Studies and Pilot Projects for carrying out the Common Fisheries Policy

# Joint data collection between the fishing sector and the scientific community in Western Waters

## FINAL REPORT to the European Commission Directorate-General for the Fisheries and Maritime Affairs

Contract SI2.491885, Ref. FISH/2007/03 Lot 1.

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## Executive summary

This project was established in response to the open call for tenders, Reference No FISH/2007/03 "*Studies and Pilot projects for carrying out the common fisheries policy, Lot 1: Joint data collection between the fishing sector and the scientific community in Western Waters*" from Directorate-General for Fisheries and Maritime Affairs on 25 July 2007.

The project involved fisheries scientists and fishing industry partners from Spain, Portugal, France, Ireland, Belgium, Scotland and England in four separate pilot projects:

- Brown crab (*Cancer pagurus*) fishery
- Development of a fishery information report for demersal fisheries in the Celtic Sea and western Channel.
- Study with electronic logbook in the Basque trawling fishery
- Portuguese artisanal deep-water longline fishery

These projects variously addressed the three tasks were specified in the tender: 1) Design and implementation of pilot programmes to obtain supplementary information from the fishing industry on the practical fishing operations and the decisions made about the fisheries; 2) Design and implementation of self-sampling programmes to be implemented on board commercial vessels and 3) Pilot projects to involve stakeholders in the use of the type of data described under tasks 1 and 2 for stock assessment and management evaluation.

The brown crab study covered Scottish, French, Irish and English fisheries in ICES Areas VI and VII. The approach was to combine existing data with new data, collected on a trial basis, obtained from self sampling programmes involving voluntary log books, GPS loggers and questionnaires. The outputs are a combination of data compiled independently by scientists, data obtained by scientists from the fleet, and data provided by the fleet independently of scientists through a self-sampling programme. The different approaches to collecting data from the crab fishery are evaluated. It is concluded that: 1) a clear management context is required for self-sampling and self-reporting; 2) the assessment framework or set of indicators needs to be established and agreed with stakeholders prior to self-sampling; 3) if a strong reliance is to be placed on self-sampling and self-reporting frequent communication between fishermen and scientists is required (the scientists must become teachers and facilitators); 4) strong feedback mechanisms to 'self samplers' is required. Integration of fishers in to the assessment process is then the next logical step.

The Celtic Sea demersal fishery project covered French, Irish, UK and Belgian demersal fisheries in the Celtic Sea and western Channel. The projects provide a detailed description of the demersal fisheries in the area including fleet structure, area and season of operation, species compositions of catches, and trends in vessel and gear design affecting vessel efficiency. The projects also include some further evaluations of the impact of the Trevose cod closure on fleet behaviour including feedback from fishermen. Information was collected from national data bases (effort, species composition, VMS), questionnaires and interviews with fishermen.

The Study with electronic logbook in the Basque trawling fishery aimed to take the opportunity to collect supplementary information from the fishing industry, information on the practical fishing operations and on the decisions made about the fisheries, gear choice, target species and distribution of fisheries in space and time, to help identify fisheries/metiers a priori and improve the knowledge of the decisions taken in fisheries dynamics. Information was obtained by incorporating a few new simple questions to skipper's routine electronic log-book fill-up

requirements. It is concluded that the introduction of the new mandatory electronic recording and reporting system could be the starting point for the routine collection of a new kind of data on fishing tactics by including a range of easy-to-answer questions in the logbook. This would inform decision-makers on the impact of their future choices, and how consistent the outcomes of the management strategies are with the objectives of the current and forthcoming Common Fishery Policy

The main aim of the Portuguese artisanal deep-water longline fishery project was to design and establish a self-sampling scheme for data collection from the deep-water longline fishery in ICES Area IX. The case study is the artisanal fishery for black scabbardfish operating in Sesimbra. Data on fishing effort and catch compositions that are not normally recorded were provided by fishermen, and details of interactions between marine mammals and the fishing gear were recorded. The pilot project provided a detailed description of the fishery and how it operates. It was decisive for strengthening the relationship settled over 10 years ago between the fishing community of Sesimbra's longliners and the scientists at IPIMAR. The establishment of a plan to exchange data and information worked also as a kick-off to the collaboration within another EU financed project, *DEEPFISHMAN*. This project highlighted the importance of incentives, and of forming strong relationships based on confidence and mutual help, maintaining commitment through regular interactions, and ensuring confidentiality when necessary.

The pilot projects provide a range of additional information not currently available through routine data collection schemes including the data required by the EU Data Collection Framework, and hence can be seen as adding value to the DCF as well as supporting the work of the RACs and providing the scientific community with information to help interpret fishery data.

# 1 Introduction

## 1.1 Tender Specifications

This project was established by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) in response to the open call for tenders, Reference No FISH/2007/03 "*Studies and Pilot projects for carrying out the common fisheries policy, Lot 1: Joint data collection between the fishing sector and the scientific community in Western Waters*" from Directorate-General for Fisheries and Maritime Affairs on 25 July 2007.

The Short Description for Lot 1 stated: "*It is widely acknowledged, that quality of data regarding a number of European commercial stocks has deteriorated in recent years due to several factors. Accurate and objective data is needed to allow for sound management decisions under the CFP. In addition there is much information generated by the industry that is not collected and systematically used by scientists. A data collection scheme involving fishermen who are able to collect quality field data and scientists who can produce appropriate scientific advice would result in an improved platform for fisheries management while promoting mutual respect and understanding among the 2 groups. The main aim of the study is to expand the scope for improved quality of data to support policy decisions and further strengthen the current state of cooperation between fisheries scientists and the fishing industry by implementing joint data collection programmes. These can provide cost-effective and additional fishery data and the fishing industry can be actively involved in the scientific process leading to the provision of scientific advice*."

The following three tasks were specified in the tender:

(1) Design and implementation of pilot programmes to obtain supplementary information from the fishing industry on the practical fishing operations and the decisions made about the fisheries (e.g. gear choice and fishing gear performance, the distribution of fisheries in space and time, the practical aspects of implementation of regulations including adaptations etc). This should also include better use of existing information (e.g. logbooks, VMS) and collection and use of information which is not routinely available today such as information from fishers own logbooks or from interview or survey based collection of fishers knowledge.

(2) Design and implementation of self-sampling programmes to be implemented on board commercial vessels (e.g. discard sampling, biological sampling), including the appropriate training scheme and user- friendly software applications allowing simple data storage, processing and transfer.

(3) Pilot projects to involve stakeholders in the use of the type of data described under tasks 1 and 2 for stock assessment and management evaluation. These pilot projects should also ensure stakeholders' involvement in quality assurance and assistance to data interpretation. This can for instance be workshops prior to stock assessment working groups with interactions between stakeholders and researchers regarding data screening and quality.

## 1.2 Background

Many programmes of collaborative research and data collection have been initiated in the North Atlantic and elsewhere since the 1990s, often in response to crises in the fishing industry that led to deteriorating relationships between fishers and fishery scientists (Armstrong *et al* 2008). The programmes have helped fishers become more involved in the fishery management process and have built progressively greater capacity in the fishing industry to collect useful data and carry out scientific studies. The programmes have already yielded substantial amounts of data from fishing gear trials, resource surveys, catch-composition studies, discarding surveys, development of CPUE series, and from interviews and questionnaires capturing fishers' knowledge of fish stocks, fishing operations and tactics.

Theme Session *L* at the 2009 ICES Annual Science Conference in Berlin (*Bringing collaborative science – industry research data into stock assessment and fishery management: evaluating progress and future options*) concluded that "Fisheries management in Europe is in a process of change, and the proposals for revision of the Common Fisheries Policy indicate an increasing role for individual countries and their fishing industries to develop solutions for meeting regional fishery management goals, and for the burden of proof to shift to the industry to prove their activities are sustainable. This suggests an increasing need for effective, industry-science collaborative research alongside the conventional scientific programmes. These two avenues of research and data collection need to be blended effectively. The results must be demonstrably effective in promoting more sustainable, profitable and responsible fishing. Fishers involved in collaborative research need to see the results of their efforts being used, if their interest in participating is to be sustained and if credibility is to be maintained. Effective communication is therefore vital for raising awareness amongst the fishing community of the importance of collaborative research and how it is impacting fishery management decisions. It is important to evaluate failures as well as to showcase successes if we are to make progress."

Processes for improving the collaboration between scientists and fishermen are also being explored through the EU 7$^{th}$ Framework project GAP (Bridging the Knowledge Gap between Fishermen and Science; Project number 217639; http://www.gap1.eu/). The GAP project involves a range of case studies and has developed a "Good practice guide to participatory research between fisheries stakeholders and scientists". The four pilot projects conducted in the present Lot 1 project address the need for closer collaboration with the fishing industry to collect the type of data that can support the regional management of European fisheries, particularly in providing the Regional Advisory Councils with the information base to help them make informed decisions.

