Science Series
Technical Report no.133

A report on the perceptions of the fishing industry into the potential socio-economic impacts of offshore wind energy developments on their work patterns and income

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SEAFISH Cefas

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This report represents the views and findings of the authors and not necessarily those of the funders.

Contents

Executive summary

Offshore wind farms in the Greater Wash, Thames estuary and North West could make a significant contribution to the UK's commitment to renewable energy. However, the extent of proposed 'Round 2' wind farms will affect a range of marine users and environmental resources. Defra commissioned this investigation to seek the views of the UK fishing industry into the potential implications of proposed Round 2 offshore wind farm developments on their work patterns and income. The project was intended only to gather the views of the fishing industry in the three Strategic Areas, not those of the wind farm developers or the government departments responsible for the licensing and consenting process.

Invitations to participate in the study were made to the fishing community between May 1st – September 30th 2005 through 'Fishing News' articles, and individual mailings to fishermen in the affected areas, their Associations, and Organisations. Fishermen were offered the opportunity to describe and explain their perceptions of the likely impacts of the construction and operation of wind farms on them in face-to face meetings, phone conversations and questionnaires. A workshop was held to raise awareness of the project with the fishing industry, wind farm developers and their Fishery Liaison Officers, and government officials. Despite these efforts the response rate by fishermen was very poor, so it cannot be concluded that the results reported in this study are representative of the entire industry. Although the views described in this report are from a small group, it is still important that they are made widely available to stimulate further discussion and to encourage other members of the fishing industry to continue this open dialogue with government.

This report summarises the extent of fishing activities in the three Strategic Areas, and describes the perceptions of fishermen into the socio-economic implications of wind farm developments for their industry. The report also suggests mitigation measures for fleets that may be disadvantaged by such developments and provides guidance on how the methods used here might be used to assess the impacts of other offshore developments on fisheries.

Fisheries within the 3 Strategic Areas are numerous and varied; 27 distinct fleets or 'métiers' can be defined. More than three quarters (700+ vessels) of the fishing fleet within the 3 Strategic Areas consists of small, relatively low-powered vessels that fish on inshore grounds near to their local port. Such vessels tend to have limited opportunity to move or extend their fishing grounds, particularly when other vessels already fish neighbouring grounds. A detailed description of fishing 'métiers' and results of an investigation into what fishing activities may be carried out in and around wind farms is provided in a report available from the FLOWW group ('A study to identify those fishing activities that can be safely carried out in and around wind farms').

Causal mapping was used as a tool in the dialogue between fishermen and researchers. The method helped researchers to structure the information in a way that allowed a comprehensive and transparent understanding of the knowledge, views and perceptions expressed by fishermen, and to communicate that information to Defra in a simple and effective way.

The causal maps successfully captured discussions with fishermen, identifying 7 linked areas of concern related to (i) Fishing activities, (ii) Socio-economics, (iii) Environment, (iv) Hazards, (v) Mitigation, (vi) Communication & trust, (vii) Decision making & prioritisation.

Potential loss of access to traditional fishing grounds was widely considered to be a major concern and led to uncertainty for the future. Fishermen frequently reported that there were no alternative grounds and that displacement amongst the smaller <10 m vessels would lead to increased competition, conflict and escalating fuel costs. It was believed that larger vessels excluded from existing grounds would be similarly impacted, and, if displaced to neighbouring inshore grounds could displace several smaller vessels for each larger vessel. Their additional concerns of short and long-term disruption to fish behaviour patterns and abundance caused during construction and operation, suggested that the overall impacts of wind farm development were strongly negative. This view was widely held by fishermen, with few regarding wind farm development as an opportunity, other than the potential to fish within wind farms using fixed gear, and the possible conservation benefits to stocks if access was reduced.

Reduced catches and increased costs not only impact individual profitability, but could also lead to compromised safety and have implications for communities where fisheries are strongly embedded in the local economy. Many fishermen were concerned about their futures and the potential loss of heritage.

A large proportion of vessel businesses operating in the 3 Strategic Areas are currently earning low profits. While some shellfish potting vessels have good levels of profitability, most vessels using nets (trawled, drift or static) are vulnerable to increases in costs or reductions in earnings.

It was widely expected by those fishermen consulted that wind farm areas will have to be avoided by vessels using nets and that this will disrupt existing fishing patterns substantially. Longer steaming time will increase fuel costs and reduce fishing time and therefore fishing earnings. The resulting operations may not be profitable. The apparent widespread low profitability suggests that there is a risk of vessel business failure.

Options to change business practices are limited by licences, quota, vessel size and availability of capital. Some larger vessels may relocate, reducing the value of landings in their previous homeport. Business failure or relocation would lead to loss of landings from the 3 Strategic Areas. As a consequence, it was considered that upstream and downstream businesses would be affected and may also experience reduced profit or business failure if unable to diversify.

Recreational sea anglers were the only group to describe as beneficial the expected overall economic change generated. Market demand for commercial charter angling was not considered great enough to support many boats even if the fishing was good.

For a range of reasons, this study was unable to establish comprehensive and detailed data on current fishing activities, costs and earnings of vessels in all the areas that may be affected by all planned Round 2 wind farms. This information will be needed to accurately assess the impacts on vessel profits caused by having to avoid wind farm areas, to make an objective assessment of any claim of loss of profit due to the presence of wind farms.

Turbines were considered a major hazard to navigation and fishing activities, with some fishermen expressing the opinion that they would avoid wind farms even though they are allowed to fish within them. Most were very concerned about their ability to insure their vessels when operating near or within wind farms, suggesting that any accident would result in large increases in insurance or companies declining to provide cover.

In relation to planning issues and decision making, it was evident from discussions and analysis of causal maps that there was a poor understanding of the planning process by fishermen, although through the consenting process the government consults the fishing industry widely. Lack of information upon which to base decisions was specifically highlighted by fishermen as an important concern and underlies many of the issues relating to perceived poor or biased planning and decision-making. The combination of these factors exacerbated fishermen's feelings of alienation.

The views reported by fishermen indicated that mistrust of the planning processes and authorities was partly a result of previous negative experiences of offshore planning. Fishermen perceived that Round 2 wind farms would impose yet more restrictions on their industry, already affected by the development of other industries in the coastal zone such as oil and aggregate extraction, dredging, port developments and Round 1 wind farms.

Fishermen found it difficult to provide ideas for mitigation measures that adequately addressed their concerns. The numerous uncertainties surrounding how wind farms impact ecology, navigation and sediment dynamics, and potential consequences for their normal fishing methods and grounds, made it difficult for them to see how they might be able to adapt. The incentive to adapt by changing fishing methods was low, with lack of licences, the time taken to learn new methods and high investment costs stated as the main barriers.

Generic or area-based options for mitigating the impact of wind farms on fisheries were not identified, principally because there was no location or season in which the impacts of wind farm construction or operation would not disrupt fisheries. In addition, respondents felt that there was a general lack of information available to fishermen to help them understand the issues and actively contribute to such discussions. It was concluded that the unique ecological and socio-economic environment of each proposed development site will require site-specific mitigation options to be considered on a case-by-case basis.

Concern over the sustainability of their livelihoods and knock-on to effects to communities meant that the issue of 'industry support' or compensation featured strongly in the minds of many fishermen. It was not an objective of this report to evaluate options for compensation. The Fisheries Liaison with Offshore Wind and Wet renewables group (FLOWW) has agreed a number of guiding principles surrounding compensation matters and the results of it's work can be found at:

http://www.bwea.com/pdf/offshore/fisheries_framework.pdf

Soliciting the participation of fishermen in this study proved difficult, requiring us to adapt the approach to circumstances. Therefore the responses obtained, and the outcome of many face-to-face interviews undertaken, have provided an honest but limited description of fishermen's views and concerns of the development of round 2 wind farms, and the perceived threats to their livelihoods.

During recent years, European fisheries management has encouraged cooperation rather than administration;

providing opportunities for managers, scientists and fishermen to work more closely on the common problems they face. Many of the uncertainties highlighted in this report are being addressed by this approach, and by the joint identification of studies that could be undertaken at existing Round 1 sites and/or Round 2 sites due for development. Lessons learned from the interaction with fishermen in this work demonstrate that it is vital to include fishermen as collaborating partners to help specify priorities for investigation and in the design and undertaking of such field studies. It is important that the government sponsored Fisheries Liaison with Offshore Wind group continues to focus on this role.

1. Introduction

1.1 Report structure

This report describes the findings of a one-year study on the impacts that Round 2 wind farms may have on fishing activities and livelihoods of fishermen in the UK. The rationale and objectives of the study are provided first, followed by a brief overview of the research approaches undertaken (Section 2). The main findings are then detailed, each in a separate section corresponding to a specific objective of the study. At the end of each section, a summary of the main findings/ and conclusions is given. These are also collated in Section 8.

1.2 Background (Problem statement)

Renewable energy has a crucial role to play in delivering sustainable development and in achieving the Government's commitment to reduce carbon dioxide emissions and combat climate change. The Government has a target to generate 10% of UK electricity from renewable energy sources by 2010 and an aspiration to double that to 20% by 2020. Offshore wind energy has been identified as a key contributor towards achieving the 2010 target.

The assessment of the consent applications for the development of offshore wind farms requires the relevant Government Ministers to consider the impacts of the projects both in regard to any direct effects from the project and any effects arising from interactions with other marine industries. Two key consents are necessary.

(i) Licence for construction at sea, administered by Defra (Marine Environment Division) under the Food and Environment Protection Act (1985), for the purpose of protecting the marine ecosystem and human health and minimising interference and nuisance to other users of the sea.
(ii) Statutory consent to generate electricity, administered by The Department of Trade and Industry (Dti) under the Electricity Act (1989).

The purpose of this research is to address a current policy need in Defra by providing scientifically robust information to help guide decisions on permitting spatially demanding offshore wind energy developments that may interfere with or displace fishing activities.

Development of wind farms off the UK coastline started in 2001, when the Crown Estate offered leases for wind farm development at 18 sites (of up to 10 km^2, and most sites using approximately 30 turbines). Twelve of these, 'Round 1' wind farms have received construction licences from Defra and electricity generation consent from Dti. After a process of Strategic Environmental Assessment, commissioned by Dti early in 2003, Crown Estates awarded leases for 15 'Round 2' sites spread over three 'Strategic Areas', the Thames Estuary, the Greater Wash and the North West coast of England and Wales (Figure 1). The size of the proposed wind farms was of a much greater scale than those announced in Round 1 (up to 200 km^2 and up to 250 turbines).

The development and construction of Round 1 wind farms around the coast of the UK has caused alarm amongst coastal fishing communities who see a threat to the continuation of their lawful activity. Planning for the much larger Round 2 sites in the same regions has increased their concern. The perceived difficulties centre around the loss of access to the area of the wind farm site which may have provided good fishing opportunities, and other effects of construction and operation on fish and shellfish resources. While developers have a responsibility to assess the impacts of their plans on others, including cumulative and in combination effects, it is not clear what the broad implications will be for the fishing industry from such extensive developments. Since fishermen are the main users of the marine environment that are likely to be in conflict with wind farms, it is necessary to have dialogue with the UK fishing industry to consider their points of view and concerns on the continued development of offshore wind farms.

1.3 Aim and objectives

The aim of this study is to describe the impacts that Round 2 wind farm developments may have on the activities and livelihoods of fishermen. There were five objectives listed in the contract:

1. Provide a broad overview of the distribution and activity of fish and shellfish fisheries, as well as recreational fishermen, for the three Strategic Areas under development in Round 2.
2. Consult directly with representative parts of the fishing industry for the purpose of describing and evaluating key concerns, especially prospects of displacement and / or opportunities for fisheries development as a result of wind farm developments.
3. Detail the socio-economic implications by port/métier/ fleet (i.e. not a detailed socio-economic study of each fisher).
4. Offer recommendations for mitigation options to fleets that may be disadvantaged.
5. Provide direction and discussion on how to assess the cumulative effects of the Round 2 wind farm developments on fisheries, which can in the future be used for assessing the impact of other human activities.

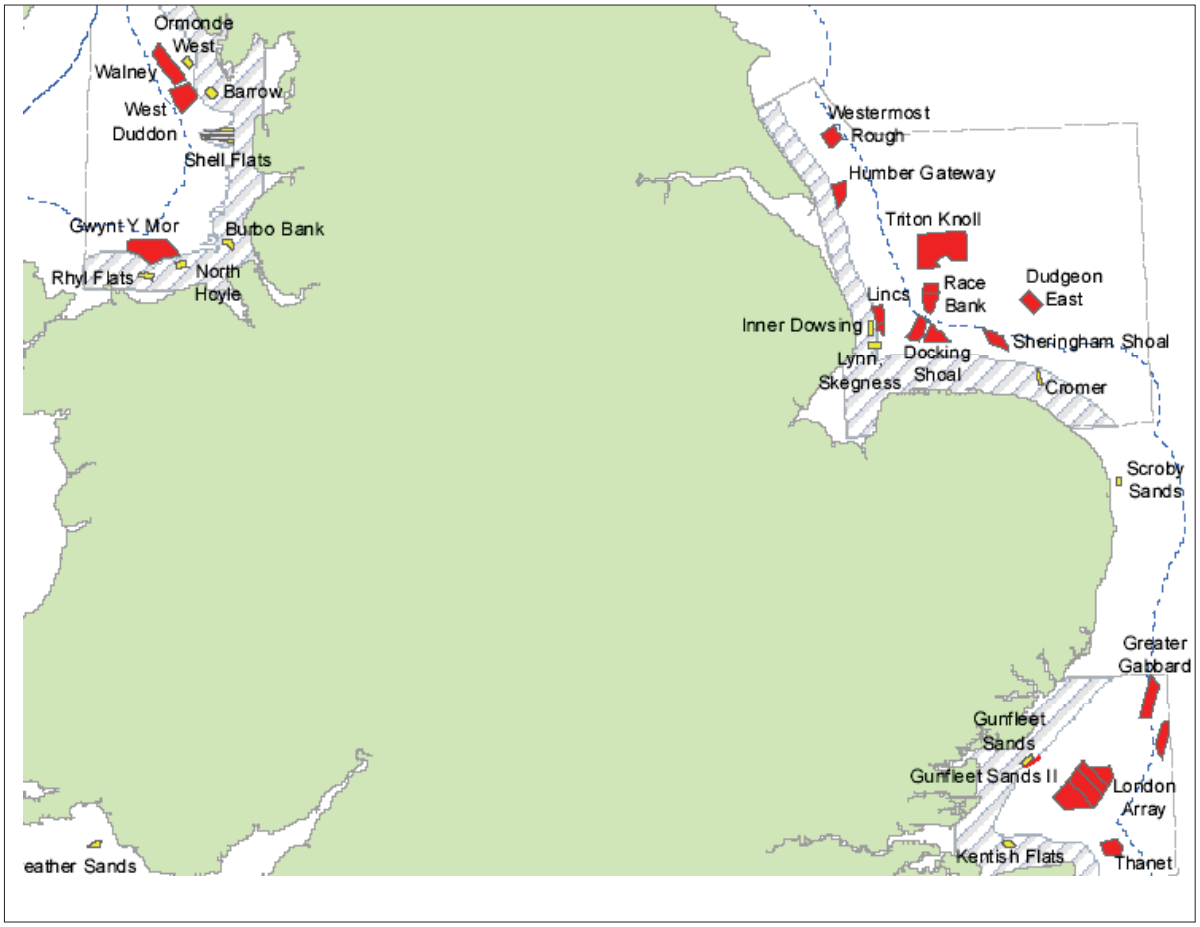


Figure 1.1. Site leases for proposed 'Round 2' wind farms (Red). Round 1 sites yellow. Grey hatched area indicates 6 nm DTI exclusion zone. Blue dashed line indicates 12 nm limit. Grey dashed line indicates DTI Strategic Environmental Assessment area. (Note: more detailed Kingfisher Awareness Charts are available for download from: http://www.cefas.co.uk/renewables/default.htm

1.4 Complementary work

This work was planned and conducted in parallel with a Dti-funded study commissioned on behalf of the Fisheries Liaison with Offshore Wind and Wet renewables group (FLOWW): 'A study to identify those fishing activities that can be safely carried out in and around wind farms'. Tasks relating to consulting with the fishing industry were planned to ensure a coordinated approach to soliciting information from fishermen, although delays to the start of the Dti contract resulted in work not being as coordinated as originally planned. This resulted in fewer people on the ground to ask questions. Nonetheless, there were several areas of overlap. Questionnaires distributed in this investigation included questions on specific aspects of vessels and gear operation that were required by the Dti study. A joint workshop was held, and descriptions of fleets and fisheries undertaken through the Dti study were used in the summary of the distribution and activity of fish and shellfish fisheries presented in Section 3 below. Readers are referred to the the FLOWW group for information on the outcomes of the Dti-funded investigation.

Key points

- Planning wind farms has caused alarm amongst coastal fishing communities who see a threat to the continuation of their lawful activity.
- Since fishermen are the main users of the marine environment likely to be in conflict with wind farms, it is necessary to have dialogue with the UK fishing industry to consider their points of view and concerns.
- This research addresses a current policy need in Defra by providing scientifically robust information to help inform decisions on permitting spatially demanding offshore wind energy developments.
- It describes the impacts that Round 2 wind farm developments could have on the activities and livelihoods of fishermen.

2. Research approach

The approach taken to address objectives 1-4 was designed to provide fishermen with adequate opportunities to contribute their knowledge, views and information on fishing activities and earnings through face-to face meetings and questionnaires. In addition to the information from fishermen, data from Defra's Fishing Activity Database for the years 2000-2004, and summary information obtained from Seafish* was also used to address objective 1 and 3.

** Undertaken for the Dti-funded study: 'A study to identify those fishing activities that can be safely carried out in and around wind farms' (FLOWW report).*

Specific approaches to research activities were tailored to be flexible enough to meet individual circumstances and availability of fishermen operating within the 3 Strategic Areas. Detailed methodology is presented in each of the main sections dealing with the 5 objectives of the contract, but there were 4 main phases to the project:

2.1 Awareness raising

Information and invitations to participate were extended to the fishing community through the Fishing News, by individual mailings to fishermen in the affected areas, announcements to fishermen's associations and organisations and via websites (Appendix 1).

Environmental Statements and Environmental Impact Assessments from Round 1 and Round 2 wind farm developments were reviewed for the purpose of providing background knowledge of the issues and to ensure that the study did not duplicate information already available. During this time, contact was made with, and information sent to, Fisheries Liaison Officers of several wind farm developments.

2.2 Information (1st May - 30th September)

At fishermen's request, **face-to-face meetings** were held with both groups and individuals at venues of their choosing. Discussions centred mostly on their knowledge, views and concerns, but also considered mitigation options (objectives 2 & 4). Flow diagrams of the linkages between causes and effects (*causal maps*) were used to help provide structure to the discussions and to enable researchers to effectively capture this information in a straightforward and transparent way.

Questionnaires were sent to all those who requested them by post and given to all participants at face-to-face meetings. Additional copies were provided for distribution to fishermen unable to attend the meetings. Questionnaires were designed to provide quantitative information to describe fishing activities and their value (objective 1), capturing industry's views on the impacts of wind farms (objective 2), how these impact fishing activities and their value (objective 3) and considering mitigation options (objective 4). (Appendix 2).

A **workshop** was held to provide the fishing industry, planners, developers and government with feedback and an opportunity to share knowledge and learn from the preliminary results of this study and the Dti funded project 'A study to identify those fishing activities that can be safely carried out in and around wind farms' (FLOWW report).

As recommended during the workshop, a request was made for **fishermen's associations to contribute economic information** by summarising average earnings and costs for typical vessels operating in the wind farm areas. The request was restricted to those organisations that had already contributed to the study through face-to-face meetings. (Appendix 1, 1.8)

2.3 Synthesis

Qualitative and quantitative information collated through meetings, questionnaires and the workshop have been analysed and summarised to provide an overview of the socio-economic impacts of Round 2 wind farms on fishing activities and livelihoods. Findings relating to each of the objectives are presented in the following Sections (3-7), with supplementary information and technical details provided in appendices.

2.4 Communication of findings

This document reports the main findings. All documentation together with supplementary information is available from the web at:
http://www.cefas.co.uk/renewables/default.htm

Key points

- Objectives 1-4 were addressed through consultation with fishermen and analysis of Defra's Fishing Activity Database.

3. Distribution and activities of fish and shellfish fisheries

Objective 1.
Provide a broad overview of the distribution and activity of fish and shellfish fisheries, as well as recreational fishermen, for the three Strategic Areas under development in Round 2.

3.1 Identifying boats fishing in wind farm areas

Two sets of criteria were used to identify from Defra's Fishing Activity Database those boats fishing in the proposed Round 2 wind farm areas. The first criterion identified boats that reported fish catch within the ICES rectangles encompassed by the wind farm strategic areas during the period 2000-2004 (Appendix 1, Table A1.1). This identified mainly those vessels over 10 m long since they are obliged to report catches. Vessels under 10 m, whose owners do not have a statutory obligation to report catches, were identified using the criterion that either their homeport or administration port occurred in the wind farm areas (Appendix 1, Table A1.2). It assumes that these smaller vessels operate locally. The database does not include information on charter angling vessels.

3.2 Fleet Structure

Nine hundred and twenty two (922) UK registered fishing vessels undertake commercial fishing within the three strategic wind farm areas and, may be affected by the proposed developments (Figure 3.1).

