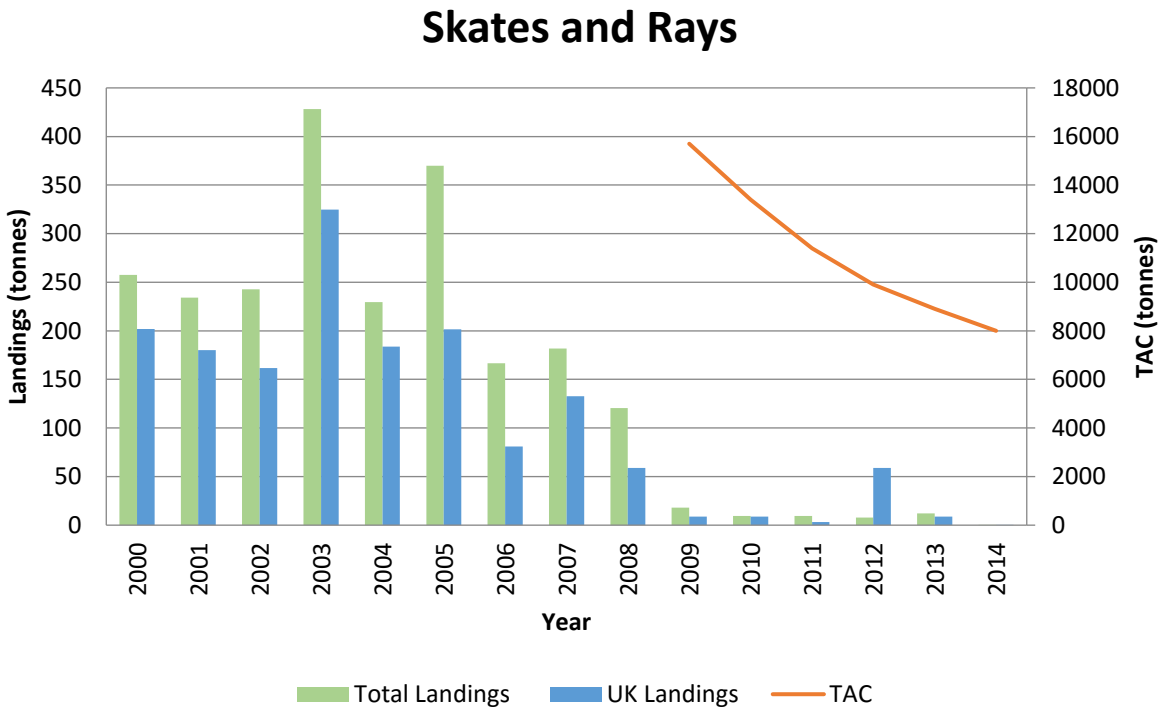


Table A.7 Total and UK landings of Nephrops from ICES Rectangle 37E6 and Subarea VII TAC from 2000 to 2014 (tonnes)

Year	Total Landings	UK Landings	Subarea VII TAC
2000	424.0	420.5	21000
2001	442.5	440.1	18900
2002	372.5	342.6	17790
2003	281.9	279.7	17790
2004	356.5	356.5	17450
2005	505.8	488.8	19544
2006	555.2	551.7	21498
2007	810.1	807.7	25153
2008	611.4	605.7	25153
2009	648.5	648.5	24650
2010	473.4	473.4	22432
2011	469.0	469.0	21759
2012	420.8	417.1	21759
2013	389.5	383.5	23065
2014	565.4	563.7	20989

Figure A.11 Total and UK landings of Nephrops from ICES Rectangle 37E6 and Subarea VII TAC from 2000 to 2014 (tonnes)

Table A.8 Total and UK landings of four main commercial species from ICES Rectangle 35E6 from 2000 to 2014 (tonnes)

	TOTAL LANDINGS				UK LANDINGS			
Year	**Cod**	**Plaice**	**Skates and Rays**	**Sole**	**Cod**	**Plaice**	**Skates and Rays**	**Sole**
2000	4.8	10.5	47.8	5.0	4.8	10.5	47.8	5.0
2001	7.7	12.8	48.5	12.4	7.5	12.2	45.1	11.5
2002	2.0	6.6	32.1	8.3	2.0	6.6	32.1	8.3
2003	0.5	8.9	31.4	10.3	0.5	8.9	31.4	10.3
2004	0.2	6.4	27.8	0.8	0.2	6.4	27.8	0.8
2005	0.3	4.0	11.3	6.7	0.3	2.6	10.7	6.0
2006	0.1	6.5	2.6	2.2	0.1	6.5	2.6	2.2
2007	0.6	8.6	14.5	2.0	0.5	8.6	14.3	1.5
2008	0.4	5.4	1.3	2.6	0.3	5.1	0.2	1.7
2009	0.1	4.3	0.1	0.5	0.1	4.3	0.1	0.5
2010	0.1	5.2	6.4	0.8	0.1	5.0	6.4	0.7
2011	0.4	5.3	3.8	2.9	0.1	2.5	3.0	0.5
2012	0.6	5.9		1.3	0.6	5.9		1.3
2013	0.6	2.4		0.2	0.6	2.4		0.2
2014	0.3	3.1		0.3	0.3	3.1		0.3