Five specific questions posed by the European Commission in relation to this project are addressed in the introduction and general discussion of each of the pilot projects:

A) What information exactly is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?

B) What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?

C) To what extent is there a need, from the stock perspective, to merge/compare these national data sets into regional/international data sets and analysis?

D) Are there drivers for designing or keeping alive such projects, for instance national interest in managing local fisheries, or interest of the sector in obtaining a sustainability label?

E) What "added value" do the projects provide to the recurrent data collection under the EU Data Collection Framework?

The overall philosophy of the Lot 1 project was to investigate, through limited pilot applications, ways in which the fishing industry can collaborate with scientists to provide data not routinely collected (e.g. through the DCF) or to provide information facilitating the interpretation and use of data collected through the DCF. This collaboration was of two main types:

- Collection and interpretation of fishermen's knowledge to help explain data, to understand how fishermen adapt to control measures, or to address specific issues (Tasks 1&3 in tender). The pilot project on Celtic Sea fisheries followed this "fishery information" approach
- Involvement of fishermen in collection of new, additional data through self-sampling schemes or recording of additional information on fishing operations using electronic or other data recording (Task 2&3 in Tender). The remaining three pilot projects included elements of data collection by fishermen as well as building fishery information (Task 1).

The distribution of funding across four pilot projects covering both the North Western Waters RAC (NWWRAC) and South Western Waters RAC (SWWRAC) meant that each project represented a relatively limited pilot study. In the case of the Brown Crab and Celtic Seas fishery projects, the responsibilities were further split between several Member States to determine the potential for coherent international programmes of relevance to bodies such as the NWWRAC, EC, STECF or ICES. Due to the limited nature of the applications, the data and information from each project should be viewed in terms of feasibility study rather than providing representative data sets covering entire fisheries.

### 1.2.1 Organization

The work was carried out through collaboration between science institutes and members of the fishing industry involved in fisheries within the remit of the North Western Waters Regional Advisory Council (NWWRAC) and South Western Waters Regional Advisory Council (SWWRAC).

As requested in the Tender, the programme of work was divided into two time periods - a design phase lasting up to 6 months and an implementing phase lasting 12 months. The initial time-line proposed for the project is indicated in the GANT chart (Annex 1). Delays in certain aspects of the work resulted in an application for a 6-month contract extension which was granted by the Commission on 7 August 2009. The revised completion date was 31 March 2010.

### 1.2.2 Design Phase

The general approach to the Lot 1 contract was for the groups of project participants involved in the four pilot projects to independently develop their proposals through local meetings with stakeholders, assuming the funding for the implementation phase to be divided equally between the four projects. An individual laboratory was designated to lead each project (Crab fishery: BIM; Celtic Sea demersal fishery: MI; Basque trawl fishery: AZTI; Portuguese longline fishery: IPIMAR). Scientists from these laboratories then provided the overall project coordinator (Cefas) with details of the proposed projects for inclusion in the interim report to the Commission. The consolidated set of proposals was then circulated amongst the Lot 1 project participants for final comment.

A technical report describing the proposed work plan for the implementation phase was provided to the European Commission and presented during a meeting at DGMARE in Brussels on 21 October 2008. The Commission provided useful feedback and suggestions and the Technical Report was accepted for progression to the Implementation Phase.

#### 1.2.3 Implementation Phase

The implementation phase was initially scheduled to run for 12 months (Annex 1). Delays resulted in an extension to 18 months. A proposed meeting of all project participants in February 2009 was altered to individual pilot project team meetings where necessary, due to the diverse nature and geographical separation of the projects. The June 2009 project meeting was delayed to 15-16 December 2009 where progress in each project was evaluated, gaps identified and a work schedule for the final few months of the project identified.

### 1.3 Study team

The Project Team comprised members from national fishing industry organisations and counterparts from fisheries science institutes in the following member states: United Kingdom (England, Wales and Scotland), France, Ireland, Belgium, Spain and Portugal. The fishing industry participants are members of organisations that are part of the North Western and South Western Waters RAC Executive Committee or otherwise are able to contribute to the work of the RACs, while the scientific partners have considerable experience of fisheries management issues in European waters, with many participating and chairing ICES groups and committees.

Science participants were full partners in the consortium. Industry participants were included as subcontractors to the appropriate national fisheries laboratories in their own country. The key staff involved in the project are listed in Annex 2.

### Reference

M.J. Armstrong, A.I.L. Payne and A.J.R. Cotter (2008) Contributions of the fishing industry to research through partnerships. In: Advances in Fisheries Science. 50 years on from Beverton and Holt. Ed. by A. Payne, J. Cotter and T. Potter. Blackwell Publishing, Oxford. pp 63-84.

# 2 Pilot Project 1: Brown crab (*Cancer pagurus*) fishery

## 2.1 Background

This is a Pilot Project for enhanced data collection from international shellfish fisheries in Area VI and VII. The case study is the fisheries for brown crab (*Cancer pagurus*). Production and effort in these fisheries in most areas is increasing, yet the fisheries are poorly sampled and described and the biology and dynamics of the stocks are poorly known. There is however a strong potential for involvement of the fishing industry in sampling and data collection and involvement of fishers in evaluation of the data.

The case study dealt with the 3 main tasks described in the tender to the EU commission

1. Collection of information on fisheries and fleet behaviour and activity that can be integrated into the management process
2. Self sampling (industry sampling) to demonstrate the feasibility of increasing the involvement of industry in collection of various types of data for assessment
3. Involvement of industry in data quality assurance and interpretation

The case study concentrated on two main stocks; the stock in ICES Area VI (from the north-west coast of Ireland to the west and north of Scotland) and the western Channel stock including the area north and west of Brittany. Participating vessels were from the 6-24m potting fleet in Ireland and UK and the 10-24m potting fleet in France. These fleets target brown crab using pots and traps (ICES gear code FPO) and have a small by catch of lobster, this being more important in smaller vessels working inshore. The fleets are active throughout the year although the activity of smaller vessels is restricted during winter.

The approach was to combine existing data with new data, collected on a trial basis, obtained from self sampling programmes and questionnaires obtained in Tasks 1 and 2. The outputs are a combination of data compiled independently by scientists, data obtained by scientists from the fleet, and data provided by the fleet independently of scientists through a self-sampling programme. Task 3 engaged the industry in the compiling of these data and demonstrated how the data supplied by industry may be used to provide management advice.

Brown crab are managed by minimum landing sizes and a restriction on the landing of claws to <1% of the weight of the catch (Council Regulation (EC) No 850/1998). In addition, Council Regulation (EC) No 1415/2004, limits the effort (kW days) of all vessels >= 15 m in length fishing in Western Waters (including Sub area VI and VII) to annual average effort over the period 1998-2002. National regulations, such as restrictive licensing schemes, and additional technical measures are also in place.

This pilot project complements a case study on the brown crab fishery in the English Channel being carried out as part of the EU 7th Framework project GAP (Bridging the Knowledge Gap between Fishermen and Science; Project number 217639). The GAP case study focuses on modelling of brown crab populations including movement data from tagging studies carried out using commercial vessels.

#### 2.1.1 Data requirements for assessment

The European Commission posed a number of specific questions in reviewing the first draft of this report. These are considered below in the context of the brown crab fishery, and the success of the project in addressing these is reviewed in section 2.6.

*What information is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?*

Generally few analytical assessments of crab stocks are undertaken at local or regional level in National territorial or EU waters. No agreed framework for assessment exists. Various member states have developed time series of catch rate indicators or use length based methods estimate fishing mortality F. There is generally no complete census of effort or fishing distribution. Access to the regional crab fisheries could be described as open with little regulation of effort or catch.
As there are no agreed methods for estimating F, any biomass or Maximum Sustainable Yield (MSY) data requirements for management purposes in the short to medium term are likely to rely on an indicator approach that can inform managers about trends in biomass, reproductive capacity and recruitment and also on the behaviour, development and activity of the fleet. Distribution of fishing effort, spatially explicit catch and effort indicators, size composition of discards and landings, fleet capacity and its evolution, participation rates, estimates of latent effort are all important in the successful management of regional crab stocks and fisheries. Assessment and management of brown crab populations has both a national perspective (ability to evaluate pressures and impacts in local inshore fisheries) as well as an international perspective (ability to evaluate pressures and impacts in offshore fisheries conducted by several Member States). ICES is currently evaluating the possibilities for joint assessments of Channel crab stocks exploited by the UK, Ireland, Channel Islands and France, and Malin Shelf stocks exploited by Ireland and Scotland. The Lot 1 pilot project attempts to apply common approaches to collaborative data collection across both of these fisheries.

*What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?*
The characteristics of crab stocks vary locally and regionally and over time. It is difficult and expensive to capture this spatial and temporal variability with sufficient precision and accuracy based on scientific observer or port sampling schemes within national DCF programmes. In contrast, the involvement of the fishing sector in data collection would allow collection of suitable data and information at more appropriate spatial and temporal scales relevant to the structuring of crab populations and fisheries.