Over 700 (76%) of these vessels are less than 10 m in length (mean = 7.5 m), are relatively low powered (mean horse power = 60) and are not required to report their catches. These small, relatively low-powered vessels fish on inshore grounds close to their homeport. Of the 220 vessels larger than 10 m, nearly half are less than 16 m long and only 8% exceed 30 m. The mean length is 18 m and mean horse power = 304.

Mainly locally registered vessels fish within the 3 Strategic Areas (Table 3.1). English registered vessels make up most of the fleet numbers, particularly in the ≤10 m sector. The North West area has the largest diversity of vessel nationalities because it is bordered by Scotland, Northern Ireland, Wales and the Isle of Man in addition to England. Numbers of Scottish registered vessels are relatively evenly spread over all of the areas. Information for visiting vessels registered outside of the UK/British Isles is unavailable.

3.3 Employment

The total numbers of crew employed by fishing vessels in the 3 Strategic Areas is estimated to be around 2000, with numbers per vessel being linked closely to size of vessel (Figure 3.2). The total crew of the under 10 m fleet is approximately double that of larger vessels. Details of crew numbers are unavailable for a quarter of the vessels, the majority (65%) of which are less than 10 m in length. Assuming that those vessels for which no information exists have, on average, the same crew as similar sized vessels, the total number of crew presented in Figure 3.2 (approx. 1500) is raised by about 500.

Figure 2.1. Numbers of UK commercial fishing vessels in each wind farm area.

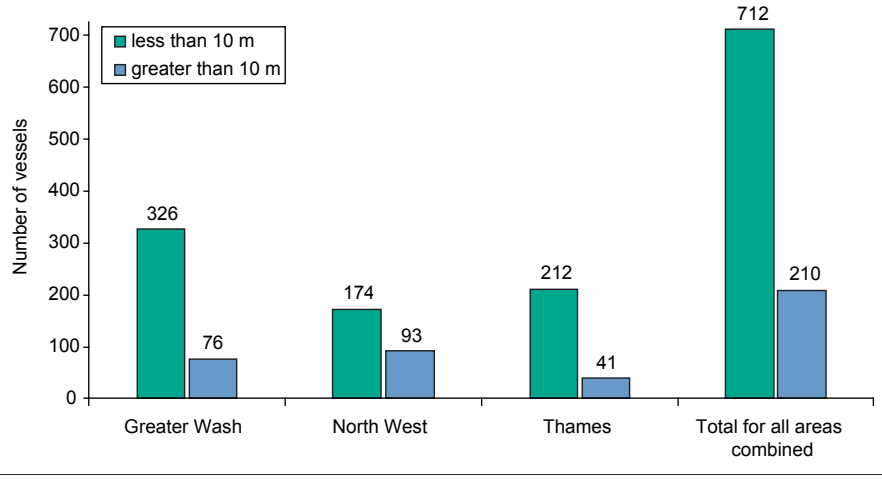
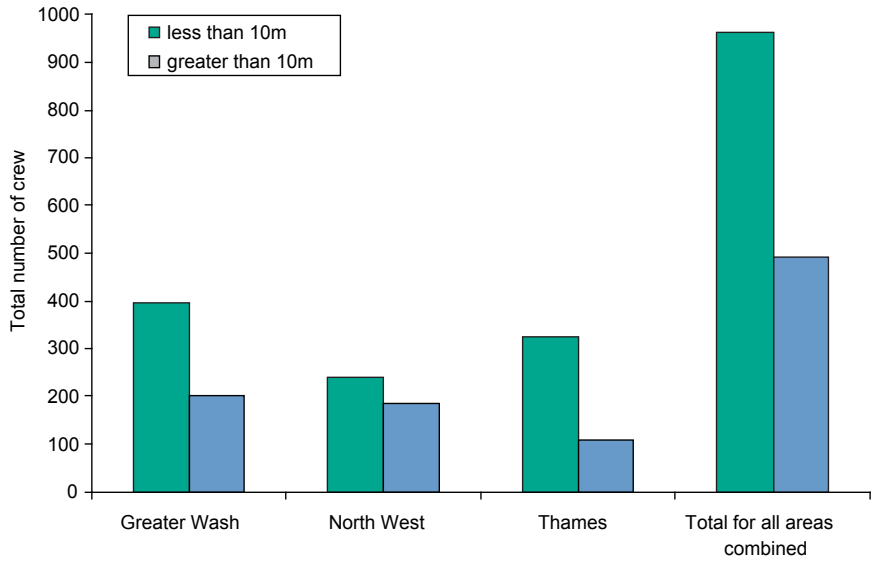


Table 3.1. Country of registration of UK and British Isles vessels fishing in each of the three Strategic Areas.

Strategic Area	Total	Number of vessels					
		Country of origin					
		England	Isle of Man	Jersey	N. Ireland	Scotland	Wales
Greater Wash	400	383	0	2	0	15	0
North West	269	171	1	2	34	26	34
Thames	253	243	0	0	0	10	0
Total	922	798	1	4	34	51	34

Figure 3.2. Number of crew employed in each region according to vessel size.



3.4 Fisheries in each Strategic Area

Twenty six distinct fleets or 'métiers' can be defined across the three Strategic Areas (Table 3.2). The métier concept identifies and distinguishes fishing activity according to the gear used, main target species, fishing grounds and season of the fishery. Using these descriptions, a métier can be defined as a category of fishing activity whose methods and timing of fishing result in the catches from vessels within the métier being very similar. It is chosen as a convenient unit to describe fishing activity since it allows for convenient operational groupings to be made without oversimplifying the complexity of fishing activities.

An overview of the main fishing activities in each Strategic Area is given below.

Table 3.2. Overview of the active fisheries (shown by X) in each of the three areas. Those of particular local importance (size and value of fisheries) are marked with (*). The table includes a simplified gear category referred to in Section 5, and is adapted from a comprehensive review of regional fisheries presented in the FLOWW report "Fishing activities that may be carried out in and around offshore wind farms" and references therein.

Gear type category	Métier	Greater Wash	Thames	North west
Fixed nets, Drift nets and Lines	Gill and trammel nets for cod and whiting in the winter	X	X*	X
	Tangle and trammel nets for small flatfish (sole and plaice)	X	X*	X
	Tangle and trammel nets for large flatfish (turbot, brill) and rays	X	X	X
	Fixed and drift nets for bass, sea trout and mullet	X	X*	X
	Drift nets for herring	X	X*	
	Fyke net fishery for eels	X	X	
	Longlines for cod, rays and dogfish	X	X	X
	Longlines and handlines for bass		X	
Trawling for whitefish, nephrops, sprat, herring, shrimp	Nephrops trawling			X*
	Beam trawlers (<10 m vessels)	X*	X	X
	Beam trawlers (>10 m vessels)	X*	X	X*
	Otter trawlers (<10 m vessels)	X	X*	X*
	Otter trawlers (>10 m vessels)	X	X	X*
	Midwater trawl for bass		X*	
	Midwater trawl for herring		X	
	Midwater trawl for sprat	X	X	
	Shrimp fishery with beam trawl or twin beam trawl	X*	X*	X*
Shellfish dredging	Cockle dredging (suction dredging)	X*	X*	X
	Mussel dredging (Baird dredges)	X*	X	X
	Oyster dredging	X*	X	
	Scallop dredging			X*
Shellfish potting	Brown crab potting	X*	X	X*
	Lobster potting	X*	X	X*
	Whelk potting	X*	X	X
	Whiteweed raking		X	
	Seine netting	X		X*

3.4.1 Greater Wash

Vessels numbers		Crew numbers	
under 10 m	over 10 m	under 10 m	over 10 m
326	76	397	201

The most commercially important inshore fisheries in this area are for shellfish (Figure 3.3). In the Wash and along the north Norfolk coast, mussels, cockles and oysters are the mainstay of the fisheries. Both wild and cultivated stocks of mussels are important, with harvests occurring during winter when the meat quality is best.

Chalk reefs from north Norfolk up to Bridlington support important fisheries for brown and velvet crabs, lobsters and whelks from spring to autumn. Many beach boats still use traditional wooden creels, although parlour pots made out of metal or plastic have become more popular.

Beam-trawling for shrimp is undertaken by boats from Boston and King's Lynn all year round with brown shrimp caught in greater quantities than pink shrimp. The shallow waters in which the fisheries operate are important nursery grounds for a number of finfish, e.g. plaice, sole, cod and herring.

Along the north Lincolnshire and Suffolk coasts finfish are caught, most commonly by small beach boats (~6 m) netting within one to two miles offshore or long lining up to 12 miles offshore. These longshore boats mainly exploit seasonal fisheries catching sole, bass, sea trout and mullet in summer; shrimp, herring and whiting in autumn; cod and sprats in winter; rays in spring.

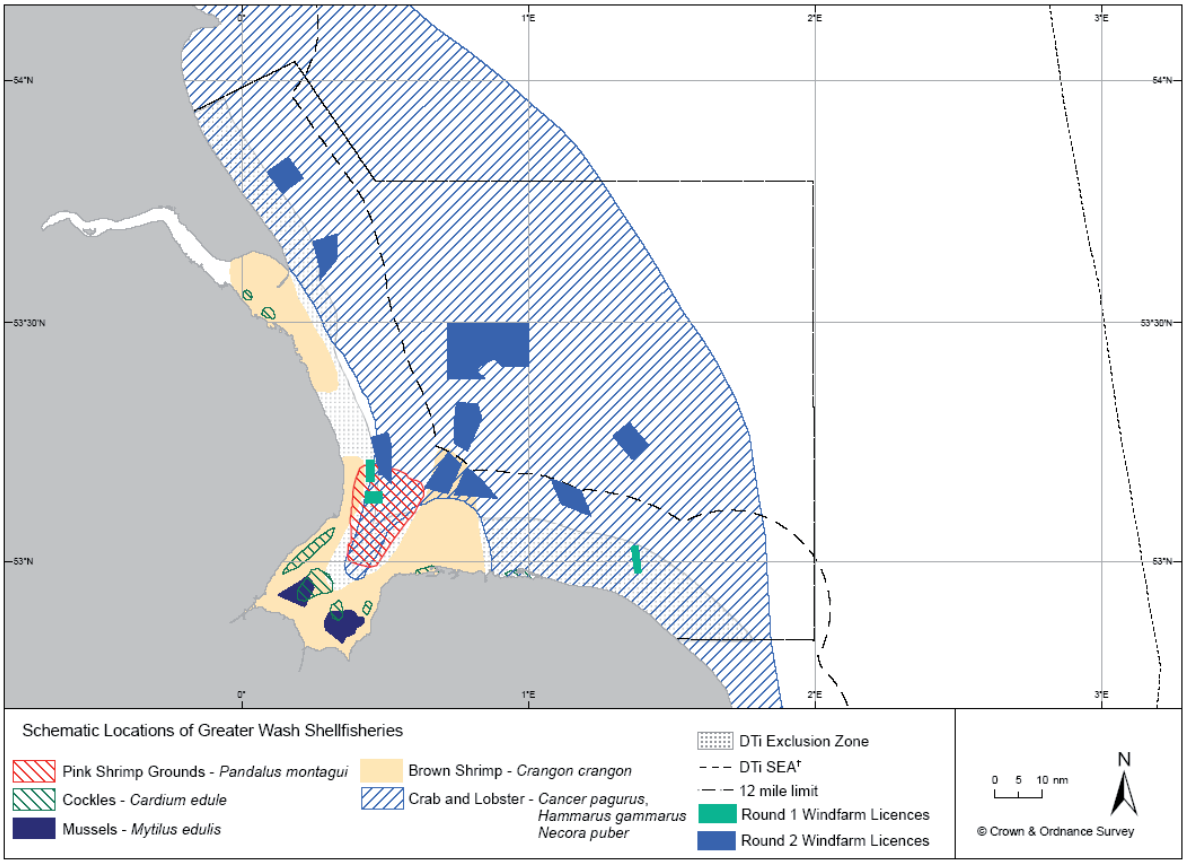


Figure 3.3.. Schematic overview of fisheries in the Greater Wash strategic area and location of wind farm licence areas. Locations of Round 1 and 2 wind farm licence sites for future development are provisional and may change during the planning process.

Inshore beam and otter trawlers target flatfish during the warmer months but land a mixed catch of demersal fish throughout the year.

Anglers fishing from the shore or in charter boat parties can catch a substantial quantity of cod, whiting, rays and bass.

3.4.2 Thames Estuary

Vessels numbers		Crew numbers	
under 10 m	over 10 m	under 10 m	over 10 m
212	41	325	108

The estuaries along the Essex and Kent coast provide rich fishing grounds and shelter allowing small boats to fish for most of the year. The sole fisheries are the mainstay for many of the small boats although numerous other fisheries support their livelihoods. Small boats work drift and fixed nets for sole, cod, bass and mullet; mid-water pair trawl for bass; long lines for cod and occasionally bass; hand lines for bass; trawl for brown shrimp; pots for whelk, crabs and lobster; eel fyke nets, and work wild oyster beds and cultivated oyster lays. Figure 3.4 displays maps of the fishing grounds based on the knowledge of local fishermen (Des Clers *et al.*, 2001)

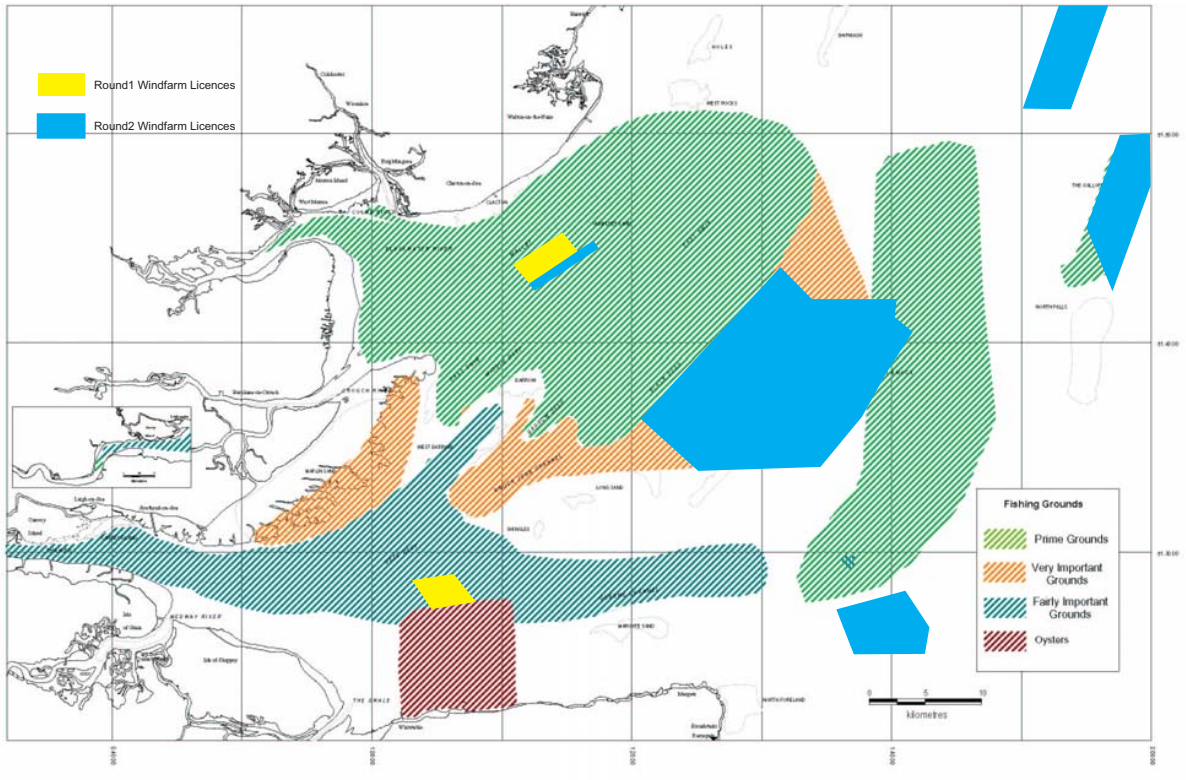
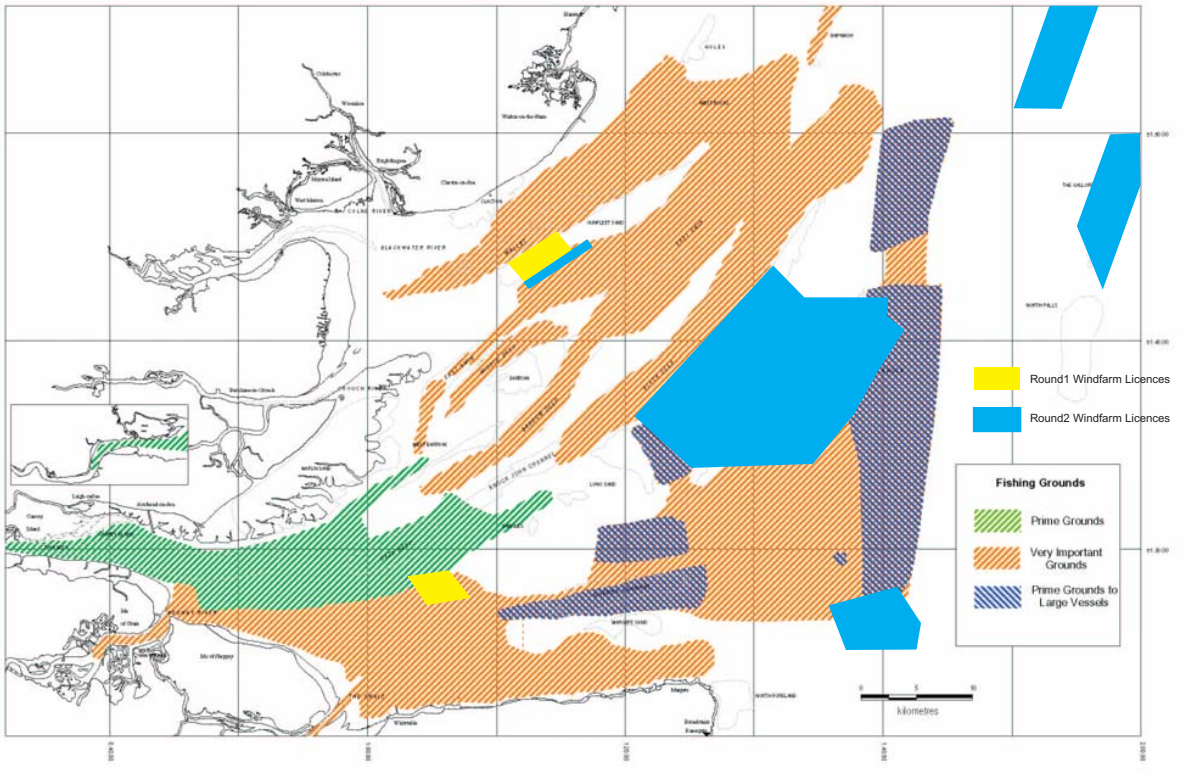


Figure 3.4. Schematic overview of fisheries in the Thames Estuary strategic area and location of wind farm licence areas. Maps of fishing grounds are based on the knowledge of fishermen from the (a) North, (b) Central and (c) southern ports of the Thames estuary (Des Clers *et al.*, 2001). Locations of Round 1 and 2 wind farm licence sites for future development are provisional and may change during the planning process.

(b) Central ports fishermen



(c) Southern ports fishermen

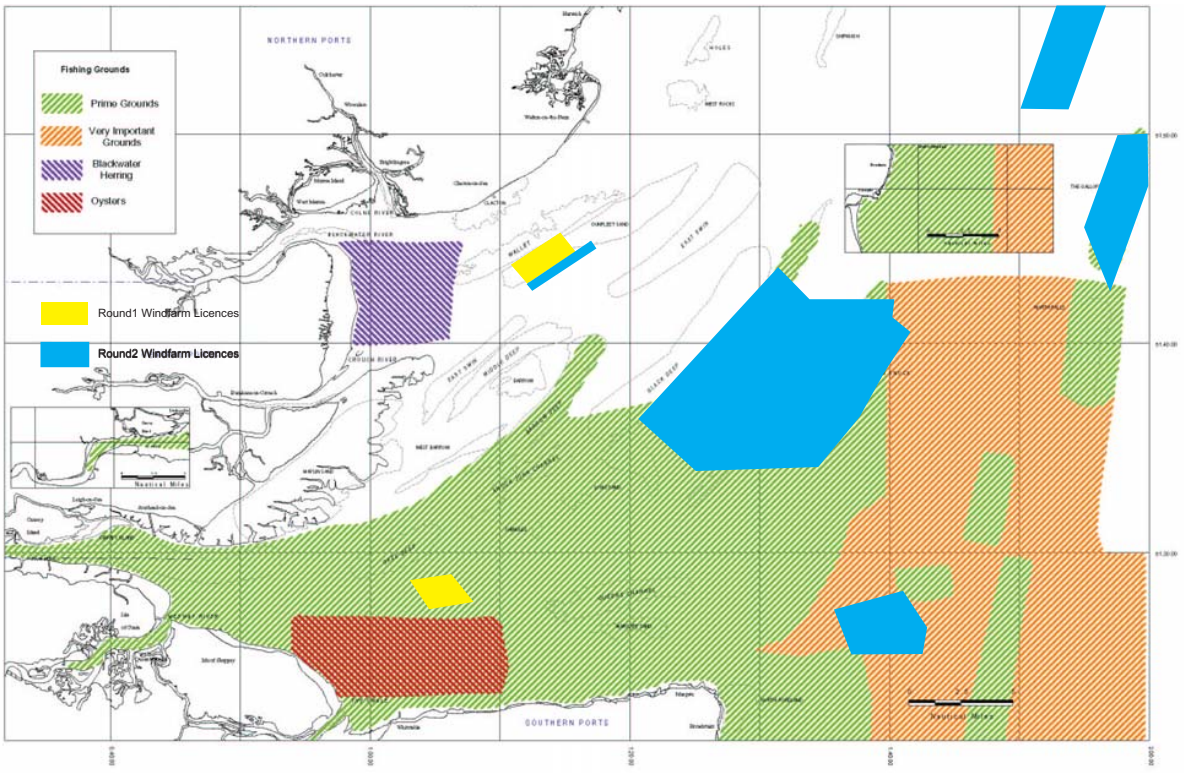


Figure 3.4. continued: Schematic overview of fisheries in the Thames Estuary strategic area and location of wind farm licence areas. Maps of fishing grounds are based on the knowledge of fishermen from the (a) North, (b) Central and (c) southern ports of the Thames estuary (Des Clers *et al.*, 2001). Locations of Round 1 and 2 wind farm licence sites for future development are provisional and may change during the planning process.