Figure A.12 Total and UK landings of the four main commercial species from ICES Rectangle 35E6 from 2000 to 2014 (tonnes)

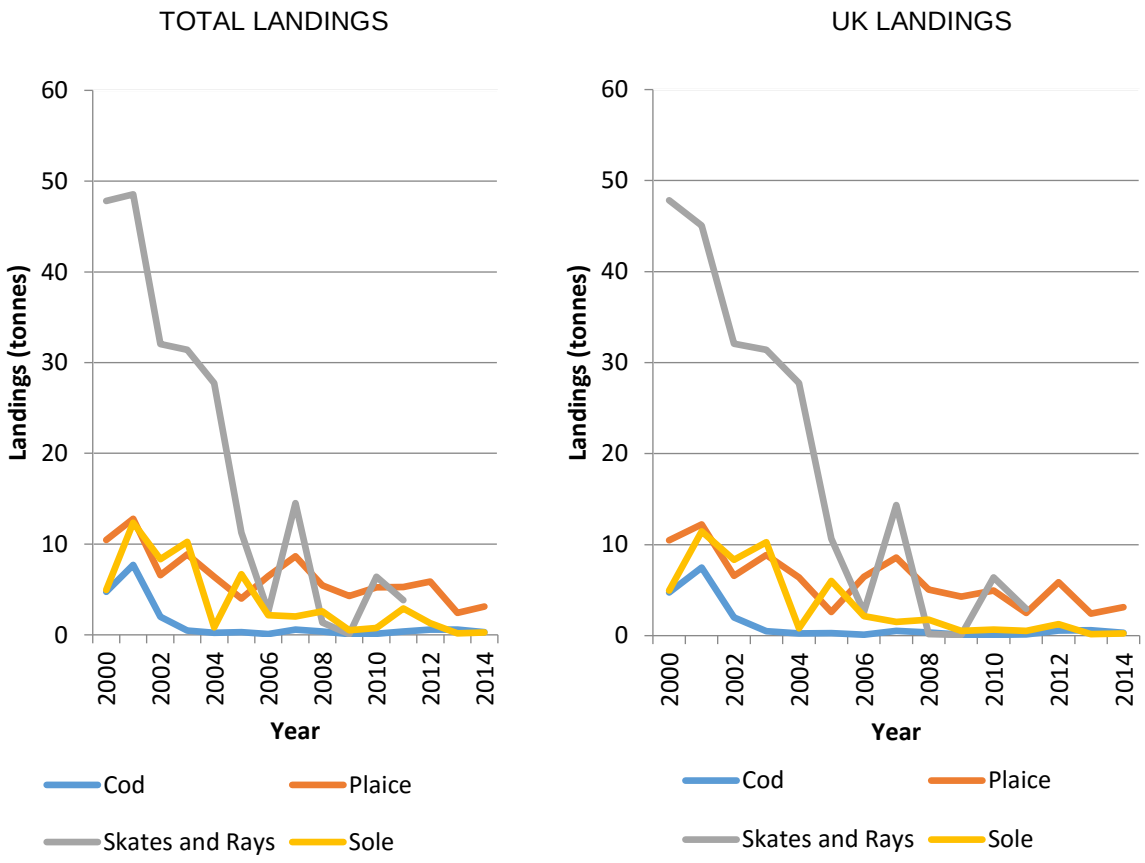


Table A.9 Total and UK landings of four main commercial species from ICES Rectangle 36E6 from 2000 to 2014 (tonnes)

	TOTAL LANDINGS				UK LANDINGS			
Year	**Cod**	**Plaice**	**Skates and Rays**	**Sole**	**Cod**	**Plaice**	**Skates and Rays**	**Sole**
2000	32.3	326.1	140.5	280.1	18.4	118.2	88.4	24.8
2001	79.4	268.8	98.4	298.4	32.0	107.1	59.5	43.0
2002	92.9	374.8	128.6	378.5	21.6	76.9	52.8	17.0
2003	69.9	316.2	194.1	253.9	17.0	113.1	105.1	19.4
2004	44.3	295.6	128.5	220.0	12.5	114.6	91.2	12.1
2005	52.5	423.1	252.2	348.4	14.2	147.1	103.9	37.0
2006	18.7	280.4	100.3	226.9	2.0	105.7	27.4	31.4
2007	8.3	175.5	82.4	83.9	1.9	127.9	45.0	9.2
2008	6.4	144.4	66.0	125.1	1.8	70.2	17.4	8.3
2009	2.5	142.1	5.1	139.3	0.4	46.7	0.1	1.0
2010	3.2	55.9	0.1	74.4	0.3	16.0	0.0	2.2
2011	3.3	58.7	5.5	64.8	0.2	22.1		10.7
2012	4.3	64.2	3.3	68.1	0.6	20.0		1.9
2013	2.6	43.1		32.6	1.5	17.6		0.9
2014	4.5	16.8		0.7	4.5	16.8		0.7