In many national programmes the catching sector has shown that it can successfully participate in data reporting. For example, time series of catch rates have been developed from private diaries of vessels, vessels have carried GPS units from which the location of fishing can be identified, self-sampling biological and economic data have been provided by vessels in Ireland on a pilot basis. The catching sector has therefore shown that it is a potentially valuable data provider especially as these data are not been and are unlikely to be provided from other sources.

Member states (Scotland, Ireland, France, UK) involved in the brown crab fishery involve industry in management discussions through various co-management arrangements. The experiences and views of industry are therefore generally taken into account prior to changes in management. These views can be captured in questionnaire data. This approach can also be used to acquire 'soft data' on trends in fishing performance, fishing effort and fleet development and are complementary to existing hard data and to hard data acquired through self sampling programmes.

*To what extent is there a need, from the stock perspective, to merge/compare these national data sets into regional/international data sets and analysis?*
Crab is commercially very important in UK, Ireland and France and stock structure is on the scale of 'regional seas'. Separate stocks may exist along the coastal waters of the north Celtic Sea, the English Channel, the Malin Shelf and west of Scotland and the Irish Sea for example. As stocks traverse national territorial waters there is a need to develop standardised approaches to data acquisition, analysis and assessment. Ideally data would be merged to a single data base at regional (stock) level by member states fishing each stock.

*Are there drivers for designing or keeping alive such projects, for instance national interest in managing local fisheries, or interest of the sector in obtaining a sustainability label?*
Although national administrations are not currently proactive in seeking substantial changes in the management regime at regional level a number of existing regulations and initiatives in the industry points to the need for new data to inform management.

- The western waters regime limits the effort of national fleets over 15m in length (>10m in length in the BSA off Ireland).
- There are proposals coming from industry to increase the minimum landing size, introduce effort controls and manage access (Nautilus report 2009 prepared fro the UK&ROI Brown crab working group)
- The UK/Ireland/France offshore catch sector is currently seeking to reduce production because of market oversupply. It would be very useful to monitor the effect of this on the fishery performance

*What "Added value" can be provided to the recurrent data collection under the EU Data Collection Framework?*

The DCF (Commission Decision 2008/949/EC and 2009/10121/EC) requires collection of a range of transversal and economic data (landings; effort; catch value etc.) at a fleet segment level (broad gear categories and vessel LOA classes) or at fleet metier level, and biological sampling data at fleet metier and stock levels. The metier biological sampling approach involves "concurrent" sampling of length compositions (all or a specified subset of species) taken in sampled landings, referenced at the fishing ground scale (e.g. VIa; VIIa; VIIfgh&j) and fleet metier. The metiers to be sampled are decided after ranking by landings, value or effort, and selecting those metiers falling in the top 90% of at least one of these variables. Metiers are also to be sampled for discards if more than 10% of the catch is discarded. Additional stock related variables are to be collected according to the list given in the Commission Decisions. Edible (brown) crab is specified for triennial collection of biological data (weight, sex and maturity) in Western Waters fishing grounds, but not in the North Sea and eastern Channel. Metiers catching brown crabs include pots, as well as bottom trawls and tangle nets with specified mesh size. The economic value of pot fisheries for crustaceans in coastal waters of the British Isles and France means that such metiers tend to appear in the top 90% ranking and are therefore to be sampled.

The level of resolution and the sampling intensity required to meet DCF targets may be suitable for some general analyses, but is likely to be insufficient to meet the precision and accuracy to define, assess and manage heterogeneous crab populations fished by extensive inshore national fleets and offshore multi-national fleets. A particular problem is the collection of appropriate and accurate data on fishing effort in under-10m fisheries where EU logbooks are not mandatory. As discussed under *What types of information can be collected by the catching sector?,* more highly resolved data are needed and these may be best provided through collaborative programmes of data collection with the fishing sector, which would add considerable value to the more general data collected under the DCF. Appropriate measures of effort and CPUE, and interpretation of such data, would also be aided by joint data collection schemes, particularly in relation to identifying sustainable levels of fishing in the growing inshore fisheries.

## 2.2 Context for the study

### 2.2.1 Ireland

Irish brown crab landings from ICES sub-areas VI and VII ranged from 6000-13000 tonnes per annum during the period 2004-2008. Trends in annual landings are dominated by market conditions. The catch is taken by a small fleet of offshore vivier vessels (>18m LOA) and a larger number of <13m vessels working inshore but also during certain times of year offshore to 30 miles. (Vivier vessels have on-board facilities to maintain crabs alive for sale.) Analytical stock assessments, such as Length Cohort Analysis (LCA) are not routinely performed and the main indicator is a standardised time series of spatially resolved landings and effort data obtained from a reference fleet of offshore and inshore vessels. Information on discard rates is collected from the inshore reference fleet. However, there is no census of effective effort and trends in total effort are unknown.

### 2.2.2 England

English brown crab landings from ICES sub-area VII have ranged from 3,600t to 5,300t per annum since 2004. The most significant fishery is that prosecuted from the ports of Devon in the South West of England. In 2008 approximately 59 under-10m and 11 vessels of 10m and over operated from these ports and landed over 2150t into Devon worth over €3 million at first sale. The larger fleet of smaller vessels typically operates within 6 miles of the coast but the larger vessels may fish mid channel or are nomadic and operate outside sub-area VII.

Currently length based VPA is used to assess the state of the stocks separately in both ICES divisions VIIe and VIId using official landings and effort data sourced from EU logbooks (>10m vessels) and monthly shellfish activity returns(<10m vessels) as well as length distributions of the landings collected at port. Effort data in the form of pots hauled is of variable quality and there is currently no provision to input the numbers of pots fishing on the official database. Historically, poor quality effort data has led to the use of logbook schemes which have been designed to address this problem but have always been limited in coverage. Trends in landings and effort for a limited number of logbook vessels have been used in the past as an indicator of the stock abundance.

### 2.2.3 Scotland

Scottish brown crab landings from ICES Sub-area VI have amounted to around 6,000t per annum in recent years (average over 2006-2008), with increasing quantities being taken in the offshore areas (Sule bank). Stock assessments, conducted using LCA are performed on a regional basis for males and females separately making use of officially reported landings and length frequency data collected as part of the Marine Scotland Science market sampling programme. Results are presented in terms of yield-per-recruit and biomass-per-recruit relative to changes in equilibrium fishing mortality. The analysis provides an indication of the state of the stock in relation to growth overfishing, but no information on actual short term stock dynamics.

There are clearly a number of areas where improved data collection would benefit our knowledge of both the brown crab fishery and the status of stocks around Scotland. Appropriate effort data (such as pots fished) are currently not recorded in official logbooks and as a result, landings-per-unit effort data (a potential indicator of stock dynamics) are not available for Scottish vessels whilst landings data reported at the level of ICES rectangle are currently the only means of mapping the spatial extent of the fishery. Identifying methods for the collection of accurate, spatially resolved catch and effort data (and information on factors affecting the catch rate) is therefore considered to be particularly important.

The pilot self-sampling project investigates the collection of data on fishing effort location and intensity) and the feasibility of industry provision of catch length-frequency data to inform how any future schemes should be designed and implemented. In the case of length-composition such a scheme could be used to supplement the data used in the LCA assessments. Discard data are currently not routinely collected from the Scottish crab fisheries in Sub-area VI and assuming that discard survival rate is high, then these data are not required as part of the assessment process. However, if these data consist of a significant number of small individuals, more regular sampling (through self-sampling) could provide an indication of inter-annual variation in recruitment. The lack of information on stock dynamics remains one of the major weaknesses in the Scottish brown crab assessments and it is envisaged that this project will identify (through these pilot studies) data collection methods with greater industry involvement which will improve the assessment process.

#### 2.2.4 France

The French landings range around 7000 tons per annum. The offshore fleet (13 vessels with LOA > 18m) represent more than 40 % and sometimes 50 % of the landings. This fleet has a large fishing area including the ICES Sub-area XIIIa, VIIh, VIIe, VIId, VIIf. The inshore potting fleet targeting edible crab is small and has been in decline for a long time. More inshore potters target lobster and edible crab is a by-catch. Conversely, the landings from the net-potter fleet are quite important but annually variable. When the market conditions are good, more edible crab is targeted using pots. A large proportion, around 25 % of the landings, comes from netters and trawlers where edible crab is a by-catch species. The increase in the number of netters and the length of net used by each boat has resulted in increased landings by this fleet. The improvement in reporting by fishermen and sampling of catches on board provide enough data to estimate the landings of edible crab by this fleet.