Larger boats trawl for sole, cod, sprats, herring, thornback ray, eels and shrimp, and dredge for whiteweed and cockles. The Thames cockle fishery is the most productive in the UK, supporting both local and visiting vessels. The cod fishery has declined markedly in the last few years. Larger meshed nets (>200 mm) are used for thornback ray, and other flatfish such as turbot, brill and lemon sole provide important by-catches. Many inshore trawlers switch to dredging whiteweed (a fern-like hydroid sold for decorative purposes) when sole or cod, for example, are scarce or fishing restrictions prevent their exploitation.

Shore-based and boat (private and charter) angling is extensive and it is possible that these catches constitute a significant part of the total landings of some species, particularly cod and bass, from within the 12 mile zone.

3.4.3 North West

Vessels numbers		Crew numbers	
under 10 m	over 10 m	under10 m	over 10 m
174	93	240	184

The majority of boats are small and fish within six miles of the coast, potting for lobsters, crabs and whelks and netting for sole, plaice, flounder, turbot, brill, rays, cod, pollack, bass, mullet, herring, salmon and sea trout. Long lines are used in a few areas for cod and rays and some shrimp beamers periodically switch to flatfish when shrimp are less available. There is some drift netting for herring in autumn and winter, but the traditional whitebait (juvenile herring and sprat) fishery (e.g. Morecambe Bay) has gradually declined due to marketing difficulties. Figure 3.5 provides a map of the fishing grounds (provided by T. Watson on behalf of Fleetwood Fishermen and prepared by Cefas).

Fleetwood harbours a declining fleet of larger boats (>10 m) that use otter trawls and seine nets to take white fish (mainly cod, whiting, plaice, sole, rays) and *Nephrops* throughout the northwest. Large visiting beam trawlers from Northern Ireland and Scotland join them. Since 2000, a Cod Recovery Programme has been implemented to reduce exploitation of the cod spawning stock in the Irish Sea. A prohibition on the use of demersal trawls, enmeshing nets or lines within the main cod-spawning area between 14th February and 30th April was put into operation. Since the late-1980s, an increasing number of trawlers have switched to netting.

Morecambe Bay has become one of the major sources of seed mussels within the UK. Its productive estuarine sands and mudflats support traditional mollusc and shrimp fisheries, where inshore boats and vehicles use beam trawls for shrimps, whilst cockles and mussels are principally gathered by hand and sometimes by dredge. Pacific oysters, native oysters and Manila clams are cultivated in Morecambe Bay, the Menai Strait and off the north Anglesey coast.

Scallop beds between Anglesey and the Isle of Man are predominantly exploited by visiting boats from the Isle of Man, Scotland and south-west England, particularly during the winter. Many scallops are also taken as by-catch in white fish trawls.

Mackerel caught on hand lines provide an important resource for the chartered angling sector whilst angling from private boats and the shore by holidaymakers has expanded around Anglesey.

Key points

- Over 700 small inshore vessels make up three-quarters of the vessels fishing in the wind farm Strategic Areas.
- Fisheries within the 3 Strategic Areas are numerous and varied; 27 distinct métiers can be defined.
- Shellfish are the most important fisheries in the Greater Wash.
- Sole, rays, bass and cockle fisheries are the mainstay in the Thames Estuary.
- In the North West, shellfish stocks support small boats and hand gathering. *Nephrops* and finfish are the mainstay for a declining fleet of larger vessels.

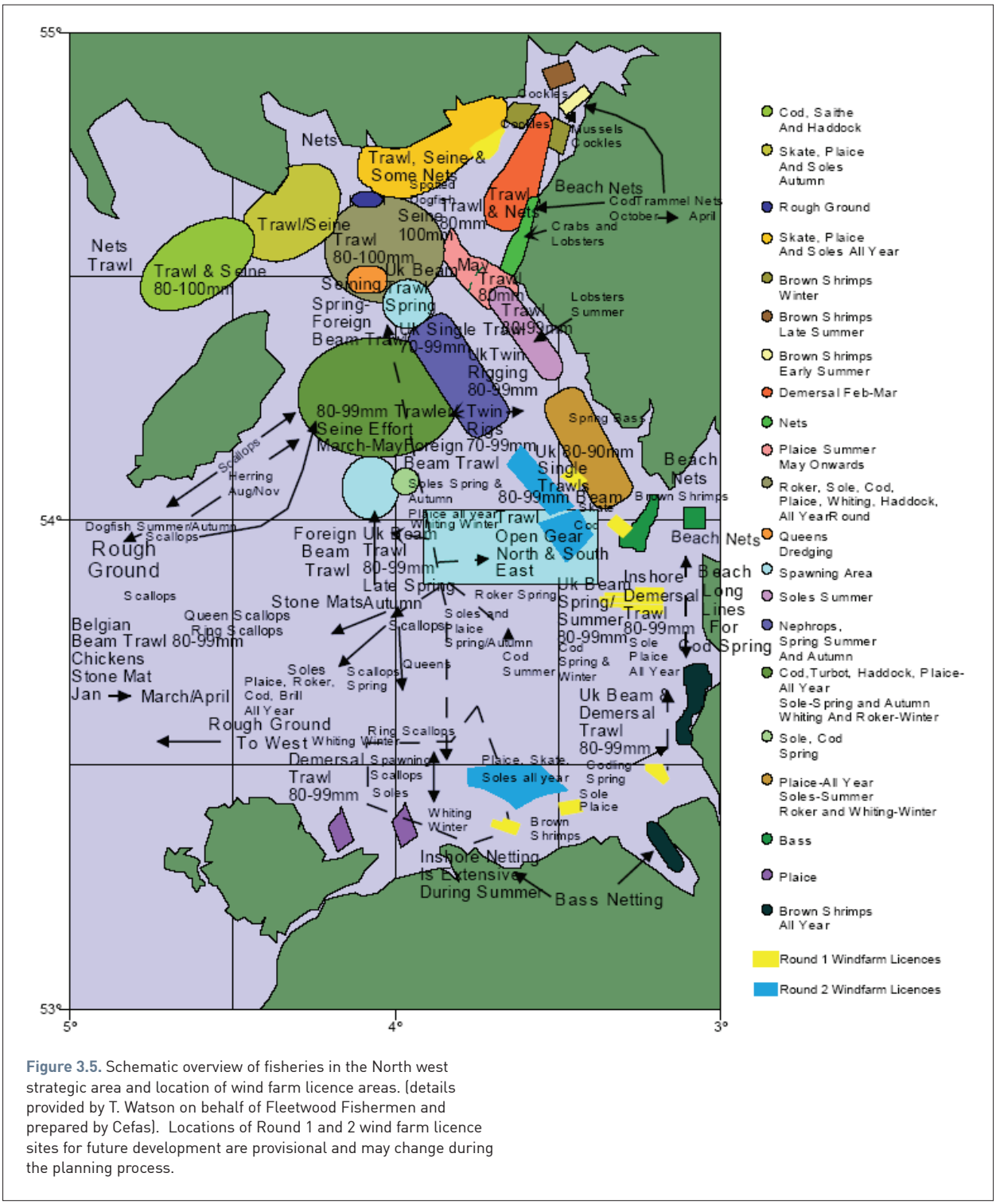


Figure 3.5. Schematic overview of fisheries in the North west strategic area and location of wind farm licence areas. (details provided by T. Watson on behalf of Fleetwood Fishermen and prepared by Cefas). Locations of Round 1 and 2 wind farm licence sites for future development are provisional and may change during the planning process.

4. Industry knowledge, views and concerns over the impacts of Round 2 wind farms

Objective 2.
Consult directly with representative parts of the fishing industry for the purpose of describing and evaluating key concerns, especially prospects of displacement and/ or opportunities for fisheries development as a result of wind farm developments.

4.1 Contacting fishermen

Invitations to participate in the study were sent to 1027 individual fishermen identified using Defra's Fishing Activity Database as the owners of UK boats fishing in the proposed Round 2 wind farm sites during the period 2000-2004 (Appendix 1). Additional information and invitations were posted to 85 relevant associations and organisations, advertised in Fishing News (29th April, 6th May and 10th June) and via Cefas, Seafish and BWEA websites (Appendix 1). To be as flexible as possible in meeting individual circumstances and availability, fishermen were asked to inform us how they preferred to participate in the study. They were requested to respond to the invitation within 5 weeks.

Follow up on the 75 telephone calls received in response to the invitation letters, resulted in face-to-face meetings with 63 fishermen/association representatives (6 meetings were held with fishermen's associations and 15 with individuals, Appendix 1). 44 fishermen requested postal questionnaires and a further 237 were distributed through face-to-face meetings, of which 23 were returned (Figure 4.1).

4.2 Face-to-face meetings

Two or three Cefas and/or Seafish staff attended each meeting. One person facilitated discussions while the other(s) took notes by hand or computer. For consistency, the same person facilitated the majority of group meetings. At each meeting, a brief introduction to the rationale and purpose of the study was given to the participants. Following this, discussions were held regarding their knowledge, views and perceptions of the possible impacts of Round 2 wind farms and of ways that these might be mitigated. The format of each meeting was adapted as necessary depending upon practical constraints and the expectations of the individual or group (Appendix 5). Causal maps (Figure 4.2) were used as a tool to structure and summarise the information arising from discussions. A description of the causal mapping methods is provided in Appendix 3.

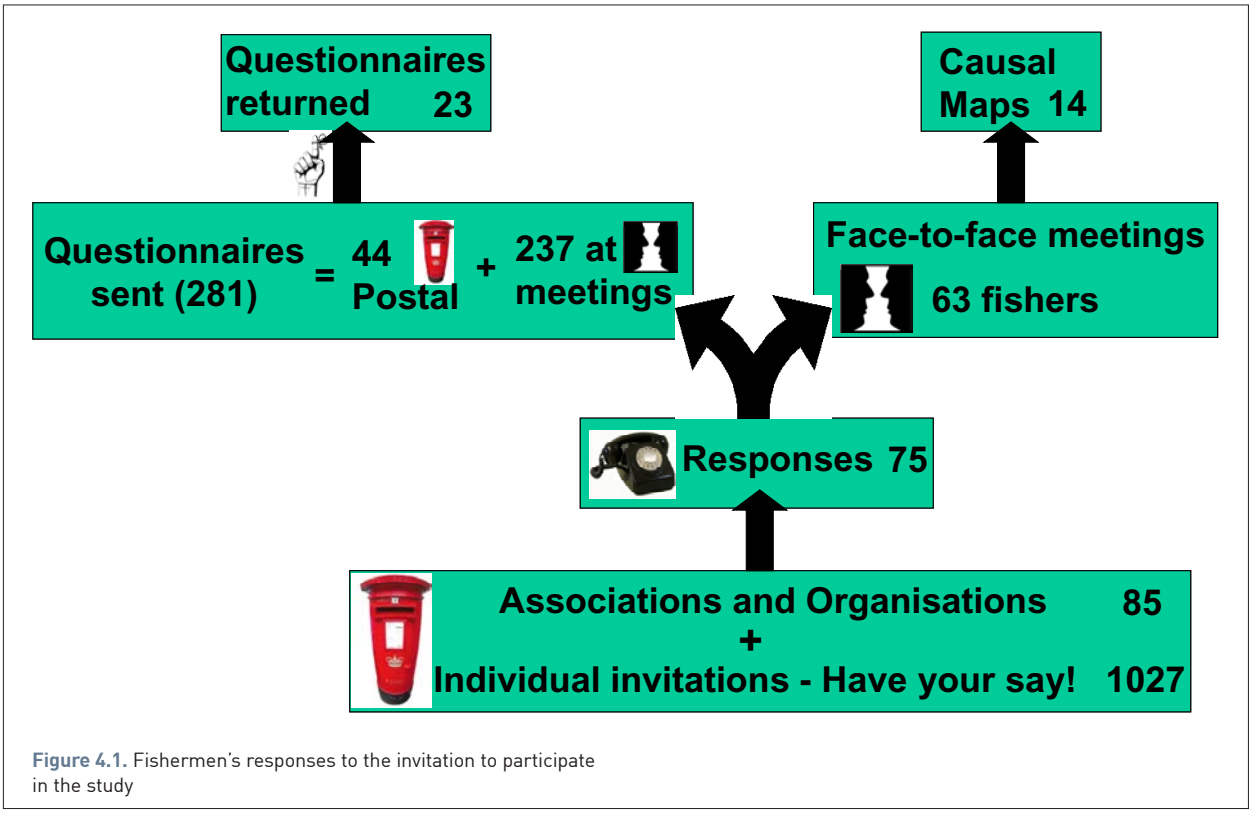


Figure 4.1. Fishermen's responses to the invitation to participate in the study

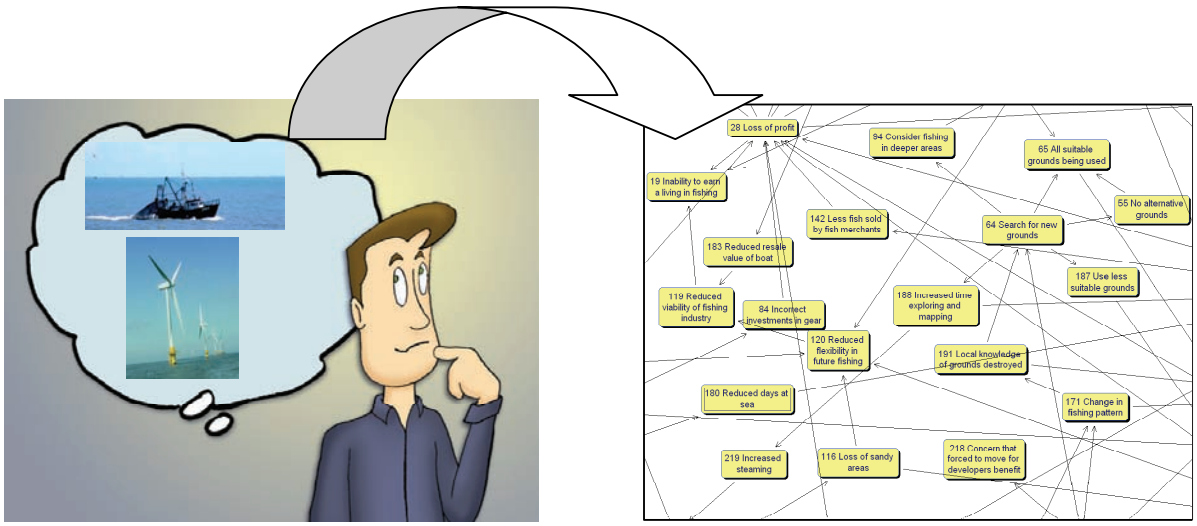


Figure 4.2. Capturing causes and effects using causal maps.

4.3 Emergent themes

Fourteen causal maps were constructed from discussions with 6 groups and 8 individuals (Table 4.1). Two of these had very small numbers of concepts and were inadequate for analysis. Twelve maps, representing information from 58 fishermen, were merged together into a single overall causal map to summarise the issues communicated by fishermen. The map represents a database of knowledge, thoughts and decision pathways that can be interrogated in various ways to help understand the fishermen's viewpoints and specific concerns regarding the impact of wind farms on their fishing activities and livelihoods. Whilst the overall causal map is an accurate and honest representation of the fishers' thoughts, it is too complex for easy comprehension. The 'cartoon' presentation of the overall causal map in Figure 4.3 is shown here solely for the purpose of visualising the depth and complexity of issues. A legible figure, and comments on analysis are presented in Appendix 3.

To capture and effectively communicate the main points arising from detailed analysis, we have identified thematic clusters within the overall causal map and used these to simplify it for clearer presentation of the main cause and

Table 4.1. Information on the individual contributory maps.

Name	Area	Number contributing	Main activity	Concepts	Facilitators
T1	Thames	1	Netters	55	KMcT, FC
T2	Thames	1	Drift netting	75	KMcT, FC
T3	Thames	1	Netters	46	KMcT, FC
T4	Thames	2	Netters	59	KMcT, FC
T5	Thames	1	Netters	62	KMcT, FC
W1	Wash	1	Long lining	31	KMcT, RGB
W2	Wash	1	Long lining	40	FC, RGB
Wells	Wash	10	Potters	78	SM, RGB
Kings Lynn	Wash	11	Potters	88	SM, NT, MM
Ramsgate	Thames	15	Netters	57	SM, NT
Whitstable	Thames	6	Potters, Netters	57	SM, NT
NW1	NW	1	Trawlers		RW, RL
NW2	NW	1	Potter, netters		RW, RL
Bridlington	Wash	8	Potters	64	SM, KMcT, MM

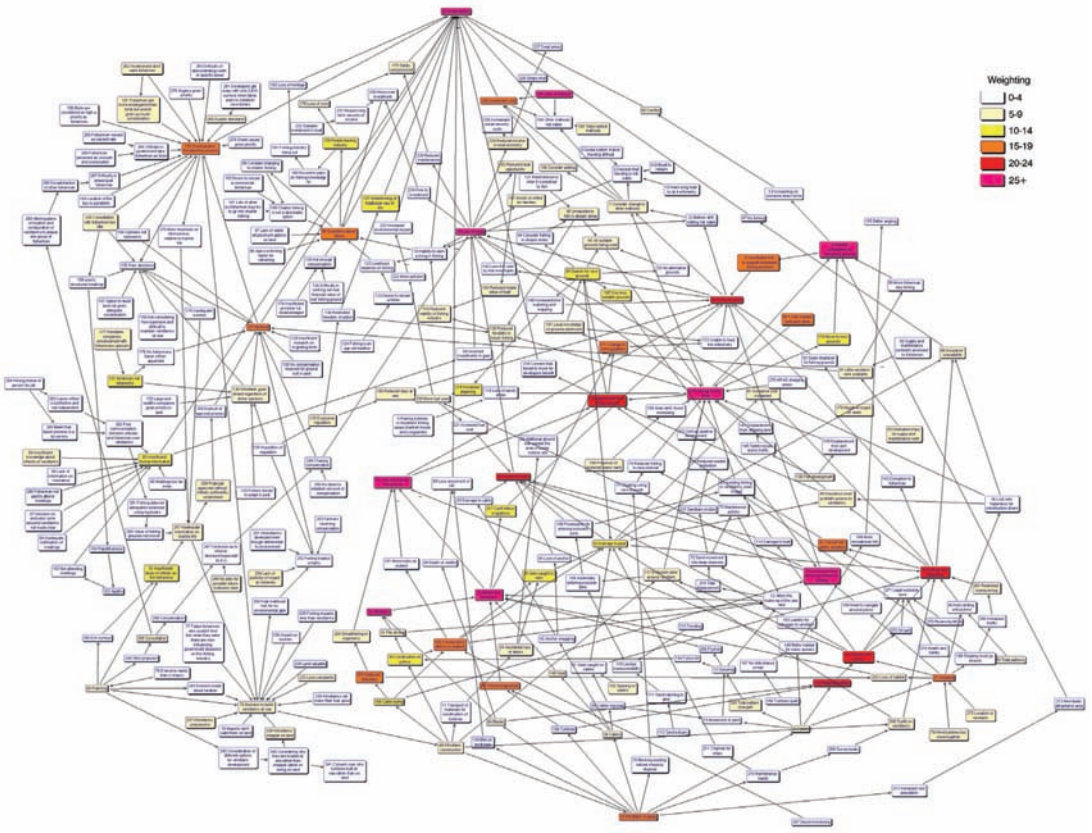


Figure 4.3. Illustrative causal map showing the full complexity of concepts summarised from face-to-face discussions with fishermen. An A3 size version and detailed analyses are presented in Appendix 3. A simplified version for further discussion is shown in Figure 4.4.

effect factors (Figure 4.4). Seven themes were identified relating to:

1. Fishing activities
2. Socio-economics
3. Environment
4. Hazards
5. Mitigation
6. Communication and Trust
7. Decision making and Information

Within each theme there were a range of more specific concepts expressed by those interviewed. Each of these ideas was assigned an 'occurrence weight', based on the number of times it was mentioned and the number of people involved in the interview. This weighting method was chosen because it provides a direct measure of opinion, highlighting where fishermen focus discussions on areas that are of special interest to them. Values range from 0-100 and are a semi-quantitative measure of the relative importance of each concept in the causal map, with higher weighting regarded as more important. The colours of the boxes on the maps reflect the value of the weight. The numbers in the boxes refer to the ID number for each concept.