Figure A.13 Total and UK landings of four main commercial species from ICES Rectangle 36E6 from 2000 to 2014 (tonnes)

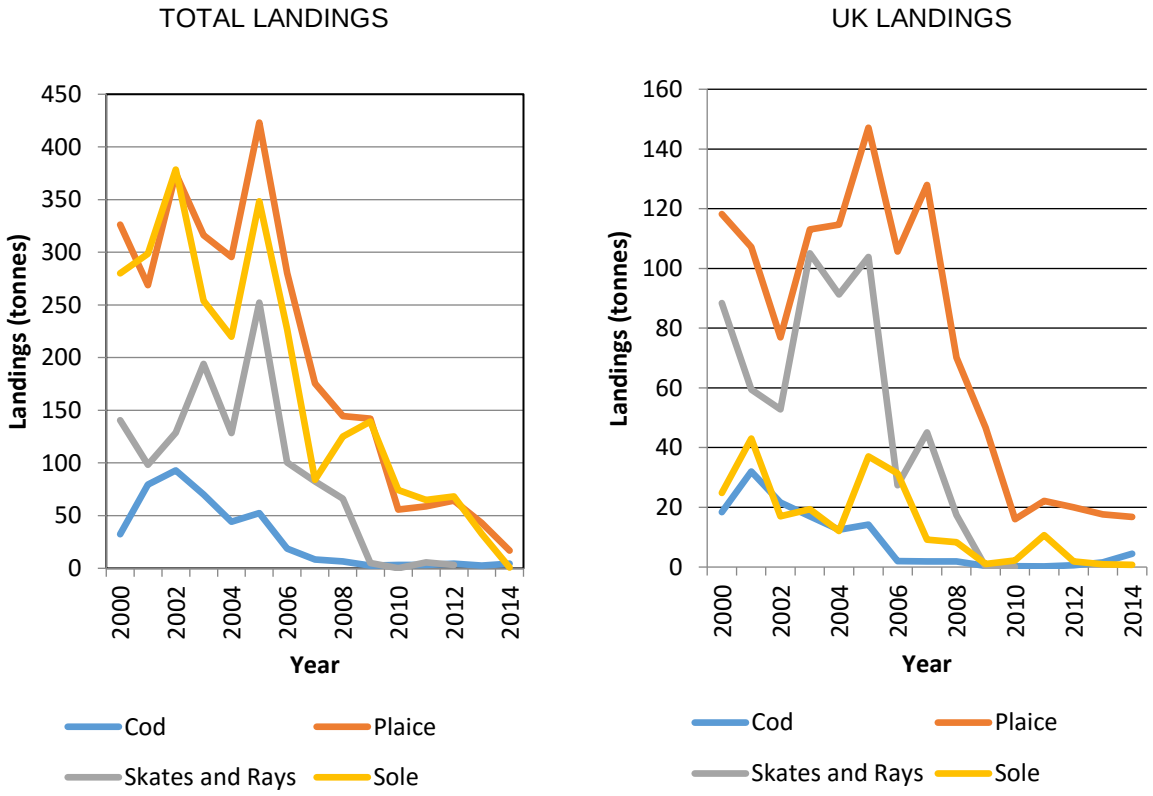


Table A.10 Total and UK landings of four main commercial species from ICES Rectangle 37E6 from 2000 to 2014 (tonnes)

	TOTAL LANDINGS				UK LANDINGS			
Year	**Cod**	**Plaice**	**Skates and Rays**	**Sole**	**Cod**	**Plaice**	**Skates and Rays**	**Sole**
2000	37.6	206.4	55.8	51.3	35.8	176.9	52.0	11.9
2001	56.6	247.6	66.2	67.7	35.9	187.0	54.7	12.3
2002	49.9	209.8	53.2	32.0	47.1	184.4	47.9	16.5
2003	42.6	155.0	129.2	56.1	31.6	102.6	114.7	21.4
2004	21.8	125.0	45.9	23.1	20.2	90.3	37.8	7.0
2005	41.3	180.4	90.0	42.8	37.3	147.6	70.4	9.1
2006	24.8	168.5	38.2	31.5	22.5	140.4	25.5	9.8
2007	24.8	143.4	49.5	35.7	22.9	126.0	37.8	16.0
2008	18.8	130.4	47.7	28.9	18.7	114.5	35.7	10.7
2009	9.0	72.5	12.9	31.9	8.2	64.3	8.7	5.9
2010	9.8	53.8	2.9	16.1	9.0	47.2	2.5	3.4
2011	7.1	46.1	0.1	20.6	6.2	36.8	0.1	6.7
2012	6.8	50.9	4.5	18.8	5.7	41.9	4.4	4.7
2013	1.8	39.8	12.2	7.7	1.6	36.2	12.2	4.6
2014	2.5	10.9	0.1	3.6	2.5	10.8	0.1	3.6