At the moment, a single stock of brown crab is considered from the Bay of Biscay to the Western Channel including the Celtic Sea. Except for a very low quantity coming from trawlers, the French landings originate from this stock. From the French data, the estimation of the index of abundance has been stable for over 25 years. Moreover, the attempts to apply an assessment model in the 'Poorfish project' did not conclude that there was any over-exploitation of the stock. The self-sampling program has confirmed the low level of catch of individuals under the MLS by the offshore potters. Conversely, the inshore potters catch large quantities of small edible crab which are discarded alive. On the other hand discard mortality in some netter fleets can be large, although there is no information on this.

## 2.3 Methods

### 2.3.1 Collection of information on fisheries and fleet behaviour and activity that can be integrated into the management process

#### 2.3.1.1 Science industry meetings

A number of meetings between science and industry partners were held to explain the objectives of the project and to get initial feedback from industry partners on the feasibility of undertaking certain types of self-sampling and reporting. Data on fishing activity and fleet behaviour can be sourced by a number of methods including EU logbooks, private diaries, voluntary logbooks or reference fleet programmes, electronic logbooks, GPS units combined with paper reporting and questionnaires that can be used to reconstruct a historic profile of the fishery where this is missing.

##### 2.3.1.1.1 Ireland

In Ireland BIM and MI worked with the Killybegs Fishermens Organisation (KFO), the Malin Head Fishermans Co-op and unaffiliated vessels. Five inshore vessels and one offshore vessel reported data specifically for the project and 12 vessel owners completed questionnaires. A number of meetings were held with vessel owners participating in the crab fishery off the north-west coast to explain the process and the relevance of the project. Generally the project was received positively and no vessel owner at this stage refused to participate. The use of voluntary logbooks, electronic logbooks, private diary information and measurement of crab at sea was discussed.

##### 2.3.1.1.2 England

The South Devon and Channel Shellfishermens' Association (SDCSA) were approached to provide volunteers to help with this project and initially five members of the association offered to participate. The contributors consisted of three skippers operating from Salcombe using two <10m vessels and a 14m vessel and two skippers operating >15m vessels from Dartmouth and Kingswear. The largest vessel was in excess of 22 m and was equipped with a vivier, and carried out multi-day trips but the other vessels typically carried out daily trips. The participants were asked to provide daily logbook records of fishing activity and to operate GPS loggers to record the location of this activity. They were also asked to provide information on the quantity of the catch which is discarded and the reason for the discarding and once a quarter to measure a sample of the catch.

In addition to providing volunteers for the project, the SDCSA were asked if all their members would fill in a questionnaire designed to describe the factors that influenced their fishing activity and in particular to assess the utility of current management measures. This questionnaire was provided for all brown crab case study areas.

A CEFAS scientist visited each of the volunteers in April 2009 to deliver a sampling pack and discuss what sampling protocols and recording levels would be feasible. The sampling packs included daily log sheets, a GPS logger (with charger and adapter as required), a flexible plastic ruler and forms suitable for recording discards and crab measurements. On seeing the level of commitment required one of the skippers immediately declined to participate further. He offered to assist by taking scientists to sea if required but was unable to commit to the level of sampling required due to his workload. At the same time one of the other skippers said he would provide daily logbooks and operate the GPS logger but would not carry out discard sampling or measure any crabs. A third skipper said he would consider what was involved, but subsequently said his crew were fully utilised and he was not prepared to ask extra work from them. At a later date a fourth skipper handed back the sampling kit and said he did not have the time to achieve what was requested. This left two volunteers who where prepared to compile daily logbooks and operate a GPS logger, one of whom hoped to carry out the discard sampling and catch sampling as well.

##### 2.3.1.1.3 Scotland

Marine Scotland Science (MSS) worked in partnership with Western Isles Fishermen's Association (WIFA) and Orkney Fishermen's Association (OFA). Six vessels agreed to take part in the data collection aspects of the project. These comprised two under 10m day vessels operating inshore around the Outer Hebrides, two vivier vessels working offshore to the west and north of the Outer Hebrides, one vivier vessel working in ICES area VIa to the west of the Orkney Isles and one vivier vessel working to the west of the Outer Hebrides and in the Minch. Collectively, these vessels accounted for 30% of the Scottish landings from ICES VIa in 2008 and their spatial and temporal fishing patterns were thought to be representative of the main fishing patterns of Scottish based vessels fishing for brown crab in VIa. Shortly after the start of the project one of the inshore vessels stopped fishing for brown crab. Data received from a 4 day deployment of a GPS logger on this vessel are not included in this report.

##### 2.3.1.1.4 France

Thanks to the IFREMER observers, there is direct contact with many fishermen. Depending of the project, IFREMER can usually identify suitable industry participants. In parallel, the different Fishermen's Associations are informed about the project. In this project we worked with 2 >15m vessels equipped with viviers, one working in the West Channel and one in Gulf of Biscay, one skipper is the oldest in this fleet and the other one is the president of the regional commission of crustaceans. The others vessels were inshore <10m targeting lobster and brown crab and working in the ICES area 7E.

At the beginning, we hope to work with more fishermen, but some did not record data.

#### 2.3.1.2 EU and National Logbooks

EU logbook data are compiled in each jurisdiction for vessels over 10m in overall length (LOA). In England vessels under 10m LOA also report catch and effort data in a mandatory national shellfish logbook. Ireland does not have a reporting system for vessels under 10m LOA. In France, vessels under 10 meters LOA, as in England have to declare their activities in a national logbook. They report catch by species and effort data by area. The ICES rectangle is used and sometimes a more precise grid. These logbooks are in place since 2000. Compliance and reporting rates have increased steadily and is now close to100 %. Nevertheless, significant work is necessary to validate the data and to ensure that all the catch is declared and accurately recorded is the national database. In Scotland, vessels under 10m in length are required to report landings but not effort. Some effort data may be reported on the Scottish 'Shell 1' forms but these data are not consistently reported or incorporated into the catch effort database.

Units of fishing effort are not generally reported in useful format in the EU log. This reporting system, for crab fisheries, can be used to show the landings by ICES rectangle, the amount of time vessels spend in a particular rectangle and the landings or landings per unit time taken from the rectangle but not the landings per unit effort or the total effort per rectangle.

#### 2.3.1.3 Private diaries

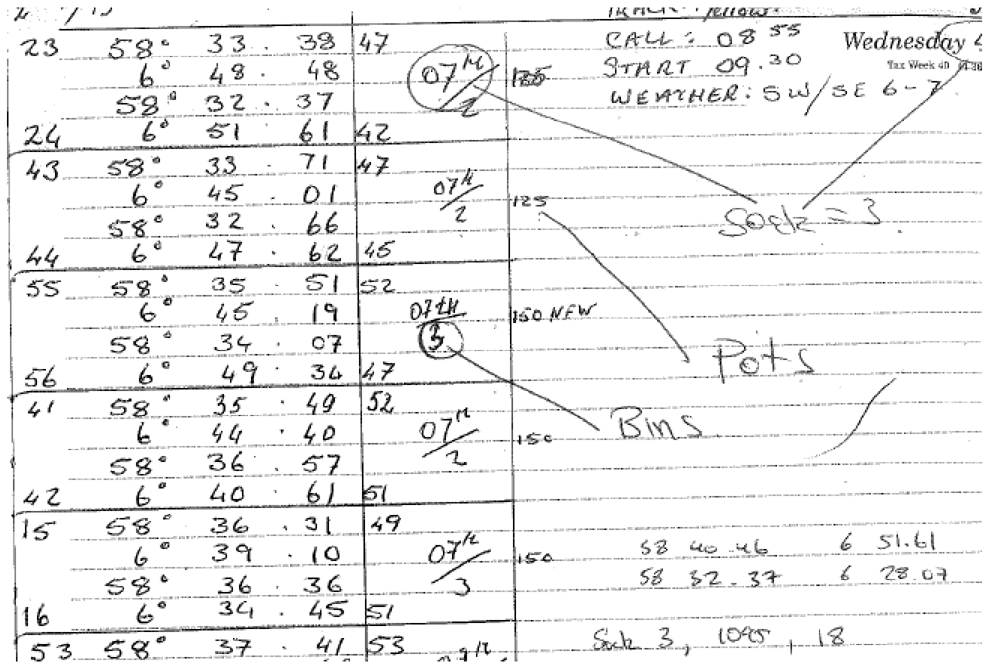
Many vessel operators in both the inshore and offshore crab fleets maintain private records of catch and effort that usually record data at very high temporal and spatial resolution. This is potentially an important source of high quality information as it is probably provides an unbiased census of landings and effort by location and time for each vessel. These records are maintained by skippers so that fishing positions are logged and a tally of catch on the vessel is maintained. Essentially the records represent the ships log.

##### 2.3.1.3.1 Ireland

In Ireland private vessel data have been compiled from offshore crab vessels in ICES Area VI since 1990 and from inshore vessels in Area VI and VII since 2000. The number of participating vessels varies annually.