These prioritised concepts have been further categorised in to drivers, issues and outcomes according to the progression of connections between them. This will help with the interpretation of the results and the selection of possible mitigation measures.

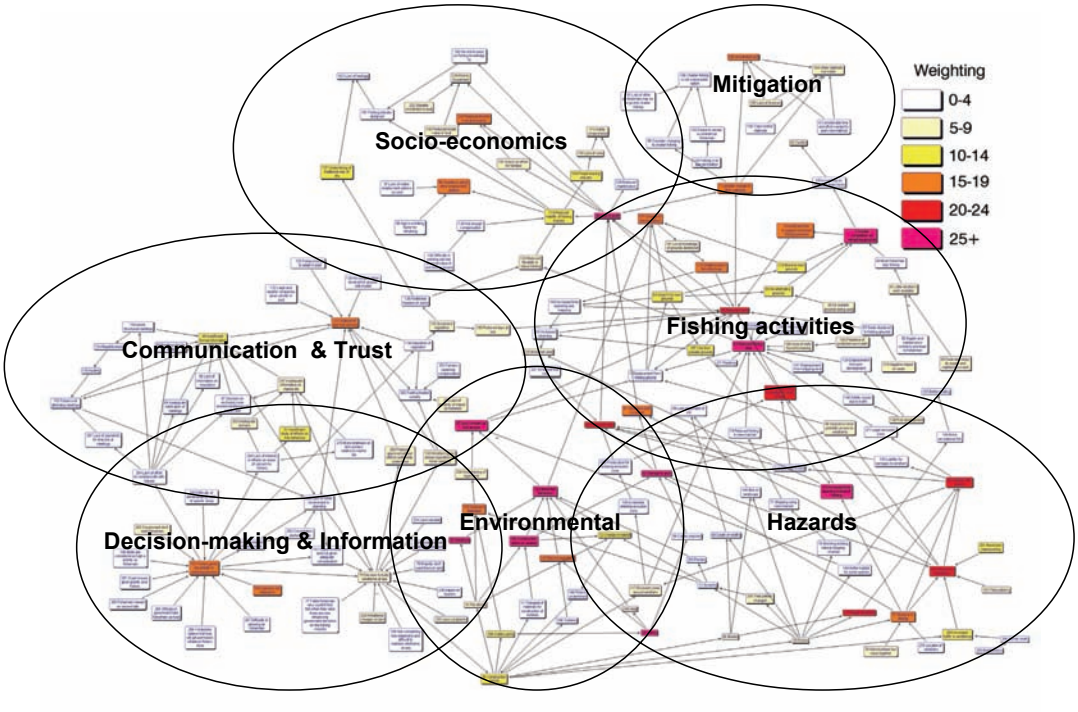


Figure 4.4. Simplified causal map with themes identified as clusters of concepts.

4.3.1 Theme 1: Fishing Activities

(Table 4.2 and Figure 4.5)

The Fishing Activities theme is dominated by highly weighted concerns of the fishermen regarding the displacement effect of wind farms. Fishermen believe wind farm construction will result in increased steaming time and reduction in the area available for fishing. In turn, they consider this will lead to greater competition for space because they believe there are 'no alternative grounds'. The reduction in area available for fishing is also influenced directly by the fishermen deciding to avoid fishing in wind farms, even if it is legal to do so. This is described further in the hazards theme. Displacement from existing grounds was said to inevitably lead to a 'search for new grounds', but because there are 'insufficient fish to support increased fishing pressure' the outcome would be a 'reduced catch', with consequent 'loss of profit'. The cumulative effects of other pressures on fishing areas will exacerbate this effect.

Fishermen stressed the fact that their work is highly dependant on a detailed knowledge of the fishes behaviour built up over years or decades and that any disruption to these behaviour patterns, for example by fishing unfamiliar grounds, could adversely affect their livelihoods. They also believed that the most profitable grounds have been identified and already worked for a long time. All these concepts are highly weighted and represent widely and strongly held views among fishermen.

Table 4.2. Occurrence weights and categories of concepts under the theme 'Fishing Activities'.

Concept ID number	Concept description	Category	Occurrence weight
170	Increased time steaming instead of fishing	outcome	40
2	Greater competition on remaining grounds	outcome	39
53	Reduced fishing area	issue	25
44	Increased costs	outcome	20
1	Displacement from fishing ground	outcome	20
56	Reduced catch	outcome	20
171	Change in fishing pattern	issue	18
172	Unable to track fish effectively	outcome	15
6	Insufficient fish to support increased fishing pressure	outcome	15
64	Search for new grounds	issue	12
187	Use less suitable grounds	outcome	12
118	Move to new grounds	issue	10
55	No alternative grounds	issue	10
191	Local knowledge of grounds destroyed	issue	8
190	Presence of protected worm reefs	driver	8
189	Area reefs found increasing	driver	8
180	Reduced days at sea	issue	8
179	Negative impact on seals	driver	8
65	All suitable grounds being used	driver	8
220	More fuel used	outcome	7
138	Port development	driver	7
83	Dedicated ships do supply and maintenance work	issue	5
81	Little wind farm work available	issue	5
277	Pipeline	driver	4
276	Dredging areas	driver	4
221	Increased fuel cost	outcome	3
188	Increased time exploring and mapping	outcome	3
165	Better angling	outcome	3
164	More recreational fish	outcome	3
148	Better habitat for some species	issue	3
5	Encroaching on someone else's niche	issue	3
69	Less enjoyment of job	issue	2
82	Supply and maintenance contracts promised to fishermen	issue	2
294	1 mile coastal exclusion	driver	1
141	Displacement from shipping lane	issue	1
139	Displacement from port development	driver	1
93	Seals displaced to fishing grounds	driver	1
80	More fisherman stay fishing	driver	1
74	Reduced fishing in new channel	driver	1

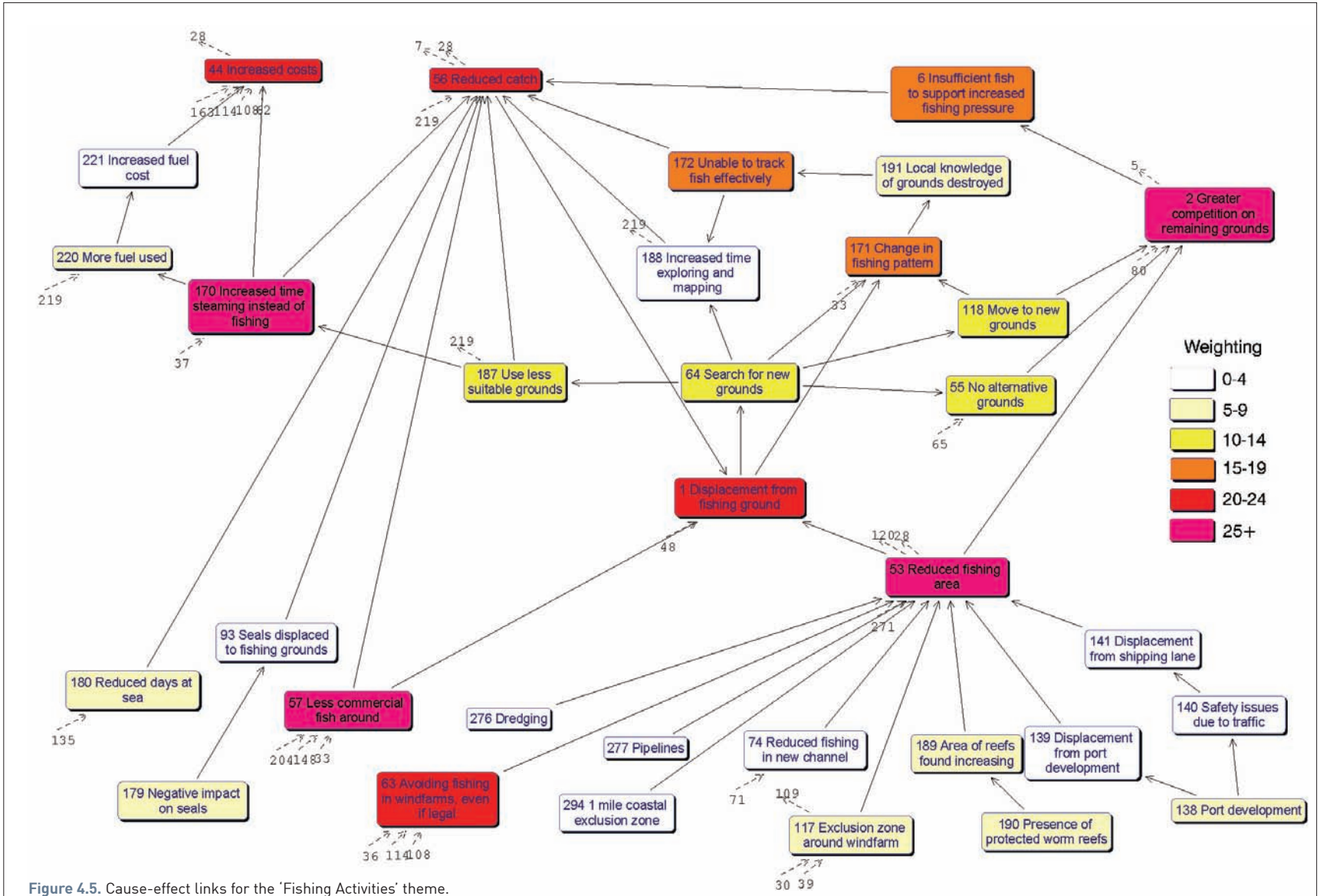


Figure 4.5. Cause-effect links for the 'Fishing Activities' theme. The numbers in the boxes refer to the ID number for each concept.

4.3.2 Theme 2. Socio-economic effects

(Table 4.3 and Figure 4.6)

The most important and highly weighted economic consequence expressed by fishermen was 'loss of profit'. This overarching concern led to several related concepts involving the consequences for families, crew and the local economy, alternative employment options, loss of heritage and the viability of the industry. Other concepts received less weight but similarly indicate that fishermen are concerned that they have few alternative employment options and that the perception of a reduced income will affect both local economies and the safety of operations at sea. The role of overly complicated regulations in reducing the viability of the industry through 'reduced flexibility in future fishing' was raised by 3 groups and seems noteworthy even though it received a low weighting overall.

4.3.3 Theme 3. Environmental effects

(Table 4.4 and Figure 4.7)

One of the most serious concerns expressed by fishermen throughout the survey was the strong feeling that wind farm construction *will* alter the behaviour of their target species (Table 4.2). These concerns were strongly influenced by the apparent uncertainties and incomplete scientific evidence describing the environmental impacts of wind farm construction and operation. Specific concerns under this theme included effects on the displacement and aggregation of fish, potential negative effects on spawning, reduced egg survival, and adverse effects on fish navigation, spawning and population dynamics.

These environmental issues can be seen as key drivers for the concerns expressed in the Fishing Activities theme (Table 4.2 and Figure 4.5), and influence the proposed mitigation and decision-making themes.

Table 4.3. Occurrence weights and categories of concepts under the theme 'Socio-economics'.

Concept ID number	Concept description	Category	Occurrence weight
28	Loss of profit	issue	27
224	Reduced income in local economy	outcome	18
96	Questions about other employment options	outcome	16
137	Undermining of traditional way of life	outcome	14
119	Reduced viability of fishing industry	outcome	11
159	People leaving industry	issue	10
173	Safety compromised	outcome	9
183	Reduced resale value of boat	issue	8
181	Knock on effect for families	issue	8
178	Loss of crew	issue	8
120	Reduced flexibility in future fishing	outcome	7
232	Sizeable investment in boat	driver	6
229	Risk to investment	outcome	6
92	Conflict	outcome	6
126	Difficulty in working out real financial value of lost fishing ground	driver	4
97	Lack of viable employment options on land	driver	4
228	Reduced maintenance	outcome	3
125	Not enough compensation	issue	2
136	Restricted freedom of action	driver	1
162	Loss of heritage	outcome	1
161	Fishing industry dying out	outcome	1
160	No-one to pass on fishing knowledge to	issue	1
98	Age is a limiting factor for retraining	driver	1

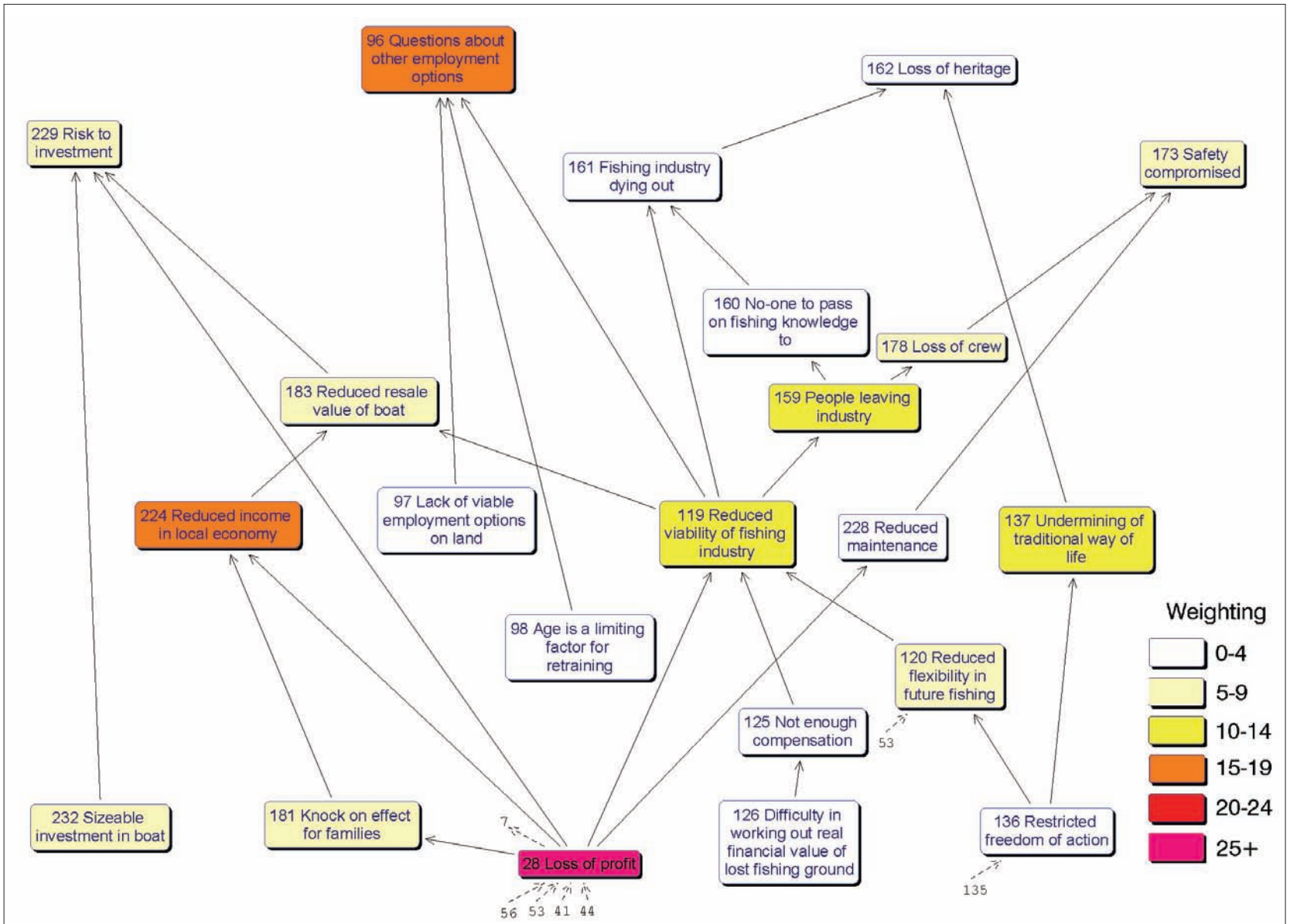


Figure 4.6. Cause-effect links for the Socio-economics theme.

Table 4.4. Occurrence weights and categories of concepts under the theme 'Environmental effects'.

Concept ID number	Concept description	Category	Occurrence weight
33	Altered fish behaviour	issue	100
57	Fewer commercial fish around	outcome	38
32	Vibrations	driver	32
147	Electromagnetism	driver	19
203	Sediment disturbed	driver	18
30	Construction of turbines	driver	14
168	Cable laying	driver	10
12	Change in habitat	issue	10
146	Heat	driver	8
31	Pile driving	driver	8
34	Cables	driver	8
205	Tidal pattern changed	issue	6
204	Smothering of organisms	issue	6
206	Plumes	driver	3
198	Turbines	driver	3
68	Death of wildlife	issue	2
13	Scouring	driver	2
144	Pylons tilt	issue	1

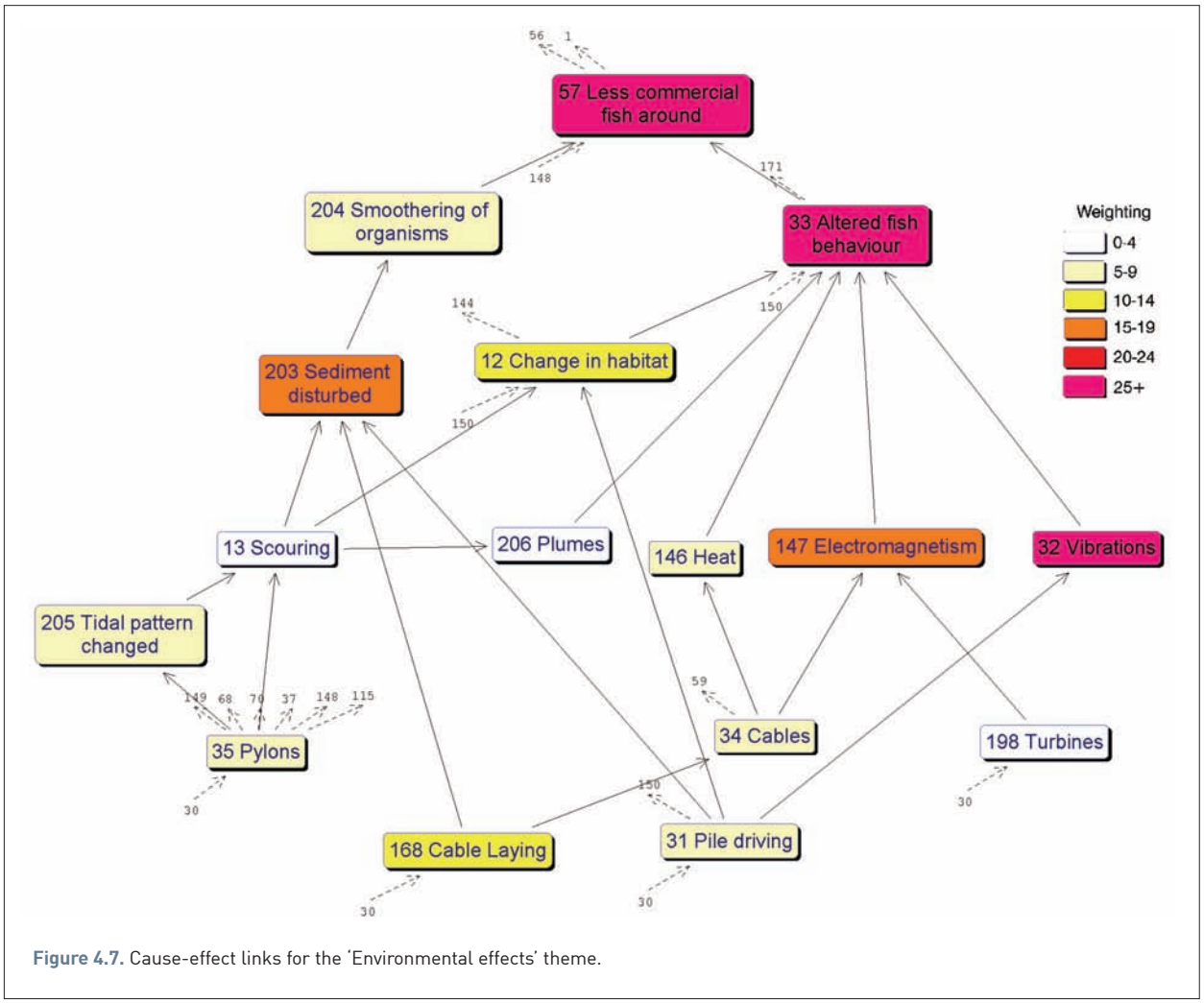


Figure 4.7. Cause-effect links for the 'Environmental effects' theme.

The majority of drivers responsible for these environmental concerns were considered by fishermen to occur during the construction phase. Physical consequences of pile driving were believed to be important drivers affecting fish behaviour patterns, while cable laying was believed to be responsible for sediment disturbance and the smothering of organisms. Important drivers from the operation of wind farms were electro-magnetism from cables causing altered fish behaviour (particularly elasmobranchs) and the disturbance of sediment and habitat change caused by scouring around turbines.

4.3.4 Theme 4. Hazards

(Table 4.5 and Figure 4.8)

This theme was driven almost exclusively by the effects of turbines on fishing operations, which was one of the most heavily weighted drivers in the overall causal map. Turbines were considered by fishermen to be a major hazard to navigation and fishing activities, but the degree to which they affected fishing operations would depend on the exact location of the wind farm and the spacing of the turbines. Possible radar disruption caused by the turbines and blades was a prominent concern for safe navigation. The physical presence of offshore wind farms were themselves considered to be obstacles to safe navigation, and the regular occurrence of maintenance vessels believed to result in additional sea traffic leading to restricted manoeuvring of fishing boats.