Figure A.14 Total and UK landings of four main commercial species from ICES Rectangle 36E6 from 2000 to 2014 (tonnes)

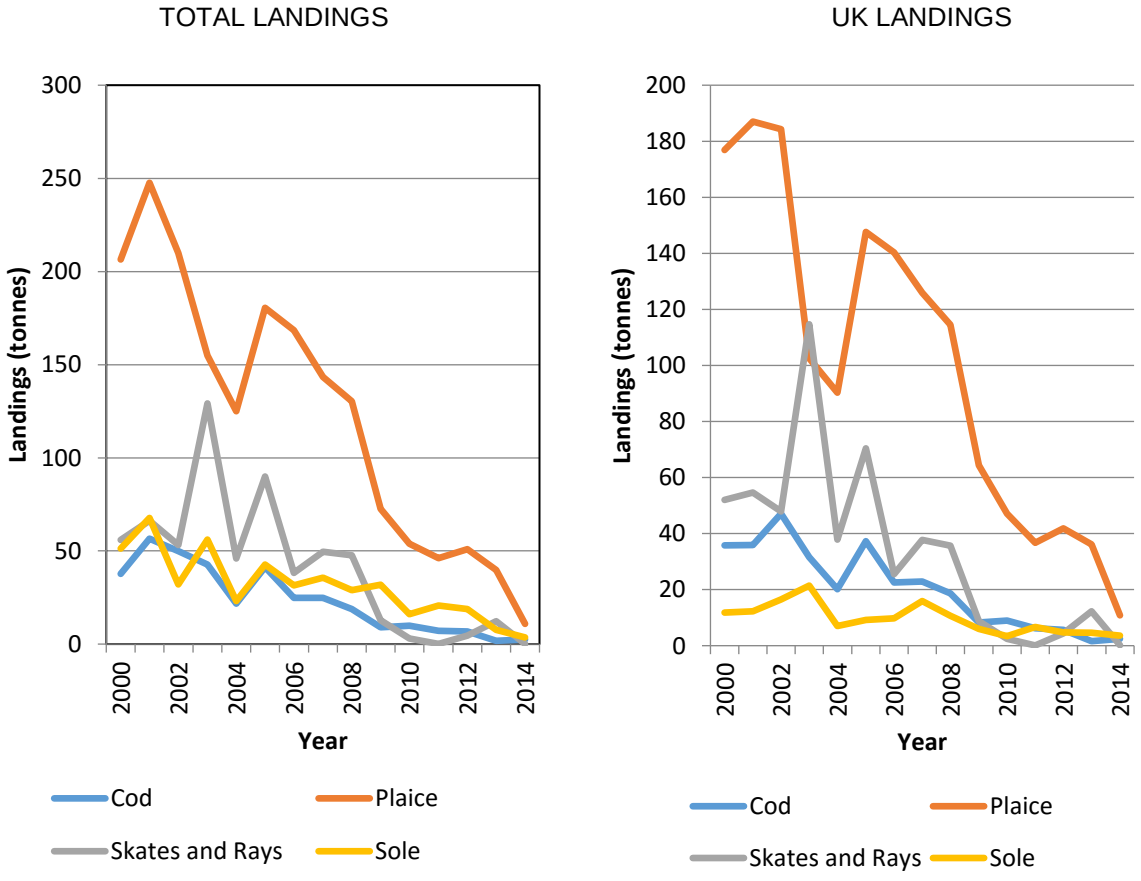
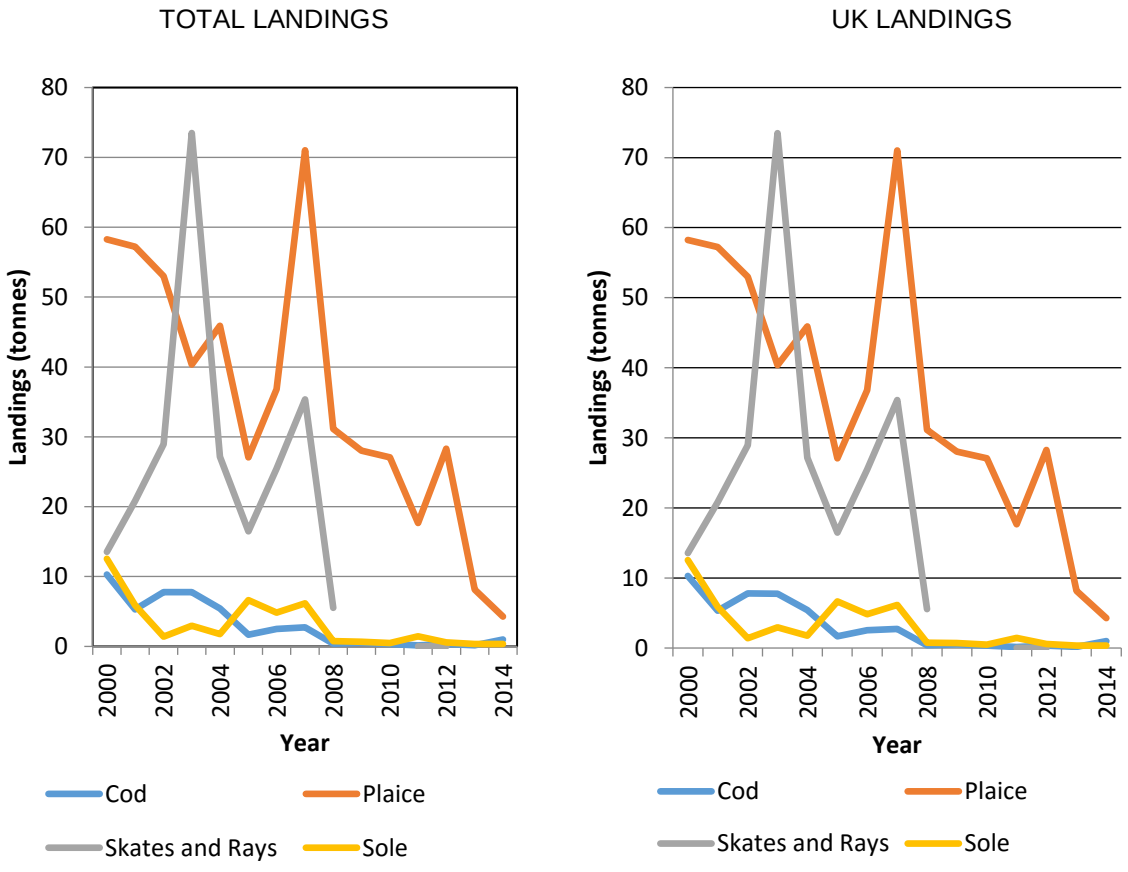