The offshore vessel diaries report the catch, effort, gear soak time and GPS location for each fishing event, in this case a string of pots. The format in which the data are reported varies by vessel. Usually the skipper has to explain the method of recording before data can be extracted. Although data are recorded for each fishing event, on extraction of data from the diaries these events are aggregated to the average GPS position of the vessel for each days fishing and the total effort and catch from gear that had similar soak times (Table 1).

**Table 1. Extract from a private diary of a fishing vessel showing critical data elements and derived catch and effort statistics. Bins = a 50kg unit of catch, pots = number of pots for each fishing event, soak = number of days the gear is soaked which is the difference between date of fishing and date of deployment. The start and end GPS data are shown for each event. In this example 18 bins (900kgs) were retained on board from 1095 pot hauls that had been soaked for 3 days.**




##### 2.3.1.3.2 France

As in Ireland, the French potters targeting crab record very accurately the catch, effort and GPS location for each fishing event. The French vessels have a fishing strategy and effort rule, with a maximum limit on pot numbers, which results in a soak time of 24 hours. Currently, the fishermen are reticent about sharing these data because its represent all their experience and their “industrial secrets”. Their declarations in the logbooks are considered as good however. Nevertheless, some discussions exist with fishermen that are retired to obtain theirs private diaries.

#### 2.3.1.4 Voluntary logbooks

Information on fishing activity was obtained from various voluntary logbook schemes introduced specifically for the project or by utilising existing schemes. Although the type of information to be collected was agreed among all project partners no attempt was made to standardise the design or format of these voluntary logbooks. Allowing for flexibility and preferences for particular reporting formats in different fleets or even individual skippers within fleets was seen as important at the outset provided the same types of data were eventually reported.

##### 2.3.1.4.1 Ireland

A voluntary, incentivised, ‘sentinel vessel’ programme for vessels under 12m LOA was established in Ireland in 2007. This replaced a voluntary fishing activity record (FAR) programme which had been in place since 2002. The sentinel vessel programme is a self-sampling scheme, the objective of which is to obtain high resolution spatial and temporal data on targeted catch, by-catch, discards, effort, size composition of the catch and daily and annual costs and earnings (Table 2, Table 6). Vessel specific daily information on these variables can be used to describe variability among vessels in fishing and economic performance that relates to their daily and annual activity and fishing strategy and gives an insight into the drivers behind changes in effort or fishing behaviour.

Five vessels in the Area VI crab fleet reported ‘sentinel vessel’ data for the Lot 1 project in 2009.

##### 2.3.1.4.2 England

The daily logbooks for this project were designed in consultation with the two participating skippers and used to capture daily fishing activity and provide information on the amount and type of gear hauled, soak time, location and the catch of crabs and other commercial crustaceans. The two logbooks were customised to suit each of two participating skippers depending on what each had agreed to record on the recording sheets (Table 3,Table 4). The daily logbooks and GPS loggers were passed to the volunteers in April and the vessels duly started to complete the forms and deploy the loggers from 28$^{th}$ April (<10m vessel) and 9$^{th}$ May (>10m vessel). Although CEFAS staff occasionally met with the two skippers during the course of the summer of 2009 for other unrelated projects communication was by phone or by mail. The fishermen were provided with stamped and addressed envelopes with which to return completed logbooks and loggers. Fresh logbooks and an exchange GPS logger were sent by return of post. Data from the log books were periodically entered onto databases and the activity of the two vessels graphically summarised and temporal and spatial trends compared. Comparisons with alternative sources of data for the same vessels were carried out. The alternative sources of data were Monthly Shellfish Activity Returns for the <10m vessel and entered by Cefas (as MFA equivalent data was aggregated to months) and EU log books entered onto the MFA official database.

**Table 2 Design of voluntary shellfish logbook in Ireland used to capture targeted and by-catch catch and effort data in the crab fishery**

| DAILY ACTIVITY RECORD | | DAILY ACTIVITY RECORD | |
|---|---|---|---|
| Date | | Wind Force | |
| Wind Direction | | Swell Height | |
| **LOBSTER**<br>Position(s) Location | | **OTHER FISHING ACTIVITY**<br>Position(s) Location | |
| № Pots Targeting Lobster | | Target Species | |
| № Pots Hauled | | № Pots/Nets Length Hauled | |
| Soak Time (days) | | Soak time | |
| № of Legal Lobster Landed | | Boxes Landed | |
| № of Undersized Discarded | | Boxes Discarded | |
| №. V Notched Discarded | | Bycatch (specify type , amount) | |
| № with Damaged Tails Discarded | | **WHELK**<br>Position(s) Location | |
| Bycatch Brown □ Spider □ Velvet □ Crays □<br>boxes | | | |
| Tagged Lobster: Nos + Carapace Lengths+ Sex + Egg ( | | № Pots Targeting Whelk | |
| | | № Pots Hauled | |
| | | Boxes Landed | |
| **CRAB (Tick Brown ☐ Spider ☐ Velvet ☐)**<br>Position(s) Location | | Boxes Discarded | |
| | | Grader Spacing Bar | |
| | | **DAILY COSTS** | |
| № Pots Targeting Crab | | Deisel ☐ Petrol ☐ € per ltr | № Litres |
| № Pots Hauled | | Bait Cost | |
| Boxes Landed | | Fishing Time (Hours) | |
| Boxes Discarded | | Miscellaneous | |
| № of Lobster Landed as Bycatch | | **Additional Comments** | |
| **SHRIMP**<br>Position(s) Location | | | |
| № Pots Targeting Shrimp | | | |
| № Pots Hauled | | | |
| Kilos Landed | | | |
| Kilos Discarded | | | |
| Graded (please tick) | 8 ☐ 9 ☐ 10 ☐ mm | | |

**Table 3. Daily logbook for English vessels >10m LOA**

| Vessel name | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | | | | | | | | | | |
| String id | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Pot nos | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Gear Spec. | Inkwells | Inkwells | Inkwells | Inkwells | Inkwells | Inkwells | Inkwells | Inkwells | Inkwells | Inkwells |
| Soak | | | | | | | | | | |
| Cocks | | | | | | | | | | |
| Hens | | | | | | | | | | |
| Lobster | | | | | | | | | | |
| Spiders | | | | | | | | | | |

Block Position

| Lat | Long |
|---|---|
| | |
| | |
| | |
| | |

**Table 4 Daily logbook for English vessels <10m LOA**

| Vessel name | | | | | Position | | | | Estimated landings (kgs) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | | | | End 1 | | End 2 | | | | | | |
| String id | Number of Pots | Gear spec. | Soak time | Time | Lat | Lon | Lat | Lon | Cock crab | Hen crab | Lobster | Spider Crab | Velvet Crab |
| 1 | 40 | soft eyed creels | | | | | | | | | | | |
| 2 | 40 | soft eyed creels | | | | | | | | | | | |
| 3 | 40 | soft eyed creels | | | | | | | | | | | |
| 4 | 40 | 26" Inkwells | | | | | | | | | | | |
| 5 | 40 | 26" Inkwells | | | | | | | | | | | |
| 6 | 40 | 26" Inkwells | | | | | | | | | | | |
| 7 | 30 | 30" Inkwells | | | | | | | | | | | |
| 8 | 40 | 26" Inkwells | | | | | | | | | | | |
| 9 | 40 | 26" Inkwells | | | | | | | | | | | |
| 10 | 40 | 26" Inkwells | | | | | | | | | | | |
| 11 | 40 | 26" Inkwells | | | | | | | | | | | |
| 12 | 40 | 26" Inkwells | | | | | | | | | | | |
| 13 | 40 | 26" Inkwells | | | | | | | | | | | |
| 14 | 40 | 26" Inkwells | | | | | | | | | | | |
| 15 | 40 | 26" Inkwells | | | | | | | | | | | |
| 16 | 40 | 26" Inkwells | | | | | | | | | | | |
| 17 | 40 | 30" Parlour | | | | | | | | | | | |

#### 2.3.1.4.3 Scotland

For each fleet sampled, participants were asked to record the amount of crab landed and the number of creels on each fleet. They were also asked to record the total crab landed and number of creels hauled for each day on which sampling took place. Finally, they were asked for an estimate of the percentage of the catch that had been discarded on the day of sampling. Information about the type of creel, bait and how long the creels had been soaked was also requested.

Logbooks were returned to the Marine Laboratory on a regular basis (monthly) in prepaid envelopes. This allowed for continuous data entry and also aimed to pick up any problems encountered or misunderstandings regarding the data to be provided.

Catch rates (kg/pot) were calculated for each sampled fleet and compared with catch rates for the day on which sampling took place.

Size measurements were used to estimate discard proportions. The numbers at length retained or discarded were converted to weight using existing sex specific length-weight relationships and weights discarded expressed as percentages of the total. These were compared with discard percentages as estimated by skippers.