Important concerns over costs and the continued availability of insurance were related to the potential for gear and/or boat damage caused by collisions or gear entanglement with turbines. The outcome of these numerous concerns was a highly weighted opinion that fishermen 'cannot fish within wind farms' and a decision to 'avoid fishing in wind farms, even if legal'.

Table 4.5. Occurrence weights and categories of concepts under the theme 'Hazards'.

Concept ID number	Concept description	Category	Occurrence weight
62	Damage to gear	issue	27
150	Construction debris on seabed	driver	26
115	Radar disruption	driver	22
39	Collision with turbines	issue	22
36	Fishing very hazardous	issue	21
63	Avoiding fishing in wind farms, even if legal	outcome	20
37	Obstacle to fishing	driver	17
41	Insurance cost increased	issue	15
209	Increased traffic in wind farms	driver	13
201	Restricted manoeuvring	driver	10
275	Location of wind farm	driver	10
48	Insurance cover prohibits access to wind farms	issue	8
35	Pylons	driver	8
193	Tidal patterns altered	driver	8
117	Exclusion zone around wind farm	issue	8
79	Wind turbines too close together	driver	5
66	Blades	driver	5
59	Cables exposed	driver	4
208	Survey boats	driver	3
163	Liability for damages to wind farm	outcome	3
114	Damage to boat	issue	1
109	Accidentally entering exclusion zone	issue	1
108	Prosecution for entering exclusion zone	issue	1
295	Maintenance	driver	1
11	Transport of materials for construction of turbines	driver	1

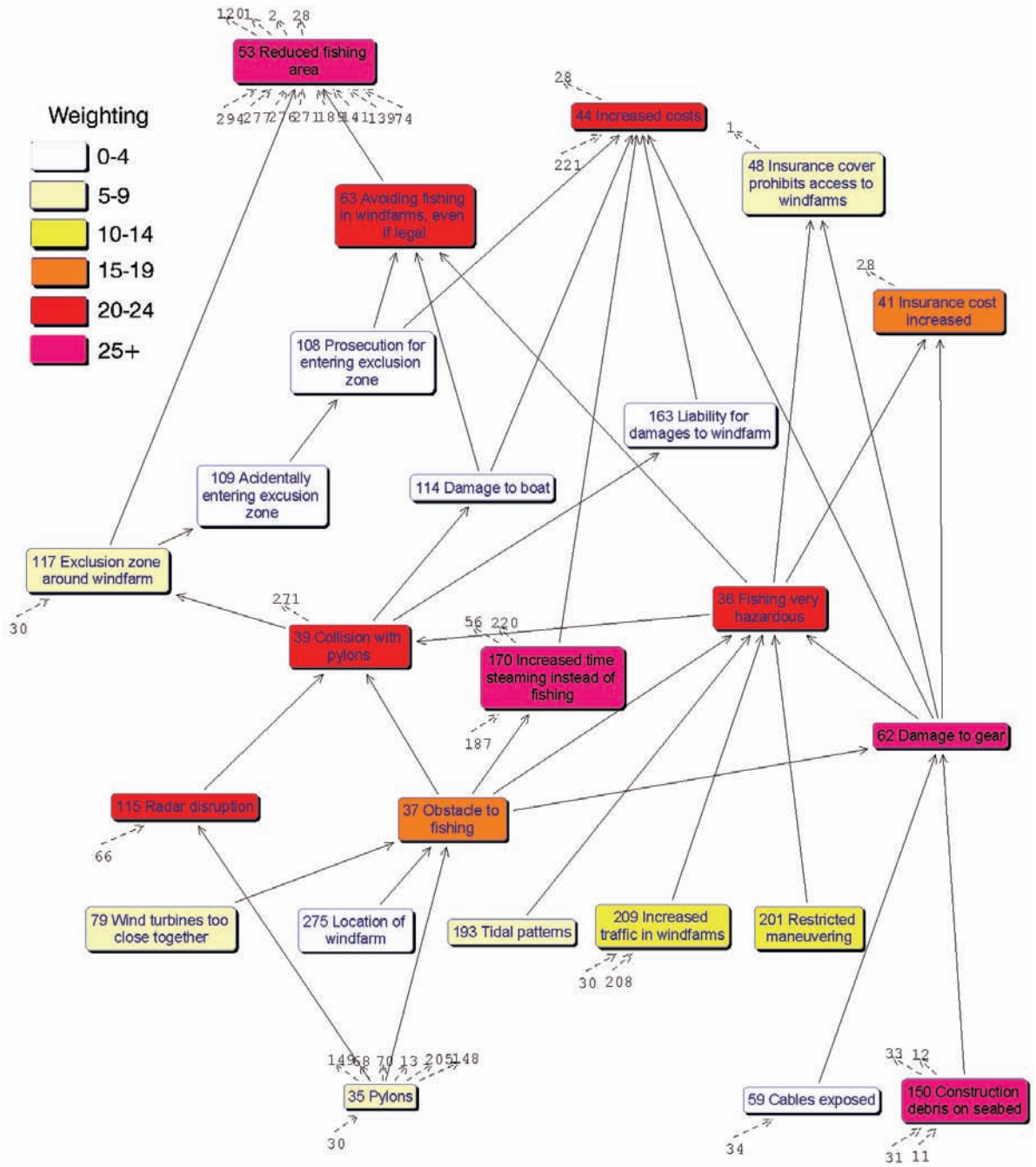


Figure 4.8. Cause-effect links for the 'Hazards' theme.

4.3.5 Theme 5. Mitigation

(Table 4.6 and Figure 4.9)

A striking aspect of this mitigation theme is its small size and low weightings, suggesting that either mitigation options do not exist or that few were known to and suggested by fishermen. The theme focussed exclusively on the concept that the only suitable alternative was investing in other fishing methods which did not conflict with wind farm operation, although there was a very strong weighting for the possibility that this would have a high investment cost. Fishermen expressed their concerns to this option, because of the difficulty of finding licences to fish using new methods, and the considerable time and effort that would be needed to learn new a new fishing method.

Table 4.6. Occurrence weights and categories of concepts under the theme 'Mitigation'.

Concept ID number	Concept description	Category	Occurrence weight
7	Consider change to other methods	outcome	16
186	Investment cost	outcome	15
195	Tides restrict methods	driver	8
185	Lack of licences	issue	8
184	Other methods not viable	issue	6
8	Difficult to relearn	driver	4
124	Fishing is an age old tradition	driver	1
102	Desire to remain a commercial fisherman	driver	1
101	Lots of other ex-fishermen may try to go into charter fishing	driver	1
100	Charter fishing is not a desirable option	outcome	1
99	Consider changing to charter fishing	issue	1

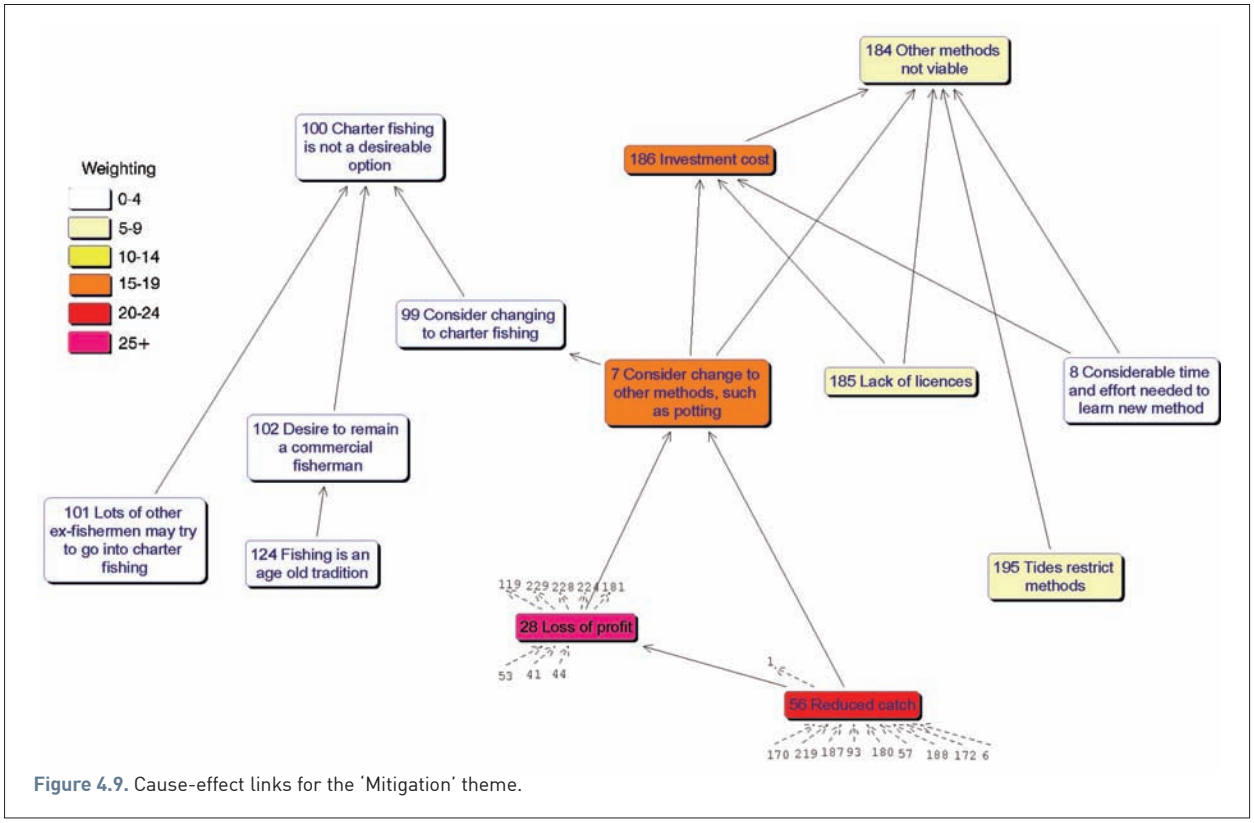


Figure 4.9. Cause-effect links for the 'Mitigation' theme.

Table 4.7. Occurrence weights and categories of concepts under the theme 'Communication and Trust'

Concept ID number	Concept description	Category	Occurrence weight
127	Distrust of approval process	issue	19
85	Insufficient formal information	issue	13
135	Excessive regulation	issue	9
254	Lack of publicity of impact on fisheries	issue	6
130	Wind farm goes ahead regardless of fisher opinions	outcome	5
134	Imposition of regulation	issue	4
282	Consultation started too late	issue	4
284	Lack of effort to communicate …	issue	4
285	Liaison process is just lip service	driver	4
286	Fishermen not paid for coming to meetings ..	issue	4
287	Lack of payments for time lost at meetings	driver	4
288	Lack of fisher involvement in planning	issue	4
291	Little interest in fishermen views	driver	4
252	Feeling treated unfairly	outcome	3
253	Farmers receiving compensation	driver	3
261	Developers get away with only 2 EIA surveys …	driver	3
133	Fishermen forced to adapt in past	driver	2
90	Meetings too far away	driver	2
128	No compensation received for ground lost in past	driver	1
132	Large and wealthy companies given priority in past	driver	1
86	Lack of information on insurance	outcome	1
87	Decision on exclusion zone around wind farms not made clear	issue	1
88	Inadequate notification of meetings	driver	1
152	Not attending meetings	outcome	1
153	Apathy	issue	1
154	Repetitiveness	issue	1
156	poorly structured meetings	issue	1

4.3.6 Theme 6 and 7. Communications and Trust, Decision-making and Information

(Tables 4.7 and 4.8, Figures 4.10 and 4.11)

The dominant feature of these two themes was the lack of clarity and low occurrence weightings of many individual concepts. Several concepts emerged as potentially important, especially, communications, trust, decision-making and lack of information. Poor communication was specifically highlighted as an important issue, and underlies many of the other issues raised. Decision-making was viewed by fishermen as being highly biased and based on political objectives rather than careful weighting of pros and cons. Many were not convinced that wind farms were economically or environmentally sustainable, and felt that the value of fishermen and their livelihoods was not given sufficient or reasonable priority in decision-making. This may be an inevitable complaint, but it also suggests that the reasons for any priority have not been clearly communicated. There is a lack of trust that stems, in part, from previous negative experiences of offshore planning. The combination of factors mentioned exacerbate this and contribute to a positive feedback that alienates fishermen.

High weighting was given to the lack of information provided to fishermen on the effects of wind farms on marine life, fish stocks, and other issues. Again, fishermen expressed that these were major areas of concern, probably because of the many scientific uncertainties. The number and weighting of the concepts identified in Tables 4.7 and 4.8 suggest either a poor understanding of the planning process by fishermen or a genuinely disorganised or non-transparent planning process. These concerns can be seen to underlie many of the other concerns that were raised and must be regarded as a major issue.

Table 4.8. Occurrence weights and categories of concepts under the theme 'Decision making and Information'.

Concept ID number	Concept description	Category	Occurrence weight
194	Opinions not listened to	driver	19
103	Fishermen given low priority in planning	driver	15
51	Insufficient study of effects on fish behaviour	issue	11
258	Proposal approved without effects sufficiently understood	issue	9
75	Decision to build wind farms at sea	outcome	8
283	Inadequate surveys	issue	7
262	Government don't want fishermen	driver	7
257	Inadequate information on marine life	issue	7
260	Double standards	driver	6
238	Wind farms cheaper on land	driver	6
233	Less complaints	driver	6
106	Birds are considered as high a priority as fishermen	driver	5
290	Lack of interest in areas of concern ….	issue	4
289	Companies believe that they will get permission …	driver	4
281	Green issues given priority	issue	4
280	Value of each fishing ground not known	issue	4
279	Green issues carry more weight ...	driver	4
278	Anglers have more say	driver	4
270	More emphasis on bird surveys relative to marine life	driver	3
269	Altering plans of location and configuration of wind farms …	issue	3
268	Dissatisfaction of other fishermen	issue	3
267	Difficulty in pleasing all fishermen	issue	3
266	Fishermen perceived as uncouth and uneducated	driver	3
264	Officials in government take fishermen as fools	driver	3
263	Difficulty of demonstrating worth of specific areas	driver	3
239	Wind farms will make Blair look good	driver	3
236	Impact on tourism	driver	3
234	Land valuable	driver	3
265	Fishermen viewed as second rate	driver	1
158	Not considering how expensive ... to maintain ... at sea	driver	1
157	Option to build land not given adequate consideration	driver	1
77	Failed fishermen ... are now influencing government	driver	1
76	Majority don't want them on land	driver	1

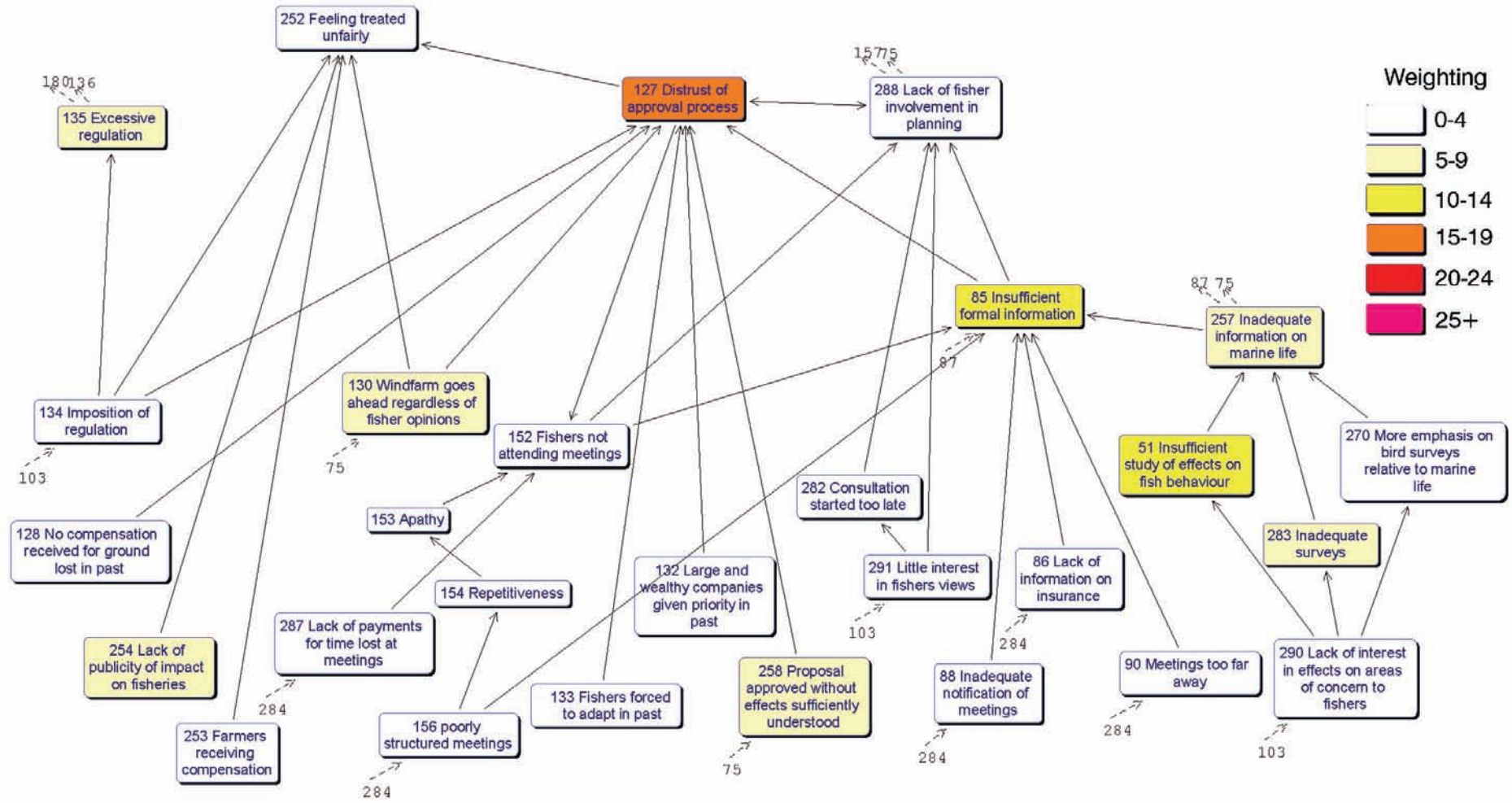


Figure 4.10. Cause-effect links for the 'Communication and Trust' theme.

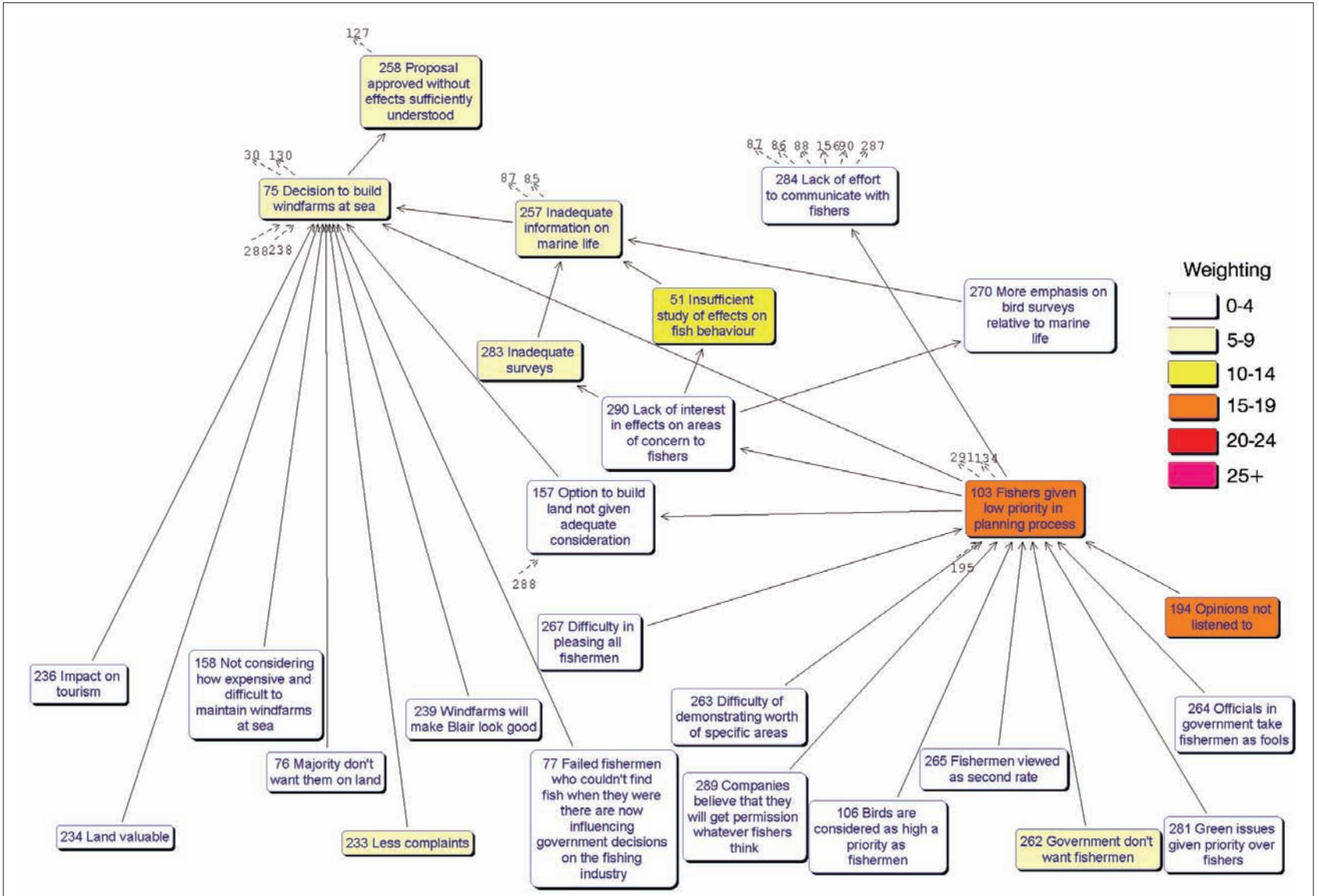


Figure 4.11. Cause-effect links for the 'Decision making and Information' theme.