Table A.11 Total and UK landings of four main commercial species from ICES Rectangle 38E6 from 2000 to 2014 (tonnes)

	TOTAL LANDINGS				UK LANDINGS			
Year	**Cod**	**Plaice**	**Skates and Rays**	**Sole**	**Cod**	**Plaice**	**Skates and Rays**	**Sole**
2000	10.3	58.2	13.5	12.5	10.3	58.2	13.5	12.5
2001	5.3	57.2	20.8	5.9	5.3	57.2	20.8	5.9
2002	7.8	53.0	29.0	1.4	7.8	53.0	29.0	1.4
2003	7.8	40.4	73.5	3.0	7.8	40.4	73.5	3.0
2004	5.4	45.9	27.1	1.8	5.4	45.9	27.1	1.8
2005	1.7	27.1	16.5	6.6	1.7	27.1	16.5	6.6
2006	2.5	36.8	25.5	4.8	2.5	36.8	25.5	4.8
2007	2.7	71.0	35.4	6.2	2.7	71.0	35.4	6.2
2008	0.4	31.1	5.5	0.8	0.4	31.1	5.5	0.8
2009	0.5	28.0		0.7	0.5	28.0		0.7
2010	0.4	27.1		0.5	0.4	27.1		0.5
2011	0.1	17.7	0.0	1.4	0.1	17.7	0.0	1.4
2012	0.3	28.3	0.0	0.6	0.3	28.3	0.0	0.6
2013	0.2	8.1		0.4	0.2	8.1		0.4
2014	1.0	4.3		0.3	1.0	4.3		0.3

Figure A.15 Total and UK landings of four main commercial species from ICES Rectangle 36E6 from 2000 to 2014 (tonnes)



ANNEX G OFFSHORE WIND FARM MONITORING DATA

Summary of offshore wind farm development environmental predictions, and where applicable, monitoring results

Barrow Offshore Wind Farm

Owner: DONG Energy
Location: 7km SW of Walney Island, near Barrow-in-Furness
Construction: 2005
Commercial Operation: June 2006
Number of Turbines: 30

Factor	Predictions	Monitoring Results
Biological Environment	Protected benthos species are not anticipated in the area and the site is located outside of important shellfish areas	No rare, unusual or protected fish species recorded
	There will be no significant effect on marine mammals as the area is not considered rich in mammalian species	No pre or post-construction monitoring for marine mammals was carried out
	Spawning fish in the proximity of the wind farm have planktonic eggs which will be highly unaffected	No effect recorded
	Electro-sensitive fish are unlikely to be impacted significantly by Electromagnetic Fields	Electromagnetic Field measurements have not been taken
Fisheries	Fishing activity will not be greatly effected as there is limited fishing in the wind farm area	Liaisons with fishermen suggested that the site is not of high commercial importance
	It is likely that wind turbines will prompt some changes to current fishing methods within the farm site	No effect recorded
	It is unlikely that there will be a significant effect on commercially important species	There did not appear to be any clear of significant pattern for species abundance pre and post-construction
Navigational Risks	Assuming the adoption of risk reduction methods, collision and snagging risks are reduced to an acceptable level	Identification that some sections of the export cable were exposed