##### 2.3.1.4.4 France

Thanks to several IFREMER observers along the coast, a list of vessels can be established whose declarations are known to be of high quality. The data of the vessels are used to describe various elements of fishing activities. In parallel, the IFREMER observers contact, at the beginning of each year, the skippers in their sector to establish the fishing calendar of the previous year. For each month, the two principal "metier" associated with the two main fishing areas are reported in the calendar data. Some gear characteristics or their number are also recorded. In this way, exhaustive information is known for all-French fishing vessels. The logbook and the annual calendar are complementary. The economic aspects are also obtained every year from a sample plan where all the costs associated with the fishing activity are recorded (bait, fuel, insurance…). The main limitation in these data is the lack of precision on the spatial distribution of fishing effort. To improve this situation, IFREMER has developed a specific program described below.

#### 2.3.1.5 Vessel monitoring system data and GPS

Although the logging of vessel position does not indicate fishing performance, catch or effective effort in crab fisheries the Vessel monitoring System (VMS) or similar Global Positioning System (GPS) data can be used to show the distribution and extent of fleet activity and can be developed and reported as an indicator of fishing effort. It can also be integrated with reported data on catch and effort to give high spatial resolution data on catch and catch per unit effort.

Crab vessels over 15m LOA carry VMS units which report position usually every 2 hours. This ping rate is low relative to the duration of individual fishing operations of crab vessels and individual fishing operations, which usually last less than 2 hours, will be missed. The VMS data, therefore, is likely to be useful to show the distribution, range and extent of fishing activity on crab but could not be used to develop an index or a census of fishing effort *per se*. GPS loggers, which in the present context are essentially a VMS with higher ping rate, can be used to identify individual fishing operations by filtering the data either by vessel speed or by identifying spatial pattern in the GPS positions that can be interpreted as a gear recovery or deployment operation as opposed to a non-fishing operation. These fishing operations should appear as straight lines, representing strings of pots, for vessel speeds of less than 2-3knots. It should be possible to calculate the length of these strings and as the spacing between individual pots on the string is usually known the number of gear units on the string could be calculated.

GPS units were deployed on crab vessels in Scotland and England.

#### 2.3.1.5.1 Ireland

Sample VMS data were extracted from the national VMS database for a vessel over 15m in length and compared to private diary information for the same vessel in order to compare the resolution and distribution of reported positions. The private diary information recorded only actual start and end positions for individual fishing operations which were averaged for the day where as the VMS reported position every two hours.

#### 2.3.1.5.2 England

RoyalTek GPS loggers (Fig. 1) were used. These were small and easy to use but the low battery capacity provided by the internal Li ion battery (typically <10 hours use) necessitated the use of an alternative power source. For our volunteers this was provided by means of a USB connection to their wheelhouse PC, although a cigar lighter style adapter was also available if required. The internal storage capacity is adequate for recording approximately 250 days of data at a logging rate of 1 per minute (64Mb). PC based software called “MTB data downloader” was used to configure the receivers and download the data. The GPS loggers create a data file for each logging operation (daily) and a visual basic programme was used to generate a table in MS Access to acquire and store the data in a more accessible form.

The use of the logger required the fishermen to turn the device on and off at the start and end of their working day, a situation not always compatible with their busy working schedule. Also, one of the devices malfunctioned and this was not noticed and rectified immediately so that the records for vessels are not comprehensive and do not provide a census of fishing operations for the duration of the study. A relatively comprehensive account of the spatial positions of fishing operations for the two vessels is available from the end of April to the end October 2009 (except late June and July >10m vessel).


**Figure 1. RoyalTek GPS loggers used on 2 vessels in the English Channel.**

#### 2.3.1.5.3 Scotland

GPS loggers were deployed on 5 vessels between March 2008 and December 2009. Each logger consisted of a GPS receiver, data logger and modem powered from the vessels main current supply. The loggers transmitted date, time and position information at five minute intervals via the GPRS telecom network to a unique IP address at “Business Solutions” in Sunderland. From here the data were restructured and transmitted to Marine Scotland-Science in Aberdeen to the purpose built GPS-driven Effort Monitoring (GEM) database. If tracked vessels went outside the GPRS range (limit about 10 miles off-shore), data were stored (data logging mode) until the vessel was next within transmission range. Storage capacity of the loggers in data-logging mode was approximately about 10,000 data points, which was sufficient to track a vessel for about five weeks. If the storage capacity was exceeded, data would continue to be logged, overwriting the oldest existing data.

For each fishing trip logged, the full track and speed profile, as calculated from position and time in the GEM database were plotted using the mapping and speed profile functions available within the GEM database application and checked for completeness of the track.

The speed profiles of fishing vessels show distinctive patterns which can be used to identify fishing locations. Typically creel fishing vessels slow down to pick up the marker at the start of the first fleet of creels, move along at slow speed (~1-4 knots, depending on the vessel) while hauling, emptying and re-baiting creels and slow right down again at the end of the fleet to pick up the end marker. Vessels then move off at relatively high speeds while the creels are shot back into the water. Vessels continue to the next fleet and this cycle is repeated.

In the GEM database, fishing locations were extracted from the tracks of each vessel by filtering these tracks based on speed. For each vessel the presumed fishing locations were mapped and the number of days on which fishing took place and number of strings hauled during each trip were determined.

*Data treatment and evaluation*
GPS estimates of fishing positions and number of fleets hauled were compared with data from fishing diaries, provided by two of the industry participants (additional to the data collection described below).

To represent the distribution of creel fishing activity, maps of fishing effort based on GPS creel positions for all participating vessels were produced by intensity mapping within grids equivalent to 1/16 of an ICES statistical rectangle. Aggregated fishing distribution for the three vessels with the longest logger deployments were compared for winter and summer months to investigate seasonal differences in fishing distribution.

Fishing activity maps were compared with brown crab landings records of tracked vessels extracted from the Scottish Fishery Information Network (FIN) data base (fully logged trip records only). Catch composition, the percentage of brown crab by weight in monthly landings was also examined to assess the appropriateness of mapping brown crab fishing distribution on the basis of logger data. .

Landings data from FIN and effort estimated fleets hauled for each tracked trip were used to estimate monthly catch rates (LPUE) of brown crab by participating vessels over the study period.

To protect confidentiality, estimated catch rate data was mean standardised before presentation, meaning that values are presented relative to the average for each vessel for the entire period.

#### 2.3.1.5.4 France

A specific program is developing in order to improve the estimation of fishing effort. GPS are fitted to vessels to get the geographic position and some sensors are fixed on the gears to estimate the fishing time. The development phase of this project is finished and the resultant products are validated. The system is completely automatic and fishermen do not have to manually do anything on the vessel. The data arrives directly at the IFREMER centre by email at the end of each trip. The GPS box is associated with a GPRS system that sends the data in text format. In parallel, these vessels provide daily declarations on catch and effort. Four potters are now equipped; one inshore and three offshore. One of the advantages of the system is the flexibility in 'ping rate' of the GPS position which is currently 15minutes and which enables fishing operations to be identified. Nevertheless, the catches in the declaration are not specified by fishing operation. Some self-sampling is realised for a quantity of the pots hauled.

#### 2.3.1.6 E-Logbooks

##### 2.3.1.6.1 Ireland

A custom designed electronic logbook for static gear fisheries was designed in Ireland in 2006 (Fig. 2). This unit transmits fishing activity data by encoded GSM text message to a receiving station which decodes and parses the data into a relational database. However, the system has not generally been used because of technical hitches in transmitting messages and resources required to maintain contact with participating vessels, administer the database and ensure data quality. Successful trials were completed in 2006-2008 on scallop, whelk and crab vessels.

The data recorded is similar to the high resolution private diary data in that each fishing event can be characterised regarding effort, catch, position and soak time. There is a considerable time and cost saving compared to extraction of information from private diaries. The vessel track and records transmitted are also retained on the unit on board the vessel for the skippers records.

In 2008 a number of electronic logbook units were installed on Irish inshore vessels operating in ICES Area VIa south. Due to various technical problems none of these vessels successfully reported data.