4.4 Results from questionnaires on impacts and opportunities

The questionnaire was carefully structured to obtain information necessary to make a through evaluation. It was tested with fishermen prior to receiving full approval from Defra's Survey Control Unit (Appendix 2).

Of the 281 sent out, 23 questionnaires were returned and analysed. Due to the small number, no attempt was made to categorise responses according to area or type of fishing activity. All responses from answers to specific questions and additional text provided was pooled and summarised according to whether comments related to impacts of wind farm construction and operation, or the potentially beneficial opportunities presented (Table 4.9).

Concerns from individuals tended to focus on a smaller range of issues and were less specific in their detail compared to those discussed at face-to-face meetings, although the main views expressed and the significance of each were similar overall.

With one exception, all respondents considered that the majority of impacts arising from wind farm development in their area would be disadvantageous to fishing activity and, in the main, would continue over the long-term. No longer being able to fish with existing gear on grounds of historical high value rated of greatest importance overall. Multiple consequences associated with the exclusion from and navigation around wind farms was frequently cited. For example, increased competition and fishing pressure on alternative grounds was seen by respondents to be a major problem with the potential to cause conflict between groups of fishermen as well as reduce catches and therefore income. In some cases, respondents found the prospect of finding new grounds of comparable quality a near impossible one, particularly when knowledge and experience of favoured sites had taken many years to establish. Longer times and distances spent steaming to new grounds or circumnavigating wind farms represented another detrimental impact for respondents. Reasons given for this included a potentially crippling increase in fuel costs (on top of ever-increasing fuel prices), compounded by a decrease in the hours available to fish. Anxiety over the safety of vessels was also conveyed, not least because fishermen felt they would be 'forced' to go further and stay out for longer to maintain earnings. Many of these comments correspond to those listed under the Fishing Activities theme (Table 4.2 and Figure 4.5).

In contrast to responses received at the face-to-face meetings, concerns over the ecological and biological effects of wind farms on fish and shellfish populations were not widely reported. However, dissatisfaction at so-called 'cumulative' effects was expressed. Proposed Round 2 wind farms were seen to impose yet more spatial restrictions on the industry, adding to the large amount of ground that fishing activity has already been excluded from by the development of other offshore industries and activities such as oil and aggregate extraction, dredging, port developments and Round 1 wind farms. Several respondents gave written accounts of their view that wind farms are a costly and inefficient way to produce energy and livelihoods are being put at risk for minimal return or environmental gain.

Table 4.9. Summary of potential impacts and opportunities received via questionnaire. The number of times an impact was described was used as an indicative scale of the importance (left hand column).

Occurence	Impacts	Opportunities
Highest	Loss of existing fishery or use of ground	Creates a nursery/protected area
↓	Have to move to or find new grounds	Fishing opportunity for fixed nets and anglers
↓	Increased competition and conflict	Opportunity for tourism venture, i.e. sightseeing trips
↓	Increased fuel costs and reduction in time spent fishing	New grounds of high quality discovered
↓	'Cumulative' effects: ground already lost to shipping, dredging, Round 1 wind farms	
↓	Compromised safety	
↓	Effects of electrical currents and vibrations on fish/shellfish	
Lowest	Stress/negative influence on family	

Few respondents regarded wind farm development as a likely economic opportunity for themselves. For those that did provide comment on this issue, the creation of protected nursery or conservation zones was regarded as the principal positive outcome. Other potential benefits included the opportunity to fish within wind farms using fixed netting gear, and an opportunity to take tourists out on vessels to view the turbines close up. The only group to describe as beneficial the expected overall economic change generated by wind farm development were sea anglers who, if it was decided that angling was the only fishing activity allowed within the wind farm sites, would profit greatly from exclusive use of the ground and possible increase in fish abundance.

Whilst this analysis has been confined to vessels and fishermen in the UK vessels it can reasonably be expected that the impacts would be similar for fishermen from European Member States operating within the 3 strategic areas under partial derogation (6–12 nm) and normal (12+ nm) CFP access rights.

4.5 Discussion on the approaches used to consult fishermen

Face-to-face meetings led to a high level of engagement with fishermen, seemingly meeting their expectations of consultation in a way that questionnaires did not.

Causal mapping was used as a tool to capture and make available the knowledge and views of fishermen on the impacts of wind farms on their fishing activities and livelihoods. Although not familiar with the method, most fishermen appeared to be comfortable with it and understand how it could be used to capture their knowledge and thoughts. The results prove the method to be useful, successfully summarising fishermen's thinking in a structured and comprehensive way that revealed most areas of concern. Flexibility to adapt to individual and group situations was an important strength of the approach (Mackinson *et al.*, 2005).

Causal mapping requires that the sample taken for analysis is representative of the population being studied. Although the number of people interviewed was relatively small, many were representatives of fishing associations, and were considered to represent a larger 'sample' of fishermen throughout the 3 Strategic Areas.

Since causal maps provide a summary of concepts that 'may lead to' other concepts, uncertainty is an inherent feature. Unfortunately, it is not easy to assess how likely each of the links might be, and this can be an issue where levels of uncertainty are seen as major areas of interest. Uncertainty about the effects of the wind farms was a repeated and dominant topic in discussions with fishermen and this is represented in the discussions and accounts of their views. The areas given high weighting by the fishers often included those where there appeared to be high uncertainty, therefore uncertainty can be regarded as being included indirectly in the occurrence weighting.

While the occurrence weighting proved a useful measure of relative importance concepts, we caution that it is only a simple measure of the fishermen's prioritisation, and thus the exact values and order of concepts in the table should be taken as indicators rather than absolutes. There is scope to develop such measures further. In particular, similar weightings based on links rather than concepts would be useful. Similarly, flexible weightings that include the importance weights of the components directly ascribed by fishermen would be useful.

Variability in the approaches/style of different facilitators complicates the process of coding and merging maps and greatly increases the time this requires. Statistical rigour would be improved if a single person did all of the collection and analysis. We have found however, that the possible impingement on statistical quality is generally offset by the benefits that can be gained through alternative aspects of the maps being explored as a result of different styles of individual facilitators. Contrasting approaches can serve to cancel particular biases of any one individual and provide a more broad and complete description of the subject.

Based on previous successful uses of questionnaires and the obvious strength of feeling on the wind farm issue that was received during trials at Glasgow Fishing Exhibition, the project team reasonably believed that fishermen would take the time to complete the questionnaire. They did not. There are five possible reasons for the poor return rate, (i) reluctance to provide any sensitive information on earnings and costs because of the mistrust of Defra arising from a prosecution case where confidential logbook data were subpoenaed from Cefas by Defra, (ii) perception that any effort made to give any information or views was already too late to make any difference or (iii) that they would not be listened to anyway, (iv) fishermen are not unduly worried about the possible impacts of wind farms, and (v) that completing questionnaires is a tedious unenviable task to which they give low priority.

Extensive efforts were made to persuade fishermen to return questionnaires (Appendix 1), even if incomplete, to assess whether poor returns were reflecting unwillingness to participate. Little response was received. The workshop (see next section) provided the opportunity to discuss these matters and an industry suggestion to offer 'aggregated'

financial data through several fishing organisations was taken up (see Section 5).

4.6 Encouraging dialogue and understanding: workshop

A workshop was held on the 10th October 2005, for the purposes of (i) providing feedback on the preliminary results of this study and the complementary Dti funded study "Fishing activities that may be carried out in and around offshore wind farms", and (ii) encouraging dialogue and understanding by providing an opportunity to share knowledge amongst the fishing industry, planners, developers and government.

4.6.1 Structure of the day

There were 35 participants including representatives from the fishing industry, offshore wind developers, government, planning and consulting agencies (Appendix 1.7).

The morning was a dedicated information session, providing the audience with feedback on the preliminary results of both studies and discussion on specific technical issues arising.

The afternoon session consisted of broader discussions around 4 key topics arising from the morning session, (i) structures, their impacts and ability to fish around them, (ii) distribution of fishing activities in the Strategic Areas, (iii) potential impacts on fishing activities and livelihoods, (iv) assessing economic impacts.

As a direct result of the workshop, fishing associations and the project team put in additional effort to identify the average costs and earnings associated with typical fishing activities (see Section 5). Further consideration of how to take forward other actions suggested during the workshop was given during the FLOWW group meeting held on 2nd November. Specific attention was given at that meeting to the need for communications and dissemination of information and the need for field-testing the manoeuvrability and operation of various fishing gears in and around wind farms.

The workshop outcomes summary (given below), presentations and invitee list (Appendix 1) were emailed or posted to all invitees and participants and made available for download from the Cefas website [http://www.cefas.co.uk/renewables/default.htm].

4.6.2 Outcomes (brief summary of the main points arising)

Feedback and Views

- Because of the dynamic nature of the <10 m fleet fisheries and lack of obligation to report landings, detailed information on their activities and earnings is hard to come by. Fishermen suggested that in many cases, the information currently available is not much better than guesswork. In addition to this, uncertainties regarding possible effects of wind farms makes it extremely difficult for fishermen to assess what the impacts to their fishing activities and livelihoods might or might not be. Consequently…

- Assessment of the economic impacts is very difficult if impacts are unknown. *"It is impossible to put a figure on what might have been caught"*!

- Fishermen were insistent that 'face-to-face' meetings were the only way to successfully gather necessary information from them. They were clear that better quality information was needed in order to assess the full impacts of wind farms on their operations. The research teams had supplemented their face-to-face meetings (that explored views, impacts and mitigation options) with detailed questionnaires seeking such quality information. These had achieved a poor response. Devoting more time to face-to-face meetings than was available during this study would help to build relationships and trust and might be beneficial to accessing more detailed information.

- Lack of field testing on vessel manoeuvrability and operation of various fishing gears in and around wind farms hinders discussions on what appropriate mitigations options might be available.

- Seafish would be putting teams of ex-fishermen into the field over the next six weeks or so. These would seek very detailed information about the manoeuvrability of different types of gear/boat combinations in and around the various proposed development sites.

- In general, it appears there are no universal mitigation options appropriate to fishermen across all sites. Mitigation options are best considered on a site-specific basis with appreciation of the fishermen's and developers needs/constraints.

- Fishermen (and other affected industries) should have been consulted during the Strategic Environmental Assessment stage (day 1). *"…there is an overwhelming planning rush that ought to be halted until more information is forthcoming"*.

- More information on possible impacts should be gathered from existing developments to see whether it was applicable to the current rounds. It was claimed that some data could be available from up to ten years previously.

- The accuracy and appropriateness of some EIAs was queried. Fishermen believed that some areas under threat were much more important for certain species than had been recognised.

- Safety and the implications of exclusion zones were important concerns and sources of uncertainty. Fishermen commented that even if allowed to fish within a wind farm, it was not really an option for the safe operation of most gears.

- Causal-maps (e.g. Figure A3.1, Appendix 3) representing the views and concerns of the fishing industry were criticised (by some) for being overly complicated, even though the diagrams represented an honest account of the meetings with fishermen. Every effort would be made to ensure that their views were adequately represented to Defra in a thorough, yet simple and concise manner.

Actions for government suggested by workshop delegates

1. Learn from Round 1 developments and experiences from other countries. Implement methods to disseminate the latest scientific information and research results in a comprehensible form to fishermen using the FLOWW (Fisheries Liaison to Offshore Wind) group.

2. Economic information should be sought directly from associations – who will provide 'average' costs and earnings associated with typical fishing activities.

3. Field test the manoeuvrability and operation of various gears in and around wind farms. FLOW suggested they might be able to initiate such work. It was suggested that trials could be conducted within 1 week and might take place at North Hoyle or Kentish Flats.

4. Industry liaison, through representative organizations, must be improved in order to gain better trust from fishermen.

5. Information on long-term trends in the levels of different types of fishing activity is needed to help interpret possible impacts from turbine arrays.

6. Knowledge of the location and timing of fish and shellfish breeding stocks should be made available to developers so that construction phases can avoid these most sensitive times.

Key points

- Displacement from established grounds would lead to increased competition, conflict and escalating fuel costs. Combined concerns over environmental effects (particularly altered behaviour patterns) mainly during construction, and the overall impacts are believed by fishermen to be strongly negative.
- Few fishermen regard wind farm development as a prospective fishing opportunity because of safety concerns and uncertain risks of making changes.
- Recreational sea anglers were the only group to describe as beneficial the expected overall economic change generated.
- Turbines were considered a major hazard to navigation and fishing activities. Many fishermen were so concerned about safety, that they would avoid fishing within wind farms even it were legal to do so.
- Creation of protected nursery or conservation zones was regarded as the principal positive outcome.
- Knock-on effects to communities is likely to occur where fisheries are strongly embedded in the local economy.
- Fishermen are anxious about the uncertainty in their futures.
- Poor communication and lack of information upon which to base decisions are important concerns of fishermen and underlie many of the issues relating to poor or biased planning and decision-making.
- Mistrust of planning processes and authorities is partly a result of previous negative experiences of offshore planning.
- Causal maps provided a transparent and an honest description of fishermen's perceptions of how the development of Round 2 wind farms threaten their livelihoods.
- Soliciting the participation of fishermen in this study was not always straightforward, with fewer fishermen than anticipated responded to the questionnaire, seemingly because of the overwhelming feeling that their views would not make a difference.
- Liaison between the fishing industry, through their representative organizations, and offshore wind developers, must be improved in order to gain the trust and cooperation of fishermen.
- Experience from Round 1 wind farm construction and operation, both in the UK and internationally, should be disseminated directly to fishermen so they are better able to assess the likely impacts on their activities and decide how best to adapt.
- Uncertainties surrounding the safe operation of fishing vessels within wind farm arrays, and effects of wind farm construction and operation on fish and shellfish stocks, could be addressed through systematic studies performed on existing Round 1 and/or Round 2 sites due for development.

5. Assessing economic impacts

Objective 3.
Detail the socio-economic implications by port/métier/fleet (i.e. not a detailed socio-economic study of each fisher).

Economic information from a variety of sources was used to try and provide an assessment of the potential financial impacts to fishing businesses operating within the 3 Strategic Areas.

The value of the landings reported from vessels fishing within the ICES rectangles encompassed by the wind farms areas during the period 2000-2004 was obtained from Defra's Fishing Activity Database. This database identifies mainly the landings of vessels over 10 m, since vessels under 10 m are not obliged to report their landings. Because official landings data for the under 10 m fleet are incomplete, the total value of landings from fisheries within the 3 Strategic Areas is not easily estimated. After a poor response to requests for economic information via the questionnaire, direct approaches were made by letter and telephone calls, following the commitments made by fishermen at the workshop to provide information. Specific economic data, pertaining mostly to the inshore under 10 m vessels, were collected directly from fishing associations and vessel owning companies and is used here to describe and assess the financial profile of the under 10 m fleet and to discuss likely financial impacts.

5.1 Current financial performance of vessels likely to be affected by Round 2 wind farms

The majority of the vessels likely to be affected by wind farms operate inshore and are fairly modest businesses in terms of turnover and profit. After the owner/skipper has taken a salary, there is often very little profit for the business, so very little return on the capital invested in the business. As an example, typical average annual earnings (sales) for under 10 m gill netters in the Thames area are around £60,000. A smaller number of vessels that may be affected by wind farms are bigger businesses. For example, vessels fishing in the Irish Sea, using single-rig or twin-rig trawl for *Nephrops* may make annual earnings of around £200,000 to £300,000.

Catches declared (predominantly by over 10 m vessels) from the ICES rectangles covering the 3 Strategic Areas over the past five years is shown in Figure 5.1. The total declared landings in 2004 was around £15 million, 4.4% of the total declared value of UK whitefish and shellfish landings by UK vessels (£340 million in 2004).

5.1.1 Current finances of vessels fishing in the Greater Wash area

Vessels that operate in the Greater Wash wind farm area are predominantly under 10 m, with around 23% of identified vessels over 10 m. Twenty-four vessels, of various métier s, landing predominantly in Kings Lynn, make average annual catches from ICES Area 35F0 valued at around £5.7million (averaged over last four years). The vessels, ranging in size from 12 m to 17.5 m, fish mainly off Lincolnshire and east Norfolk coasts, but sometimes further south and into the Thames Estuary. Average annual value of landings per species for these vessels are shown in Table 5.1. These vessels also land smaller amounts of scallops, caught by dredging, and crabs, caught in pots.

Table 5.1. Average annual value of key species caught by 24 vessels landing principally in King's Lynn (majority of catch from ICEA Area 35F0).

Species	Catching method	Average annual value £
Brown shrimp	Trawling	2,200,000
Pink shrimp	Trawling	50,000
Cockles	Suction dredging	2,000,000
Mussels	Suction dredging	900,000
Whelks	Potting	2,200,000

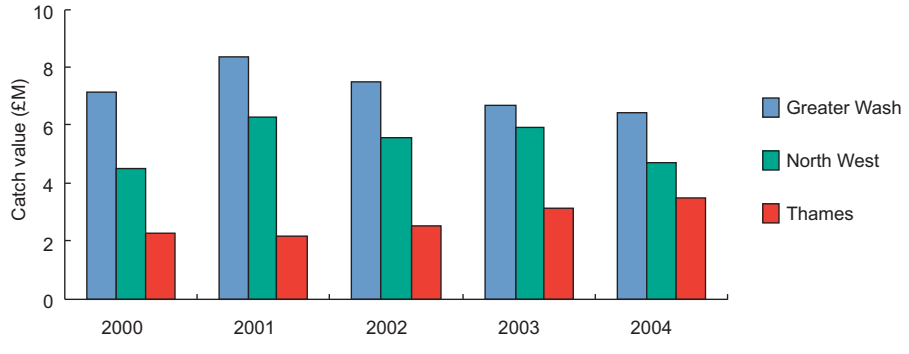


Figure 5.1. Value of landings from ICES rectangles which overlap with wind farm zones, for ›10m vessels. Source: Defra Fishing Activity Database

Vessels that catch shellfish with pots can make good profits under current operations. Small vessels used for catching shellfish in pots have low fuel consumption and catch high value species. Their costs and earnings profile is quite different to vessels catching fin-fish, with significantly lower costs as a percentage of earnings. The figures provided in Table 5.2 are based on typical 10-12 m potters working off Yorkshire coast, with the catch characteristics:

Catch:	brown crab, velvet crab, lobster
Working period:	all year round, c. 200 days per year
Trip length:	10 - 13 hour trips
Crew:	2 crew including skipper

Table 5.2. Typical costs and earnings for profitable 10-12 m shellfish potting vessels off Yorkshire coast, 2004.

	£
Gross earnings (sales)	120,000
Total fishing costs	50,000
Total owner expenses	20,000
Total costs	70,000
Profit	50,000

Shellfish potting vessels in the North Sea seem to be profitable. Data collected for this survey suggests that lobster and crab potters around 15 m in length can achieve sales of around £200,000 with profits around £25,000. An under 10 m crabber had sales around £150,000 with profits around £20,000 (13% of sales) before deduction of depreciation and interest. Figures published in 2004 by Seafish indicate that 2003 earnings for Bridlington-based vessels were typically around £60,000 to £70,000 per year for under 10 m vessels, fishing part time with one or two crew, and typically around £250,000 to £300,000 for larger vessels, around 13-16 m in length, working with 4 or 5 full time crew. Across a range of vessel sizes, profit before deduction of depreciation and interest was around 19% of earnings on average.

Under 10 m trawlers have higher fuel costs and catch lower value species than static gear vessels. Financial data on this vessel type collected in this survey indicates that small inshore otter trawlers may have average earnings around £60,000 to £80,000 per year, generating modest average profits around £7,000 to £10,000 before deduction of depreciation and interest. The most recently published Seafish survey of vessels of this type was based on data from vessels around the UK and indicates average earnings of around £46,000 with no profit to the vessel business (Seafish, 2002).

Over 10 m trawlers have higher gross earnings but higher costs. Data from previous Seafish surveys indicates that trawlers under 24 m with under 300 kW engines earn on average around £200,000 per year with profit around £20,000 (10% of sales) before deduction of interest and depreciation. Data collected for this survey suggests that trawlers of around 20 m–22 m (with 4 crew) based in the Humberside area have average earnings around £400,000 with average profit around £20,000 (5% of sales). This level of profitability is lower than earlier years, as would be expected due to fuel costs having doubled recently. Other data for over 10 m otter trawl vessels (and some smaller ones) operating in the North Sea, obtained for comparison with this survey, gives average figures of around £180,000 for earnings and £15,000 for profits. This suggests that the figures for Humberside vessels are likely to be around the top of the range.

Static and drift netters are predominantly smaller boats, with one or two crew, likely to have gross earnings up to around £200,000 per year. Earnings and profits for these vessels are likely to be very modest. Figures for this survey suggest that some larger gill netters, around 18 m–20 m, may earn on average around £200,000 - £240,000 per year with profits around £20,000 (around 8%–10% of sales). Some smaller boats have returned financial data for this survey with earnings around £30,000 - £35,000 and little or no profit. These vessels are clearly vulnerable to disruptions in operations.