Robin Rigg Offshore Wind Farm

Owner: E-ON Climate and Renewables UK Ltd
Location: Solway Firth
Construction: 2008
Commercial Operation: 2010
Number of Turbines: 60

Factor	Predictions	Monitoring Results
Benthic Communities	No significant long-term impacts on benthos	No significant or permanent impact on the benthic fauna, however over the construction years there was a spatial shift in biotopes
Fish and Shellfish	Negligible impacts on commercially important flatfish Short-term displacement of demersal species Impacts on migratory and non-migratory fish expected to be low Effects of EMF to electro-sensitive fish are likely to remain negligible/minimal significance	During construction there was a significant change in the community structure of fish and epifauna, and evidence for a general decrease in species richness through time During operational surveys, fish and invertebrate numbers increased. Some evidence of difference in species diversity between pre-construction and operational year 1 for both the wind farm area and cable route were noted

Ormonde Offshore Wind Farm

Owner: Vattenfall Wind Power Ltd
Location: 10km off Barrow-in-Furness
Construction: May 2010 – February 2011
Number of Turbines: 30

Factor	Predictions	Monitoring Results
Benthic Communities	No species of conservation importance are anticipated within the site or cable route	
	Disturbance to soft sediment faunal communities will be short-lived	
	Loss of roughly 1.2 hectare if soft sediment habitat	
	Overall impact is considered to be minor	
Fish and Shellfish	Electro-sensitive fish are unlikely to be impacted significantly by the subsea cable	
	Migrating Salmon and Sea Trout could be affected by sediment plumes during construction	
	Overall impact is considered to be minor	
Marine Mammals	Overall impact is not considered to be significant	Very few sightings made during the course of the project
Commercial Fisheries	Presence of wind farm is unlikely to greatly impact the value of the fishery in the area	
	May result in a change of fishing methods from mobile to static	
	Both the summer prawn fishery and the inshore Rough ground will not be affected	
Navigation and Shipping	Siting of the project would not represent a navigation problem to commercial vessels leaving and entering the ports of Barrow, Fleetwood and Heysham	
Sediment and Coastal Process	Likely to have a localised impact on the waves, currents and sediment transport regime but there is not anticipated to be any measurable far-field impacts	Sediment disturbance was highly localised and temporary, affecting an area of less than 300 metres from the piling activity

West of Duddon Sands Offshore Wind Farm

Owner: DONG Energy and Scottish Power Renewables (50:50)
Location: 14 km from the coast of Walney Island, Cumbria.
Construction: 2013
Commercial Operation: 2014
Number of Turbines: 108

Factor	Predictions	Monitoring Results
Benthic Communities	No benthic species of conservation importance were recorded in the baseline survey 2005	
	Temporary loss of seabed area during the construction and potential smothering effects from the settlement of disturbed suspended materials	
Fish and Shellfish	Loss of habitat created by the introduction of hard substrates will impact fish and shellfish	
	By-catch discard species will benefit from the reduction of fishing during operation	
	Potential moderate negative impact from electromagnetic effects to elasmobranch species	
Sediment and Coastal Process	Likely to have a localised impact on the waves, currents and sediment transport regime but there is not anticipated to be any measurable far-field impacts	
Commercial Fisheries	Overall impact from loss of fishing area will be no greater than minor	
	Trawling will be excluded from the site, but it is possible that static gears may be feasible under certain conditions, including gears and anchoring methods	
	Based on the 14nm distance to the closest dredging licence area, there will be no impact during active dredging operations	

Walney 1 and 2 Offshore Wind Farm

Owner: DONG Energy (>50%)
Location: 15 km off Walney Island, Cumbria.
Construction: 2010
Commercial Operation: 2011 and 2012
Number of Turbines: 51

Factor	Predictions	Monitoring Results
Commercial Fisheries	Impacts arising from the loss of area will be vessel-specific, and mainly confined to vessels based at Fleetwood, Barrow and Kilkeel/Whitehaven The residual loss of access is expected to have only minor impact	Commercial fishing is permitted but there has been no standardised and co-ordinated gathering of data to quantify activities.
Physical Environment	Only negligible impacts on the physical environment are expected to occur	
Biological Environment	No special protected fish, shellfish or bottom fauna will be affected The impacts of EMF are considered to be negligible	In Walney 1, slightly higher catch rates and species diversity were recorded post construction, and catch rates of Nephrops showed a slight decrease post-construction In Walney 2 total catch rates for fish and shellfish were similar in all surveys with the exception of June 2009 pre-construction which was exceptionally high

Walney Offshore Wind Farm Extension

According to the 'Issue Specific Hearing 27 March 2014: summary of case – Biodiversity – Fisheries Monitoring' by DONG Energy, the applicant's position is that fisheries monitoring is not required either before, during or after construction because the findings of the ES are such that in EIA terms, the potential impacts on fish and shellfish are not significant, and are minimised further by mitigation measures. In response to questions raised by the examining authority (ExA) however, the applicant agrees that if required by the ExA, the applicant will carry out baseline surveys on the abundance of Nephrops and the abundance of elasmobranch species in locations where cable protection is proposed and burial is less than 1.5m in depth. Additionally, surveys will be undertaken (if required) annually for up to three years from the baseline to determine any changes.