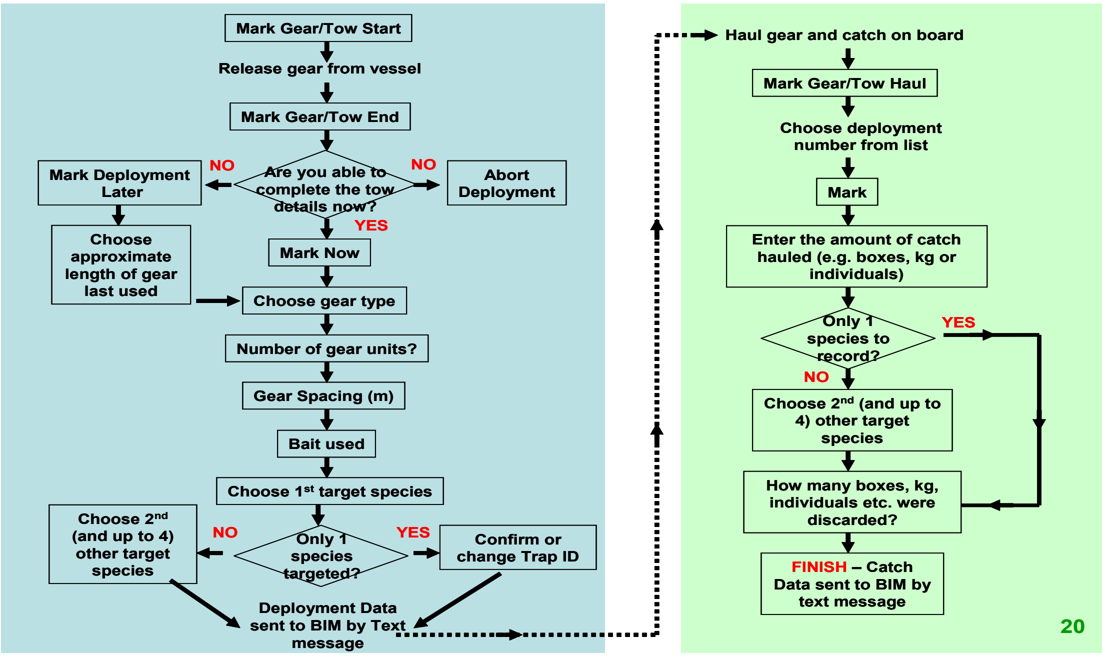



**Figure 2. Flow chart for acquisition of data from a custom designed electronic logbook for potting vessels.**

#### 2.3.1.7 Questionnaire

A common questionnaire was developed by the crab case study partners to identify drivers of fishing effort and entry and exit to the fishery (Fig. 3).

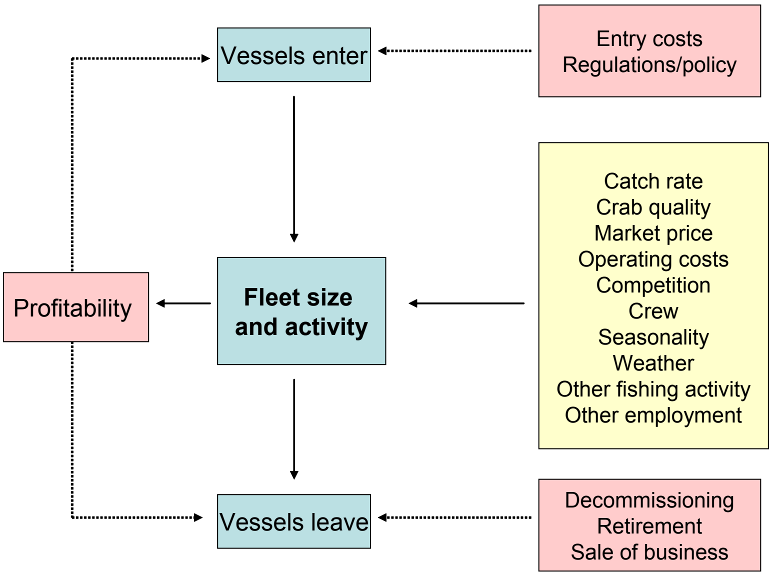



**Figure 3. Drivers of activity in the crab fishing industry**

##### 2.3.1.7.1 Rationale for the questionnaire (with reference to Ireland)

*Question 1: Vessel profile and activity:* The responses to issues dealt with in the questionnaire are expected to depend on vessel size. Small inshore vessel operators will have a different perspective than operators of larger offshore vessels. This section sets the context; this vessel is such a size and has a specific profile of seasonal activity so what is his perspective on the issues dealt with in the questionnaire.

*Question 2: Did management measures affect your vessels activity in 2007- 08?*
Section 2 and 3 are related and enquire about factors that influence the activity of a vessel in the most recent fishing years. This section asks how management (regulatory) measures might have influenced activity. There aren't many; kw days, minimum sizes.

*Question 3: What other factors have affected the activity of your vessel in 2007-08 ?*
Other non-regulatory issues may have been important in influencing activity of the vessel. This could be economic (expected catch rate was too low) or other operational issues related to crew etc. This section, and section 2 above, is important in identifying effort drivers in the fishery.

*Question 4: What influenced your choice of vessel ?*
Over the past 20 years the profile of vessels in the Irish fishery has obviously changed from inshore wooden 'trawlers' to modern fast workers inshore, 15m rule beaters to offshore vivier vessels. What drives that change? For instance a contraction of the stock and lower availability of stock inshore may push fishermen into larger vessels. Competition for ground may do the same thing. A combination of lower catch rate and lower price may push fishermen into higher total effort levels, and therefore into bigger or faster vessels, to maintain income.

*Question 5: What circumstances would influence you to leave the fishery ?*
Over the past 20 years the number of vessels in the Irish fleet has declined even though new people and vessels have also come into the fishery. The net result has been an aggregation of capacity and effort, reduced employment and increased specialisation by the remaining vessels. Could those changes have been modulated by policy if the trends were detected in time and if economic and social policy for the fishery were explicit? Although entry and exit in the fishery is dynamic it is not clear what is driving it. The factors could be external or internal. External issues would include 'Celtic Tiger' factors (other employment opportunities) which if important would in 2009-2011 be expected to reverse. Internal issues include the net profit equation (Net profit = (catch rate * unit price) – costs) or operational difficulties related to legislation for instance.

*Question 6: What influenced your decision to enter the fishery ? (if in the fishery less than 10 years)*
Although participation in the Irish fishery has declined and therefore some participants did not see it worthwhile (economically or for other reasons) to continue in it other people at the same time invested significantly to enter the fishery. These two scenarios are somewhat contradictory; if the fishery was performing well everyone in the fishery should have stayed and people wishing to enter would have done so as there is an open access licensing system. This suggests that not everyone, whether in the fishery or prospective investors, was making the correct decision! Alternatively, the entry-exit dynamics could simply be driven by competition in the open access licensing system pertaining in this fishery. Theoretically, in such a system participation and effort would accumulate to a level resulting in an economic return that was well below the optimum and in its extreme toggling around the break even point. In this environment perceptions of the merits of staying in, leaving or entering will vary given that these decisions are multi-factorial and not simple based on the net profit equation. In any case hard data on costs and earnings may not always be calculated by vessel operators before they make a business decision. Existing economic data supports the competition argument.

*Question 7: Can you describe changes in practice in the crab fishery over the past 30 years ?*
Long term changes in fishing practice reflect the learning experience of operators, as they find better ways of doing things, increased availability of technology, responses to changes in the stock and the market and responses to other operators in the fishery who are competing. Data on these changes supports the information in previous sections on issues related to 'decision making'. The results of these decisions should be seen in this section eg in response to stock changes the operator increased daily effort and had to steam longer distances to obtain commercially adequate catch rate. This in turn influenced choice of vessel. It also increased costs and may not have been sustainable. The operator may have then left the fishery. All of these issues can be linked.

#### 2.3.1.7.2 Methods

The number of questionnaires completed varied across each fleet. Skippers were interviewed individually. The number of interviewers that may have interviewed skippers in the same fleet varied from 1 (Scotland, England, France) to 3 (Ireland). The description of the rationale behind each question was an attempt to standardise the approach that each interviewer took and to direct the interview to extract the data required by the question and its rationale.

Responses to questions 2-7 were analysed in two categories based on the respondents' vessel size. Skippers of the larger vessels, 15m and above were all vivier crabbers fishing offshore all year round on multiday trips. Skippers of the smaller vessels (under 15m) typically carry out day trips closer to shore, although a few were able to fish further offshore by virtue of their vivier and or engine capacity.

For questions 2 to 6 inclusive, depending on the question, fishermen were asked to evaluate a series of factors on scales of ‘No importance’ to ‘Critical’ and ‘Never’ to ‘Very often’. For each factor, answers were expressed as percentages of responses in each category. An additional category of ‘Not answered’ was included when the factor had not been evaluated (left blank). This ensured that a percentage response always referred to the same number of responses. Each factor was then scored according to the importance assigned to it, the scores were tallied and ranked in importance. If a factor was not evaluated it was given a score of 0. Responses to Question 7 which asked about changes in the fishery over time were not quantifiable in some cases and are presented as a summary / digest of answers received. In Ireland some ‘hard’ data were derived from question 7.