5.1.2 Current finances of vessels fishing in the Thames area

Vessels operating in the Thames Strategic Area are typically small, using static or drift nets, with two crew per vessel. They make day trips and their flexibility to operate in other areas is significantly restricted by their size and engine power.

Gill netting vessels have low profit margins under current operating conditions. Data on typical costs and earnings of these vessels show that while the skipper is earning a salary from the business, there is typically very little financial return on the initial investment in the business (Table 5.3). Some fishermen consider that they have few, if any, other employment options. Others feel

Table 5.3. Summary of vessel performance in Ramsgate. All figures per vessel.

No. of vessels	Gear	Length m	Typical species caught	2005 estimated average sales £	Range of sales £	Typical costs £	Profit to the boat £
22	Gill netters	7 - 10m	Bass, Dover sole, skate	60,000	30,000 - 110,000	55,000	5,000

that these owner/skippers get a lifestyle return - they enjoy being fishermen (although many do complain of increasing pressures that reduce their ability to earn a living and enjoy their job).

Any profit remaining in the business must also be used to pay interest on any debt. Although debt repayments are not shown in profit and loss accounts, they do of course require cash flow in the business. A local representative commented that current operations provide a "reasonable living" for the skipper/owners in his area.

Other vessel types that fish in the Thames area also have low profit margins. Due principally to catch restrictions and high fuel costs in particular, small inshore trawlers (under 10 m) in this area also currently have very modest profit figures. The most recently published Seafish economic survey of this sector indicates average earnings of around £46,000 with no profit to the business (Seafish, 2002).

5.1.3 Current finances of vessels fishing in the North West (Irish Sea) area

A larger range of vessels fish in the North West Strategic Area, making trips of various lengths from one day for the smaller boats up to 4 days for larger *Nephrops* boats.

Many whitefish trawlers fishing off Cumbria are based in Fleetwood and Northern Ireland, and include some larger vessels. Earnings for Northern Ireland twin-rig trawl tend to be around £300,000. Average earnings for single-rig vessels, usually smaller, have recently been around £200,000. Profits are modest, especially due to high fuel costs for trawled gear vessels. Seafish data for 2001 shows profit before depreciation and interest at around 20% for Irish Sea *Nephrops* trawlers, but that proportion is now likely to be much lower. The few seine netters based in Northern Ireland have estimated average annual earnings around £280,000. Unfortunately, no financial data was made available for Fleetwood-based vessels. Typical earnings are summarised in Table 5.4 below.

Earnings for vessels using lines, nets and pots are fairly modest in the north west, most likely to be under £150,000 per year. Shellfish potting is likely to be more profitable than fin-fish vessels or shellfish dredging, as in other areas.

5.2 Practical and financial impacts expected by fishermen

Most fishermen expect a range of cause and effect relationships triggered by the existence of Round 2 wind farms to result ultimately in reduced profit, through increased costs and/or reduced earnings. In particular, fishermen do not expect to be able to use either towed or static nets in and around wind turbines. They expect that wind farms will in effect be exclusion zones, with a margin around them in which safe use of nets (towed, static or drift) is unlikely to be practical and safe. They expect to have to steam further distances to other areas, increasing fuel costs and reducing fishing time and earnings per day. Displacement of effort to other areas is likely to cause knock-on impacts to boats already in those areas.

Table 5.4. Average/typical earnings of vessels expected to be affected by Round 2 wind farms off the Cumbria coast. Source: Survey information.

Métier (boat & gear type)	Notes	Home port	Estimated no. of vessels affected	Estimated Average length	Estimated Average no. of crew	Estimated average earnings 2005 £
Northern Ireland twin-rig trawl	*Nephrops* with whitefish by-catch	Portavogie, Kilkeel	30	21 m	5	300,000
Northern Ireland single-rig trawl	*Nephrops* with whitefish by-catch	Portavogie, Kilkeel	20	17 m	4	200,000
Seine netters whitefish, flat fish.	May-Sept: 75% of catch in Round 2 area	Portavogie	2	25 m	6	280,000

5.3 Estimates of financial impacts on fishing businesses

Most fishers found it very difficult or impossible to estimate what would be the impact of wind farms on their operational costs and earnings. They do not know enough detail about what the practical effects might be, and these will affect volume and type of species caught, increases in fuel use and ultimately, business performance. Consequently, it has not been possible to make detailed estimates of expected financial and economic impacts. It is not possible to estimate how many vessels may go out of business or to what extent vessels will become less profitable, or possibly more profitable, in the case of some potting vessels.

The most widely expected types of impact and the nature of their expected financial implications are outlined here, with examples given as an idea of the potential financial implications to fishing businesses. These relate to avoiding wind farm areas and fishing elsewhere or being unable to fish elsewhere. Relocation and the availability of capital to invest in new business patterns is mentioned. Implications for the overall value of landings from ICES rectangles covering the 3 Strategic Areas are also discussed.

In general, vessel owners using towed, drift or static nets expect to have to avoid the wind farm areas, and many expect an increase in fuel costs and a reduction in fishing earnings. If wind farm areas do become *de facto* exclusion zones (even if not legally defined as such), then it is reasonable to expect that boats having to steam around the areas and fish elsewhere, could expect higher fuel costs and lower earnings.

An example of financial impact for a towed gear vessel that avoids a wind farm area could be:

- increase steaming distance by, for example, 15% over current patterns
- reduce fishing time by, for example, 15%
- These operational changes could lead to an increase in fuel costs by 10–15% (since there would also be less towing) and a reduction in earnings of around 15%.

This type of impact was typical of expectations by groups of fishermen in all the affected areas. This would clearly reduce profit for vessels affected, potentially to the extent that the business must either cease trading or attempt to relocate.

Some vessel owners might not expect much difference to steaming times if the wind farm area is not close to their home port, but expect a reduction in catch value if wind farms are constructed in the area where they currently fish.

Many fishermen expect to have to cease trading or relocate as a result of these impacts. Relocation was not a popular option. Given the low profit margins of many vessels likely to be affected, this expectation has some basis for credibility. It is not possible based on currently available data to make estimates of how many vessels might be unable to continue business in their current location. Widespread low profitability for towed and static gear vessels suggests that there is a risk of business failure for many vessels.

Larger vessels may have some flexibility about where they fish, but might still find their choices and earnings restricted by wind farms sites, particularly off the coast of Cumbria. Many Northern Ireland-based *Nephrops* vessels earn 75% of their March to September income in the area that includes Round 2 sites off Cumbria. This could amount to around 40%–50% of annual gross earnings. Some of these vessels may not be able to operate profitably in the Cumbria coast area and may move to operate off the east coasts of England and Scotland. Several vessels based in Northern Ireland have recently made this move and the value of their landings has now been transferred from Northern Ireland to English and Scottish ports. There is a risk of impacts on the volume of *Nephrops* landings in Northern Ireland if the number of vessels fishing in the Irish Sea is further reduced. Such a reduction would be likely to have consequences for employment in processing of *Nephrops* in Northern Ireland and for port services.

Smaller vessels, especially those based in ports local to the Cumbria coast wind farm sites, may find earnings affected. Fishermen interviewed were very concerned that the areas in which their boats operate would be taken up by Round 1 and Round 2 wind farms. They felt that the area of potential operation was much reduced and potential for incurring higher costs due to additional steaming time was high. These views are to be expected, but are also credible. The financial performance of these vessels suggests that there is little margin under current operating circumstances, making the businesses vulnerable to increased costs or reduced earnings.

Many vessels fishing out of King's Lynn take the majority of their catch in ICES area 35F0, which is designated for several large Round 2 wind farm areas. Smaller vessels do not always have the choice to fish further away from port, so many businesses may not be able to continue in their current form if the wind farm areas are not practical or safe for fishing with nets. Others may experience a reduction in landings value and increase in fuel costs if they travel to fishing grounds beyond the proposed wind farm areas.

Boats may relocate to another area to avoid wind farms, reducing the earnings of vessels already active in that area. If a larger fishing boat changed practices in reaction to the presence of wind farms, it may result in the displacement of several smaller vessels.

Some owners may be able to reshape their business to mitigate the impact of wind farms, but this may incur significant one-off switching costs. Some have considered options for switching to different methods and species but have found that other opportunities are fully subscribed by existing vessels. One or more existing operators would have to retire or otherwise cease trading in order to allow a wind farm-affected business to switch. Switching costs include purchase of new equipment, new licence, and acquisition of knowledge to operate new fishing methods and on new fishing grounds (this cost is likely to arise in the form of sub-optimal earnings under the new method until experience is gained). Fishing businesses that have been trading at modest profits in recent years may have limited access to capital to invest in switching costs.

Some shellfish potters thought that it was possible there might be landings benefits as a result of wind farms. These businesses are among the most profitable of those likely to be affected by wind farms.

To illustrate the possible financial impacts for a trawler day boat having to avoid a wind farm area, 2 hyptohetical scenarios were developed by the author using the advice of fishermen on the characteristics of a typical trawling vessel (Figure 5.2). The illustration assumes a steaming speed of 7.5 knots, towing speed of 3 knots, fuel useage of 21 l h^{-1} at £0.33 per litre and an overall catch value of £120 per tow. The value of the sales minus the fuel costs is a simple approximation to the daily vessel earnings. Gross annual earnings are calculated on the assumption of 150 fishing days per year.

Scenario 1. Steaming distance doubles. After the wind farm, fewer tows are made because the vessel spends more time steaming to find suitable grounds. Although fuel costs might be lower, the reduction in catches results in a reduction in the daily margin of around 30%.

Scenario 2. Steaming distance doubles and number of tows maintained. Travelling further to avoid the wind farm, fuel costs increases reduce the daily margin by around 4%. The fishermen is required to increase working time by over 2 hours per day.

Assuming that fishing near to or among wind turbines with nets will cease when wind farms are constructed, there is likely to be a reduction in value of landings. Although some effort may be displaced to adjacent areas and the total yield of those areas may increase in the short term, it is not likely that all displaced effort can deliver equal value of landings. Ports and communities affected are likely to be local to the wind farm areas, and also in Northern Ireland. A range of potential scenarios for vessels fishing with nets is presented in Figure 5.3, but this is not exhaustive. The scenarios were developed by the author as illustrations based on the comments and information supplied by fishermen throughout the survey in meetings and questionnaires.

The value of landings from the wind farm areas is lower than the potential total loss to the economy. If the wind farm areas and a surrounding safety zone are not fished by boats with nets, the loss of value of fish into the economy will not simply be the value of fish that would have been caught in those areas. If a loss of earnings or increase in costs as a result of wind farms causes some vessel businesses to fail, then the entire earnings of that vessel will be lost to the economy in the short term. At some stage, the potential catch of failed vessels may be taken up by remaining vessels.

Business failures may result in unemployment for former skippers and crew. Some fishermen feel that their alternative employment opportunities are limited. Unemployment levels in the areas likely to be affected vary, so job prospects will vary accordingly. It is not possible to comment at this stage on likely levels of immediate or longer-term job losses, until it is more apparent to what extent fishing businesses may fail. It is possible that employees in upstream (supplying) and downstream businesses may also be affected if there is a reduction in landings and in vessel numbers.

5.4 Discussion and suggested approach for assessing economic impacts

Fishermen have strong views about expected negative financial impacts on their business and, in some cases, the risk of losing their livelihoods. Many believe that the sum of the losses to their industry resulting from wind farms is a small figure compared to the profits likely to be made by wind farm companies. Because the government has permitted this impact on their businesses, they feel that the government should ensure that unavoidable losses are compensated. At least some groups of fishermen are likely to take legal action if they are adversely affected by Round 2 wind farms.

Fishermen's reluctance to contribute detailed financial data has limited the extent of financial impact analysis for

Scenario 1. Steaming distance doubles

	Before wind farm	After wind farm	Difference	% difference
Tows/shots (per day)	4	3	-1	-25.0
Towing distance (n.mi. per day)	42	31.5	-10.5	-25.0
Towing time (hours)	14	11	-3.5	-25.0
Steaming distance (n.mi. per day)	16	32	16	100.0
Steaming time (hours per day)	2.1	4.3	2.1	100.0
Total distance (n.mi. per day)	58	64	5.5	9.5
Total time (hours per day)	16.1	14.8	-1.4	-8.5
Fuel use (litres per day)	338.8	310.1	-28.7	-8.5
Fuel cost (£ per day)	111.8	102.3	-9.5	-8.5
Catch value (£ per day)	480	360	-120	-25.0
Daily margin (sales value - fuel cost)	£368	£258	-£111	-30.0
Annual margin: 150 fishing days/year	£55,229	£38,650	-£16,579	-30.0

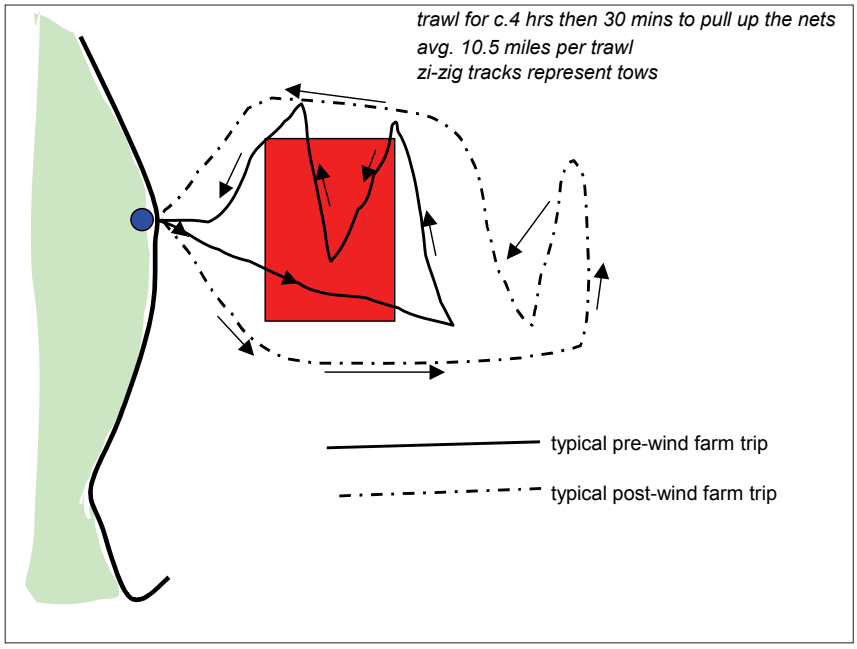


Figure 5.2. Two hypothetical scenarios illustrating the possible financial impacts for a trawler day boat having to avoid a wind farm area. See text for full explanation.

Scenario 2. Steaming distance doubles and number of tows maintained

	Before wind farm	After wind farm	Difference	% difference
Tows/shots (per day)	4	4	0	0.0
Towing distance (n.mi. per day)	42	42	0	0.0
Towing time (hours)	14	14	0	0.0
Steaming distance (n.mi. per day)	16	32	16	100.0
Steaming time (hours per day)	2.1	4.3	2.1	100.0
Total distance (n.mi. per day)	58	74	16.0	27.6
Total time (hours per day)	16.1	18.3	2.1	13.2
Fuel use (litres per day)	338.8	383.6	44.8	13.2
Fuel cost (£ per day)	111.8	126.6	14.8	13.2
Catch value (£ per day)	480	480	0	0.0
Daily margin (sales value - fuel cost)	£368	£353	-£15	-4.0
Annual margin: 150 fishing days/year	£55,229	£53,012	-£2,218	-4.0

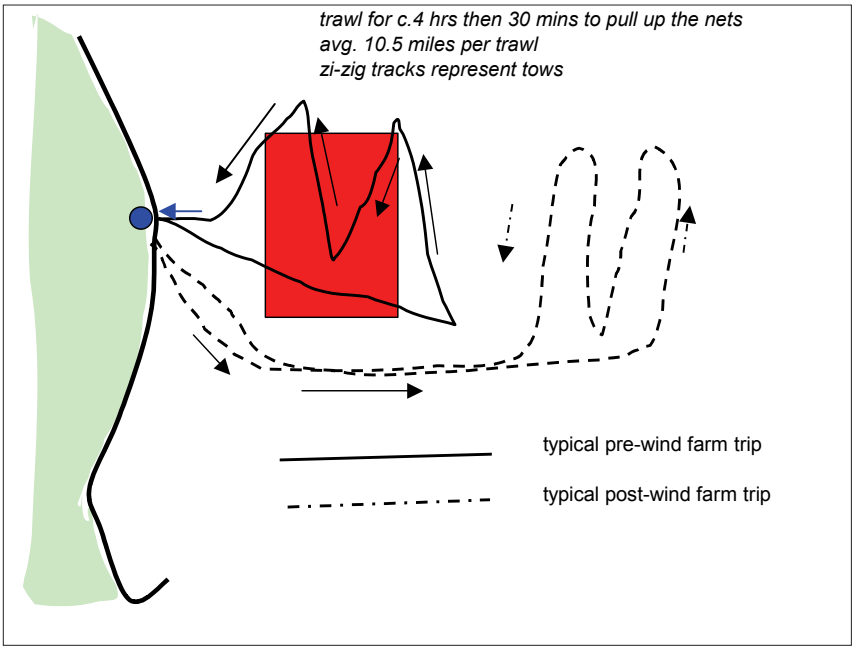


Figure 5.2. continued: Two hypothetical scenarios illustrating the possible financial impacts for a trawler day boat having to avoid a wind farm area. See text for full explanation.

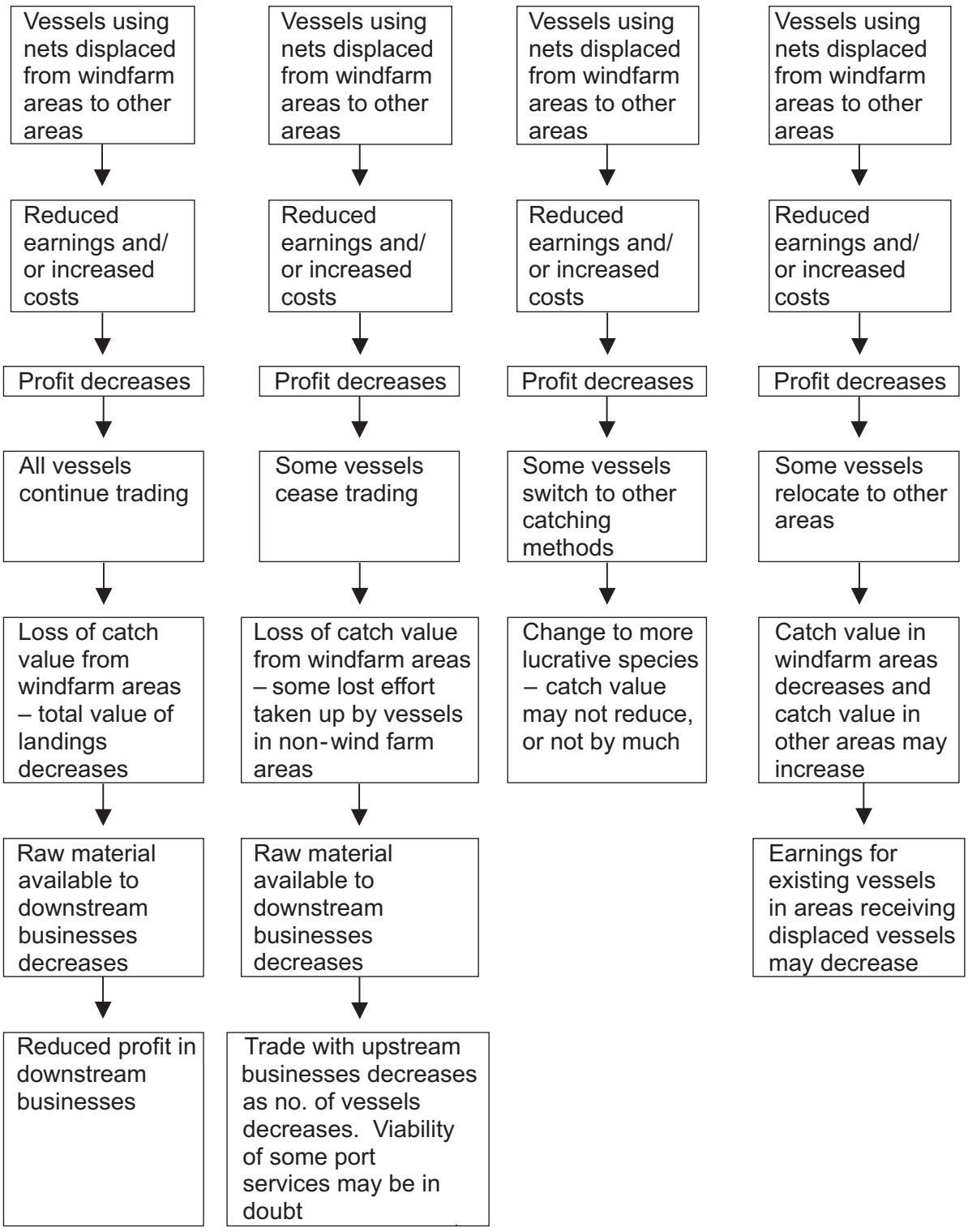


Figure 5.3. Some potential scenarios for vessels fishing with nets (static or towed) assuming that they are unable to fish in and around wind farm areas.

this study. The difficulty of anticipating what the impacts of wind farms might be, coupled with the unpredictable nature of fishing incomes, meant that fishers were reluctant and/or unable to make estimates of expected changes in financial performance. In addition to this, many fishermen commented that they did not trust that data supplied for this survey would not be obtained by Defra and used to bring prosecutions against them for illegal fishing. Some fishermen are involved in disputes with existing wind farm operators and were reticent to provide financial information that might somehow prejudice their case for compensation in relation to Round 1 wind farms.