Factor	Predictions	Mitigation Measures
Biological Environment	No rare or unusual species were recorded within the Project area, however, sparse patches of *Saberllaria alveolata* were recorded along the shore at the cable landfall site at Heysham	
	The southern cable landfall locations will overlap with the Lune and Wyre Estuaries rMCZ designated for nursery grounds for smelt and European eel	
	Habitat disturbance through increased sediments and related effects on filter-feeding and sessile species are anticipated to be of moderate significance	
Benthic Communities	Direct loss of habitat as a result of foundation installation and increases in suspended sediment are considered short term and are not considered to be significant	
Fish and Shellfish	The project and its export cable will fall within the spawning and nursery grounds of species include Sole, Plaice, Cod, Whiting, Mackerel and others	Mitigation in the form of limits on the timing and location of piling will be implemented
	A number of migratory and elasmobranch species could potentially transit or inhabit areas relevant to the project	
	No significant effects of electromagnetic frequencies associated with inter array and export cables are expected	Where cable burial is not an option, rock protection will be used

Physical Environment	Impact on sediment and water quality from cable installation is of negligible to minor magnitude	
	Taking a precautionary approach, the potential impact on water quality during construction activities for foundation preparation is predicted to be of major magnitude	
Commercial Fisheries	Residual effects from cessation of some fishing activities during construction were generally considered not to be significant	Engagement with local fishermen
	During operation, fishing will be allowed to continue within the wind farm site, and the effect on commercial fishing is not considered to be significant	

Burbo Bank Offshore Wind Farm

Owner: DONG Energy
Location: Burbo Flats in Liverpool Bay
Construction: 2006
Commercial Operation: 2007
Number of Turbines: 25

Factor	Predictions	Monitoring Report
Physical Environment	No additional impacts are expected on water levels, sediment transportation or contaminants from the construction or operation of the wind farm	Cable installation techniques had only small scale impacts on localised suspended sediment
Marine Ecology	Habitat disturbance will be insignificant, and no rare species are present	
	Impacts on seabed communities arising from the laying of submarine cables will be insignificant and recovery is expected to be rapid	There were considerable changes in the benthic fauna at most survey stations between 2005-2006, with marked reduction in numbers of many of the more abundant species; most noticeable in the central area of the wind farm site The overall community types at each station are relatively unchanged
	No significant operational impacts on intertidal invertebrates are expected to arise	Post construction intertidal biotope survey report indicated that there has been no significant effect on intertidal invertebrate communities or sediments
	Impacts from the EMFs are predicted to be insignificant	Construction report concludes that no more than a low magnitude impact to elasmobranchs is a justified conclusion, however monitoring is ongoing
Navigation and Shipping	The risks to commercial and recreational shipping are considered to be low	
Commercial Fisheries	The level of activity in the farm area is relatively low	
	Fishermen can continue to operate within the wind farm site	

Proposed Burbo Bank Extension Offshore Wind Farm

Owner: DONG Energy
Location: Burbo Flats in Liverpool Bay
Number of Turbines: 30-69

Factor	Predictions
Sediment Transport	Sediment transport and waves and currents will not be significantly changes by the project at any phase
Seabed Disturbance	Temporary seabed disturbance is likely to occur whilst installing turbine foundations
Subtidal and Intertidal Benthic Ecology	No highly important habitat or rare or unusual species are present in the proposed site
	Installation of cables with cause temporary loss of seabed habitats which will recover quickly
Fish and Shellfish Ecology	Habitat loss from turbine and scour protection installation
	EMF impacts will not be significant as a result of cable burial and cable armouring where necessary
	There may be a significant impact of construction noise on dover sole spawning, and also on the migratory patterns of salmon smolt, adult salmon, adult sea trout and whiting originating from the River Dee and River Mersey
Navigation and Shipping	No impact identified to be greater than moderate during any phase

ANNEX H BARRIERS TO AND OPPORTUNITIES FOR CO-EXISTENCE

A summary of the reasons put forward by fishermen, fisheries officers and wind farm operators as to why fishing was restricted inside wind farms, possible solutions to improve co-existence and who could initiate the solution.

Issues	Possible solutions	Initiator
Risks posed by turbines, cables, rock armouring, cable crossing points and waste material following construction.	Comprehensive, up-to-date and readily available maps of seabed hazards. Guidance on safe fishing practice inside wind farms. Skippers with experience of operating within wind farms impart their knowledge to others. Reduction and removal of seabed hazards such as waste material. Use of fishing-friendly cable armouring structures.	Wind farm developers and FLOWW
Uncovering of cables due to natural seabed movement.	Durable cable armouring and regular monitoring of the status of cables.	Wind farm developers
Permanent fishing exclusion zones.	Review the need for fishing exclusion zones and explore the possibility of conditions being imposed on fishing gear and operations as an alternative.	Wind farm developers, fishermen and FLOWW
Impact of decommissioned wind farm infrastructure and removal.	Agreement to remove all wind farm infrastructure. Assessment of the impact of infrastructure removal on fishing activity and the environment.	Wind farm regulators and wind farm developers

Issues	Possible solutions	Initiator
Fishing closures due to maintenance work.	Minimise disruption caused by maintenance work by minimising closure times and improving communication of closures and the need for the maintenance work.	Wind farm developers
Conflict between maintenance and fishing vessels.	Improve working relationships through communication and working agreements.	Wind farm developers and fishermen's representatives
Loss of fishing gear due to maintenance work.	Allow fishermen time to remove fishing gear.	Wind farm developers and fishermen
Increased steaming distance and time to fishing grounds beyond wind farms.	Identify safe passage through wind farm sites.	Wind farm developers and FLOWW
Construction and operation of wind farms has reduced the population of *Nephrops* and demersal finfish that were found on the wind farm sites post-construction.	Ecological monitoring of wind farms could include regular assessment of the status of commercial shellfish and finfish. If necessary, expand monitoring to cover commercial species.	Wind farm regulators and wind farm developers
Use of limestone for rock armouring which is claimed to have extirpated local marine life.	Evaluate the risks of using limestone. Review alternative fishing-friendly methods and materials for cable armouring.	Wind farm developers and FLOWW
Cumulative spatial pressure on fishermen from multiple activities, interests and fisheries management.	Provision of evidence to protect fishing grounds and fishing industry engagement in marine industry development. Better coordination and communication of marine spatial management, which could be achieved through the English Marine Plans. However, the timescale for delivery is 2020 and a strategic approach is lacking.	Fishermen's organisations, fisheries management and marine planning bodies (eg MMO)

Issues	Possible solutions	Initiator
Inaccurate information on the importance of fishing grounds which are developed into wind farms.	Improve consultation and information flow between wind farm developers and fishermen.	Wind farm developers, fishermen's representatives and FLOWW
Site wind farms away from prime fishing grounds.	Provision of evidence to protect fishing during strategic (eg zonal appraisal) and wind farm planning stages.	Fishermen's organisations and MMO
Inequitable compensation agreements.	Fair compensation scheme ensuring equitable and proportionate compensation.	Wind farm developers and fishermen

ANNEX I WEST OF MORECAMBE FISHERIES FUND

The West of Morecambe Fisheries Fund (WoMFF) was established in 2013, operating through a not for profit company, the West of Morecambe Fisheries Ltd. This administers donations from the owners of several UK offshore windfarms in line with their corporate social responsibility objectives. Voluntary donations to the fund are made following the commissioning of the respective wind farms.

Funding is directed to community projects of direct benefit to the fishing industry operating within the vicinity of the donating wind farms. In the Eastern Irish Sea this currently includes the Walney (1 and 2), Ormonde, and West of Duddon Sands Offshore Wind Farms. In the North Sea this includes the Westermost Rough Wind Farm.

In the case of the Eastern Irish Sea, project applications are invited from the fishing industry on an annual basis. They are first reviewed by a Fishing Industry Advisory Group comprising of representatives covering all of the relevant fishing ports. Applicants are invited to attend a review meeting to present their projects. The advisory group then makes recommendations on projects to support to a Steering Group of wind farm owners. The Steering Group undertakes its own review, prior to taking final decisions on projects to fund.

The following principles guide whether or not an application is deemed suitable for funding:

a) Fairness – is the application in proportion to the affected fishing community? Projects must not represent a disproportionate use of the available funds for any one community.

b) Appropriateness – is the application to fund something appropriate?

c) Recommendations – as received from the Industry Advisory Group

d) Who will benefit? – Projects which benefit multiple individuals in a community rather than individuals are preferred

Further information can be found at: http://www.westofmorecambe.com/

THE CROWN ESTATE

London
The Crown Estate
16 New Burlington Place
London
W1S 2HX
T 020 7851 5000

Edinburgh
The Crown Estate
6 Bell's Brae
Edinburgh
EH4 3BJ
T 0131 260 6070

Glenlivet
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Tomintoul
Banffshire
AB37 9EX
T 01479 870 070

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The Crown Estate
The Great Park
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SL4 2HT
T 01753 860 222

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