The available financial data was not sufficient to make reliable estimates of overall expected financial impacts to fishing businesses. To accurately assess the impacts on vessel profits caused by having to avoid wind farm areas, this information would need to be obtained prior to construction of Round 2 wind farms. This would ensure that useful comparison data is available should there be any loss to fishing businesses after construction commences. An independent scheme that could establish an agreed framework for consideration of loss of profit may be preferable to individual legal actions by groups of vessel owners against wind farm companies. A suggested outline method for calculating and substantiating loss of profit is given in Appendix 4.

Key points

- Defra's FAD and information obtained directly from fishermen was used to provide an assessment of the scale of potential financial impacts to fishing businesses.
- Because official landings data for the under 10 m fleet is incomplete, and fishermen are reluctant to provide information directly, the total current value of landings from fisheries within the 3 Strategic Areas, is not easily estimated.
- Greater Wash vessels that catch shellfish with pots can make good profits under current operations, while trawlers and netters make modest average profits.
- Thames Estuary netters and small inshore trawlers have low profit margins under current operating conditions.
- Northern Irish whitefish trawlers operating in the North West, currently have modest profits, particularly because of high fuel costs. Around 40–50% of annual earnings may come from Round 2 areas. No financial information was available for Fleetwood vessels.
- It is not possible to make a detailed estimate of the financial impacts because of the difficulties of obtaining financial information and because the impacts on fishing activities caused by wind farms (good or bad) are difficult to anticipate in advance.
- Most likely scenarios of financial impacts appear to be negative, particularly for fishermen using nets.
- It is reasonable to expect that if vessels have to avoid wind farms, fuel costs may rise and earnings may reduce.
- Widespread low profitability for towed, drift and static gear vessels suggests that there is a risk of business failure.
- Smaller vessels do not always have the capability to relocate to other fishing grounds and those whose income is currently from Strategic Areas, may not be able to operate profitably after wind farm construction.
- Reductions of number of larger vessels in Northern Ireland (through business failure or relocation) could have knock-on consequences for processors and port services.
- Switching to other fishing methods is restricted by availability of capital, licenses and quota, and does not appear to be an attractive option because of high costs and uncertain risks.
- The current value of landings from the wind farm areas is lower than the potential loss to the economy.
- Fishermen have strong views about expected negative financial impacts. At least some are likely to take legal action.
- To accurately assess the impacts on vessel profits caused by having to avoid Round 2 wind farm areas, the costs and earnings of fishing vessels prior to construction should be obtained. (Note: A method for calculating and substantiating loss of profit is given in Appendix 4).

6. Mitigation to disadvantaged fleets

Objective 4.
Offer recommendations for mitigation options to fleets that may be disadvantaged.

When invited to suggest possible ways to lessen the impacts of wind farms on local fisheries the most frequent response from fishermen was simply to abandon offshore development. The view of many fishermen was that even if relocation of the proposed Round 2 wind farm sites was a realistic option, any new location would affect one fishery or another. In face of this opinion, it was a difficult task to encourage dialogue on the issue because fishermen felt that there would be few, if any, acceptable mitigating circumstances. Despite these problems, a number of viable options were explored. Table 6.1 provides a list of recommended mitigation options suggested by fishermen at meetings and from questionnaires.

Table 6.1. Fishermen's suggested recommendations for mitigating and lessening the impacts of Round 2 wind farm developments. Recorded at face-to-face meetings and provided in questionnaire returns. Summarised by area.

Mitigation option suggested	Implication
Thames Estuary	
Consult with the fishing industry before any leases are granted	At an early stage, fishermen could influence site choice by advising on grounds that were least valuable to them, thereby minimising loss of the most profitable areas
Lay power cables using the method that least damages the seabed	Disturbance of marine flora and fauna would be kept to a minimum, as would long-term damage to the seabed
Lay cables with opposing currents alongside each other and dig them into the ground	Provides better shielding of cables and reduces possible effects of electro-magnetic fields on fish behaviour
Relocate sites of wind farms currently proposed:	
i) Move the Kentish Flats array 5/6 nm to the east, ie beyond the daily range (in distance) of small inshore boats	Fishing activity of vessels from Whitstable that fish within 15 miles of their home port would be unaffected
ii) Re-position the London array to the east	Reduces interference and loss of valuable ground for some fishermen depending on fishing métier
iii) Re-position the London Array to the west to Sunk Sand	Reduces interference and loss of valuable ground for some fishermen depending on fishing métier
iv) Move Gunfleet site to the north east by 3 miles	If done initially, no fishermen would have been affected
Space turbines as close together as is safely possible	Reduces the overall area of the wind farm and therefore decreases the area of exclusion
Restore seabed and remove debris post-construction to pre-construction state	Damage to fishing gear reduced
Delay further development until the long-term effects of wind farms have been assessed from current operational sites	Gaps in current knowledge would be investigated such as scouring and wider environmental effects

Mitigation option suggested	Implication
Obligate the wind farm industry and Crown Estates to fund research	Some measure of responsibility towards affected parties addressed
Award long-term financial support to fishermen	Smaller, annual subsidies that allow fishermen to continue in business and protect their livelihoods is preferred to being forced to cease fishing and receive a one-off lump sum in compensation for lifetime loss of earnings and opportunity
Put measures in place that require future owners of wind farms to honour compensation agreements no matter how many times changes in ownership occur	Financial security of fishermen guarded
Build nuclear power stations	Provides a more efficient, cost-effective way of generating power with least disturbance to fishing activity
Greater Wash	
Construct wind farms on sites that are of little importance commercially or are already excluded from fishing activity eg. rough ground, ex-aggregate extraction grounds, Marine Protected Areas, or close to existing offshore construction (rigs)	Impact on existing fishing activity would be minimised
Move the Sheringham Shoals proposed wind farm to shallow banks where long liners do not fish	Reduces impact for long line fleet
Exclude commercial fishermen from wind farm sites	Protects site as a commercial opportunity for sea anglers
Manage the construction phase in awareness of seasonal sensitivities (includes appointment of Fisheries Liaison Officers (FLOs) with appropriate knowledge of local fisheries)	Would help to ensure that construction work was not carried out during critical biologically sensitive periods such as spawning
Delay development until adequate research has been carried out and ensure the surveys are biologically appropriate	A time-series would be created of the spatial and temporal effects that would allow better assessment of the impacts to be included in decision making
Consider alternative spacing options for turbines, ie increase distance to 1500 m	Would allow long liners to set and retrieve lines between the turbines
Establish better communication between fishermen and the Developers, Defra and FLOs	Encourages greater involvement of fishermen at all stages of the development process
Provide fishermen with adequate compensation for the loss of current and future earnings	Helps to ensure financial support
North West	
Seek greater input from fishermen from the start of the development process	Gives fishermen an opportunity to advise and influence decisions that will affect them directly
Reduce the total area marked out for wind farm development	Minimises area lost to fishing activity
Increase distance between turbines without expanding overall area of wind farm	Fewer, spaced out turbines makes them safer to navigate between
Award fishermen diversification grants	Enables fishermen to purchase/modify gear or boat to allow the change in fishing method they might require on alternative grounds
Provide pension schemes for fishermen	Secures future financial support

Fishermen recognised that the benefits gained by one group of fishermen might represent a cost to another group by simply displacing the problem elsewhere. An example of this was reported regarding the reconfiguration of the Airtricity proposed development in the Thames estuary. After discussions with long liners from Lowestoft, the proposed configuration of the turbines was apparently changed so as to minimise the impact on long liners. However, the new proposed configuration was unacceptable to net fishermen who need to be able drift their nets along the edges of the banks. Similarly, it was foreseen that if the proposed Ecoventures site on the Sheringham Shoals was sited on shallow banks at the request of the long liners that do not fish there, conflict with other gear types would result.

The overwhelming attitude expressed by fishermen was that the onus for putting any of these mitigation options in place rests with the Government and Developers in near equal measure. Many felt that wind farm development is a reality that will be imposed on their industry regardless of any objections, and for this reason those responsible should provide the means to help secure their present and future livelihoods.

Discussions arising during the workshop further highlighted that there are no universally or area-based generic options for mitigating the impact of wind farms on fisheries. Given that each of the proposed wind farm sites has a very different ecological and socio-economic environment, establishing appropriate measures for mitigating and lessening any impacts ideally requires case-by-case evaluations of the effects of particular wind farms. To some degree, this information is a requirement of the developer.

Key points

- The numerous uncertainties surrounding how wind farms impact ecology, navigation and sediment dynamics make it difficult for fishermen to see how they might be able to adapt.
- If wind farms are imposed upon the fishing industry, fishermen felt that those responsible should provide the means to help secure their present and future livelihoods.
- The most useful mitigation options that can be applied to wind farm construction and operation, to minimise the impacts that wind farms might have on particular fishing activities, are those developed on a site by site basis with the full involvement of fishing industry representatives.
- Problems with locations (and mistrust) may have been avoided if fishermen (and other affected industries) were consulted during the Strategic Environmental Assessment stage.

7. Utility of the approach to assessing impacts of other offshore developments

Objective 5.
Provide direction and discussion how to assess the cumulative effects of the R2 wind farm developments on fisheries, which can in the future be used for assessing the impact of other human activities.

The main components of a cumulative assessment process are, (i) geo-referenced data describing the site of all major human activities, including wind farms and fisheries, that occur in UK coastal and offshore waters, and (ii) key environmental components that are of concern such as fish and shellfish resource distributions. Subsequent analysis must then define the scale and intensity of interactions between these, taking account of sensitivity and vulnerability. However, this analysis relies on a wide range of information sources including expert judgement, meta-analysis and models, supported by Geographic Information Systems technologies and procedures, and is a complex process (Gilliland *et al.*, 2004).

Despite increasing emphasis placed on the need for cumulative assessments to be undertaken as a routine part of Environmental Impact Assessment, there is still insufficient targeted guidance for developers and regulators on the methods they can use to assess cumulative effects of their operations. Access to relevant information is essential to any assessment, and although data on the activity of fishing vessels in inshore waters is recorded on a routine basis, it is not currently possible to gain access to a national database describing inshore fishing effort and distribution. Such a facility would provide valuable contextual information to all sea users, including the wind farm developers, to allow them to target their local investigations more precisely.

Marine Spatial Planning will in future provide additional benefits to the cumulative effects assessment process, including the presentation of clear environmental objectives so that conflicts between different sectors of human activity are more easily identified and reconciled. As a contribution to this process, the development of draft objectives for the marine environment (Rogers and Tasker, 2005), has suggested the environmental limits and targets that might be acceptable, and the pressures of human activities that will need to be regulated to ensure such objectives are met. Further work is required to develop and make these objectives operational, and to identify a process for the integration of sectoral assessments such as SEA, but recent government commitments to Marine Spatial Planning will give better focus and impetus to tackling these long standing and complex issues.

An assessment of the cumulative effects of all human activities on fisheries should necessarily involve a short-term (annual) evaluation of operating issues, and a long-term assessment of future implications for income and investment. Such an undertaking is most feasible as part of a centralised, possibly government funded activity equivalent to a Strategic Environmental Assessment (SEA), where multiple sectors can be incorporated and impartial evaluation can be undertaken.

7.1 Lessons learned

The following sections consider the utility of the approach used in this investigation for assessing the impacts that other developments at sea could have on the well being of the fishing industry. Lessons learned from this study are used to highlight important principles for engaging with fishermen to assess impacts on their livelihoods. The strengths and weaknesses of causal mapping and questionnaires are briefly discussed in relation to how they may be useful as generic methodological tools.

7.1.1 Key principles

Timeliness is of foremost importance. Providing sufficient opportunity at the earliest possible stage of any planned development will foster greater participation and more open dialogue. A major complaint of fishermen, that undoubtedly hindered the two-way flow of information during this study, was their concern at not being involved at the Strategic Environmental Assessment planning stage. Lack of early engagement with fishermen increased their feeling that the government does not value the fishing industry and their mistrust of planning, regulation and development agencies.

Effective communication arises from respectful relationships. The ability to talk to one another, share knowledge, understand and respect others perspectives is essential to build trust between fishermen and relevant agencies. Face-to-face meetings were preferred by fishermen in this study; a point re-iterated clearly during the workshop. Planning and preparing meetings was at times very challenging, but it always resulted in productive dialogue. Ideally, several face-to-face meetings are required to build the trust and understanding necessary to achieve good participation. Where this is not possible, considerable effort must be made to maintain communication and flow of information by correspondence and telephone.

Fishermen need to know what is in it for them. Being clear about the purpose of any investigation in to the impacts of offshore developments is paramount to get fishermen to participate. The incentive for a fishermen to take time out to attend meetings depends on having a clear understanding of why it is worth their while to make the effort. Although the strength of feeling among fishermen is high regarding the potential loss of fishing opportunity that wind farm developments might cause, it was difficult to get them to participate in this study. The primary reason for this was that fishermen felt it was already too late, and their views would not be valued. This could be avoided in the future by assuring that first two points raised above are adequately addressed.

7.1.2 Methodological tools

Causal mapping could be a particularly useful tool for investigating cumulative impacts since it allows the relationships between causes and effects to be described in a structured way, even when knowledge of the quantitative impacts may be uncertain or unknown. The method is flexible in the way it can be applied and consequently it is capable of identifying issues that may otherwise be overlooked or not easily captured in a traditional questionnaire. Various approaches to weighting cause – effect linkages could be adopted to reveal areas of priority concern.

When causal mapping is employed earlier in the planning process it can be a valuable tool, not only for identifying areas of concern, but communicating, developing and negotiating solutions. By providing structure to consultation meetings it can help to ensure that all arguments are clearly and logically presented so that participants are able to place their own understanding in the context of others (Eden and Ackerman, 1998).

The poor return rate experienced by this study does not discount the utility of questionnaires, since they have been used to good effect in previous studies. However, we suggest that, unless very short (1 page) questionnaires ought not to be relied upon as the sole source of information for studies requiring direct input from fishermen. Where in-depth questionnaires are necessary, making effort to first build good relationships with fishermen will improve success. Where resources allow for the large time and effort, information for questionnaires is best obtained during face-to-face meetings.

Key points

- Providing sufficient opportunity at the earliest possible stage of any planned development will foster greater participation and more open dialogue.
- Face-to-face talking promotes better understanding and improves relationships by building trust.
- Causal mapping can be used to capture qualitative information on the cumulative effects.
- Detailed guidance to developers on the methods of undertaking cumulative impacts assessment, and the availability of appropriate datasets, would be valuable.
- The commitment to Marine Spatial Planning, and the development of objectives to support the implementation of an ecosystem approach is encouraging signs of coordination within government that will ultimately benefit all sea users.

8. Key findings and conclusions

- Development of wind farms has caused alarm amongst coastal fishing communities who see a threat to the continuation of their lawful activity.
- Since fishermen are the main users of the marine environment likely to be in conflict with wind farms, it is necessary to have dialogue with the UK fishing industry to consider their points of view and concerns.
- This research addresses a current policy need in Defra by providing scientifically robust information to help inform decisions on permitting spatially demanding offshore wind energy developments.
- It describes the impacts that Round 2 wind farm developments could have on the activities and livelihoods of fishermen.
- Objectives 1-4 were addressed through consultation with fishermen and analysis of Defra's Fishing Activity Database.
- Over 700 small inshore vessels make up three-quarters of the vessels fishing in the wind farm Strategic Areas.
- Fisheries within the 3 Strategic Areas are numerous and varied; 27 distinct métiers can be defined.
- Shellfish are the most important fisheries in the Greater Wash.
- Sole, rays, bass and cockle fisheries are the mainstay in the Thames Estuary.
- In the North West, shellfish stocks support small boats and hand gathering. *Nephrops* and finfish are the mainstay for a declining fleet of larger vessels.
- Displacement from established grounds would lead to increased competition, conflict and escalating fuel costs. Combined concerns over environmental effects (particularly altered behaviour patterns) mainly during construction, and the overall impacts are believed by fishermen to be strongly negative.
- Few fishermen regard wind farm development as a prospective fishing opportunity because of safety concerns and uncertain risks of making changes.
- Recreational sea anglers were the only group to describe as beneficial the expected overall economic change generated.
- Turbines were considered a major hazard to navigation and fishing activities. Many fishermen were so concerned about safety, that they avoid fishing within wind farms even it were legal to do so.
- Creation of protected nursery or conservation zones was regarded as the principal positive outcome.
- Knock-on effects to communities is likely to occur where fisheries are strongly embedded in the local economy.
- Fishermen are anxious about the uncertainty in their futures.
- Poor communication and lack of information upon which to base decisions are important concerns of fishermen and underlie many of the issues relating to poor or biased planning and decision-making.
- Mistrust of planning processes and authorities is partly a result of previous negative experiences of offshore planning.
- Causal maps provided a transparent and an honest description of fishermen's perceptions of how the development of Round 2 wind farms threaten their livelihoods.
- Soliciting the participation of fishermen in this study was not always straightforward, with fewer fishermen than anticipated responded to the questionnaire, seemingly because of the overwhelming feeling that their views would not make a difference.
- Liaison between the fishing industry, through their representative organizations, and offshore wind developers, must be improved in order to gain the trust and cooperation of fishermen.
- Experience from Round 1 wind farm construction and operation, both in the UK and internationally, should be disseminated directly to fishermen so they are better able to assess the likely impacts on their activities and decide how best to adapt.
- Uncertainties surrounding the safe operation of fishing vessels within wind farm arrays, and effects of wind farm construction and operation on fish and shellfish stocks, could be addressed through systematic studies performed on existing Round 1 and/or Round 2 sites due for development.
- Defra's FAD and information obtained directly from fishermen was used to provide an assessment of the scale of potential financial impacts to fishing businesses.
- Because official landings data for the under 10 m fleet is incomplete, and fishermen are reluctant to provide information directly, the total current value of landings from fisheries within the 3 Strategic Areas, is not easily estimated.
- Greater Wash vessels that catch shellfish with pots can make good profits under current operations, while trawlers and netters make modest average profits.·
- Thames Estuary netters and small inshore trawlers have low profit margins under current operating conditions.
- Northern Irish whitefish trawlers operating in the North West, currently have modest profits, particularly because of high fuel costs. Around 40–50% of annual earnings may come from Round 2 areas. No financial information was available for Fleetwood vessels.

- It is not possible to make a detailed estimate of the financial impacts because of the difficulties of obtaining financial information and because the impacts on fishing activities caused by wind farms (good or bad) are difficult to anticipate in advance.
- Most likely scenarios of financial impacts appear to be negative, particularly for fishermen using nets.
- It is reasonable to expect that if vessels have to avoid wind farms, fuel costs may rise and earnings may reduce.
- Widespread low profitability for towed, drift and static gear vessels suggests that there is a risk of business failure.
- Smaller vessels do not always have the capability to relocate to other fishing grounds and those whose income is currently from Strategic Areas, may not be able to operate profitably after wind farm construction.
- Reductions of number of larger vessels in Northern Ireland (through business failure or relocation) could have knock-on consequences for processors and port services.
- Switching to other fishing methods is restricted by availability of capital, licenses and quota, and does not appear to be an attractive option because of high costs and uncertain risks.
- The current value of landings from the wind farm areas is lower than the potential loss to the economy.
- Fishermen have strong views about expected negative financial impacts. At least some are likely to take legal action.
- To accurately assess the impacts on vessel profits caused by having to avoid Round 2 wind farm areas, the costs and earnings of fishing vessels prior to construction should be obtained. (Note: A method for calculating and substantiating loss of profit is given in Appendix 4).
- The numerous uncertainties surrounding how windfarms impact ecology, navigation and sediment dynamics make it difficult for fishermen to see how they might be able to adapt.
- If windfarms are imposed upon the fishing industry, fishermen felt that those responsible should provide the means to help secure their present and future livelihoods.
- The most useful mitigation options that can be applied to windfarm construction and operation, to minimise the impacts that windfarms might have on particular fishing activities, are those developed on a site by site basis with the full involvement of fishing industry representatives.
- Problems with locations (and mistrust) may have been avoided if fishermen (and other affected industries) were consulted during the Strategic Environmental Assessment stage.
- Providing sufficient opportunity at the earliest possible stage of any planned development will foster greater participation and more open dialogue.
- Face-to-face talking promotes better understanding and improves relationships by building trust.·
  Causal mapping can be used to capture qualitative information on the cumulative effects.
- Detailed guidance to developers on the methods of undertaking cumulative impacts assessment, and the availability of appropriate datasets, would be valuable.
- The commitment to Marine Spatial Planning, and the development of objectives to support the implementation of an ecosystem approach is encouraging signs of coordination within government that will ultimately benefit all sea users.

9. References, acknowledgements and acronyms

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Acronyms

BWEA – British Wind Energy Association
Cefas – Centre for Environment, Fisheries and Aquaculture Science
DE – Decision Explorer – software for causal mapping
Defra – Department for Environment, Food and Rural Affairs
Dti – Department of Trade and Industry
FAD – Fishing Activity Database
FEPA – Food and Environment Protection Act
FLOWW – Fisheries Liaison with Offshore Wind and Wet Renewables Group
SEA – Strategic Environmental Assessment
Seafish – Sea Fish Industry Authority

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