**Table 5. Common questionnaire used in Scotland, England, Ireland and France to obtain information on drivers of fishing activity and to reconstruct changes in the fishery that have occurred since the 1990s.**

| **1. Vessel profile and activity** | | | | | |
|---|---|---|---|---|---|
| | Spring | Summer | Autumn | Winter | Annual |
| Fishing days per quarter | | | | | |
| | LOA | GTs | KWs | Age | Years in fishery |
| Vessel profile | | | | | |

| **2. Did management measures affect your vessels activity in 2007-08?** | | | | | | |
|---|---|---|---|---|---|---|
| | Never | Seldom | Some times | Often | Very often | Comment |
| Effort control (kw days) | | | | | | |
| Minimum landing sizes | | | | | | |
| Other ( ) | | | | | | |

| **3. What other factors have affected the activity of your vessel in 2007-08 ?** | | | | | | |
|---|---|---|---|---|---|---|
| | Never | Seldom | Some times | Often | Very often | Comment |
| Catch rates | | | | | | |
| Seasonality in crab quality | | | | | | |
| Competition for ground | | | | | | |
| Market price | | | | | | |
| Availability of crew | | | | | | |
| Other fishing opportunity (specify) | | | | | | |
| Other non fishing opportunity for vessel | | | | | | |
| Other occupation | | | | | | |
| Seasonality of cost earnings ratio (Net profit = (catch rate*price per kg)-costs) | | | | | | |
| Weather | | | | | | |

| **4. What influenced your choice of vessel ?** |
|---|

| | No importance | Minor importance | Important | Very important | Critical | Comment |
|---|---|---|---|---|---|---|
| Vessel size | | | | | | |
| Capacity costs | | | | | | |
| Vessel costs | | | | | | |
| National licencing policies | | | | | | |
| EU legislation / regulation | | | | | | |
| Grant aids | | | | | | |
| Competition for ground | | | | | | |
| Cost efficiencies | | | | | | |
| Sea conditions | | | | | | |
| Flexibility of fishing effort | | | | | | |
| Working conditions | | | | | | |

**5. What circumstances would influence you to leave the fishery ?**

| | No importance | Minor importance | Important | Very important | Critical | Comment |
|---|---|---|---|---|---|---|
| Other fishing opportunities | | | | | | |
| Other employment opportunities | | | | | | |
| Crab prices | | | | | | |
| Increases in operating costs | | | | | | |
| Competition for ground | | | | | | |
| Any decline in catch rate | | | | | | |
| Lack of management of the fishery | | | | | | |

**6. What influenced your decision to enter the fishery ? (if in the fishery less than 10 years)**

| | No importance | Minor importance | Important | Very important | Critical | Comment |
|---|---|---|---|---|---|---|
| Tradition in family | | | | | | |
| Transfer from another fishery | | | | | | |
| Perception of or estimated profitability | | | | | | |
| Poor employment opportunities | | | | | | |
| Grant aids | | | | | | |
| Prospect of improved management | | | | | | |
| Contract arrangement with buyer | | | | | | |

**7. Can you describe changes in practice in the crab fishery over the past 30 years?**

| | 1980s | 1990s | 2000s | 2009 |
|---|---|---|---|---|
| Vessel type | | | | |
| Vessel GTs and KWs | | | | |
| Fishing location | | | | |
| Daily steaming distance | | | | |
| Daily working hours | | | | |
| Duration (months) of fishing season | | | | |
| Other fisheries in which you and your vessel participated in each year | | | | |
| Number of pot hauls per day | | | | |
| Soak times | | | | |
| Bait | | | | |
| GPS plotter installed | | | | |

| | | | | |
|---|---|---|---|---|
| Crew size | | | | |
| Pot entrance type (side, top, hard, soft etc) | | | | |
| Pot size (length x width x breadth) | | | | |
| Boxes landed per day (spring, summer, autumn, winter fisheries) | | | | |
| Month of year when crab quality was highest | | | | |
| Month of year when crab quality was lowest | | | | |
| Market price in € equivalents per kg | | | | |

#### 2.3.2 Self-sampling of biological characteristics of crab

The second main task for the crab case study was to evaluate the feasibility of self-sampling of the biological characteristics of the catch (the target species and in if possible the significant by-catch species) at sea. This was to encompass the characteristics of both the landed and discarded component of the catch. Although mortality of discarded crab is probably very low and is not a significant source of mortality the characteristics of this component of the catch is relevant as there may be a number of reasons for discarding, discarding rates different significantly on a season basis, between fleets and between individual vessels in fleets depending on the market the catch may be sold into.

The data may be used to estimate fishing mortality in length based assessment methods although size composition in space and time is also affected by migration, recruitment and the seabed environment. Mapping of size distribution in space and time in relation to fishing effort and environment may help resolve the causes of differences in size composition.

Industry self-sampling of size composition at sea is likely to be logistically difficult and time consuming. The practical issues were therefore discussed with the participating vessels prior to the design of programmes and a standardised level of sampling and precision was not attempted. The important questions regarding sampling include the temporal and spatial resolution, sample size, accuracy and precision, methods of selecting the sample from the catch, and the variables that are to be collected. The approach to these issues varied across fleets.

##### 2.3.2.1 Ireland

The inshore crab fleet operating from the north-west coast of Ireland is a mixed lobster and crab fleet. The voluntary logbook data for these vessels indicated the amount of gear that was targeted at each species for a given days fishing and the catch rate in that gear. The biological self-sampling also targeted both species (lobster, crab) in the catch. Different conservation measures apply to each of these species, which can occur in same gear unit, and each species occurs in very different volumes in the catch. The allocation of sampling effort, therefore, has to be different for each species if sufficient measurements are to be taken. The different allocation of sampling strata adds to each species adds to the complexity of self-sampling and it provides an interesting case comparison with single species self-sampling.

The sampling strata used for crab was the first 10 pots hauled on any given day once per week. For lobster skippers were asked to sample all lobsters in a string of 30 pots once per week.

Variables to be recorded were carapace length (lobster), carapace width (crab), whether berried or not, colour of berries and the tag number of any tagged recaptured lobsters or crabs that had been released during previous tagging programmes (Table 6).

**Table 6. Design of self sampling data sheet used to capture biological information on lobster and crab in the Irish crab fleet**

| Weekly Lobster/Crab Measurements | | | | Weekly Lobster/Crab Measurements | | | |
|---|---|---|---|---|---|---|---|
| Date: | | | | Date: | | | |
| Measure ALL lobsters, including undersized, caught in 1 string of pots ONCE per week 30 pots OR Measure ALL crab, including undersized, caught in 10 pots ONCE per week. | | | | Tagged lobsters caught today OR if recording Crab, use for crab measurements. | | | |
| Carapace length | Male or Female | Berried Y or N | Berries (black or orange) | Carapace length | Tag No | Berried Y or N | Berries (black or orange) |
| | | | | | | | |
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| | | | | | | | |
| | | | | Weekly Price Per Kg | | | |
| | | | | Lobster | | € | |
| | | | | Shrimp | | € | |
| | | | | Crab Specify Type | | € | |
| | | | | Whelk | | € | |
| | | | | Whitefish (specify type | | € | |
| | | | | Pelagics (specify type) | | € | |

#### 2.3.2.2 England

The five volunteer skippers were given instruction on how to sample crabs and were requested to measure the carapace width of a sample of 200 crabs per quarter randomly selected from the catch to the nearest 5mm (Table 7. Catch sampling form used on English crab vessels fishing). They were also asked, on one occasion each month, to record the quantity or proportion of the catch that was discarded and for 100 randomly chosen crabs, the reason for discarding (Table 8. Discard sampling form used in English crab vessels fishing in the Channel.).

**Table 7. Catch sampling form used on English crab vessels fishing in the Channel.**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel name | | | | | Date | | | | Ratio measured | | |
| Landed | | | | | | Discarded | | | | | |
| male | | | female | | | male | | | female | | |
| Len. | Tally | Tally | Len. | Tally | Tally | Len. | Tally | Tally | Len. | Tally | Tally |
| 5 | | | 5 | | | 5 | | | 5 | | |
| 5.5 | | | 5.5 | | | 5.5 | | | 5.5 | | |
| 6 | | | 6 | | | 6 | | | 6 | | |
| 6.5 | | | 6.5 | | | 6.5 | | | 6.5 | | |
| 7 | | | 7 | | | 7 | | | 7 | | |
| 7.5 | | | 7.5 | | | 7.5 | | | 7.5 | | |
| 8 | | | 8 | | | 8 | | | 8 | | |
| 8.5 | | | 8.5 | | | 8.5 | | | 8.5 | | |
| 9 | | | 9 | | | 9 | | | 9 | | |
| 9.5 | | | 9.5 | | | 9.5 | | | 9.5 | | |
| 10 | | | 10 | | | 10 | | | 10 | | |
| 10.5 | | | 10.5 | | | 10.5 | | | 10.5 | | |
| 11 | | | 11 | | | 11 | | | 11 | | |
| 11.5 | | | 11.5 | | | 11.5 | | | 11.5 | | |
| 12 | | | 12 | | | 12 | | | 12 | | |
| 12.5 | | | 12.5 | | | 12.5 | | | 12.5 | | |
| 13 | | | 13 | | | 13 | | | 13 | | |
| 13.5 | | | 13.5 | | | 13.5 | | | 13.5 | | |
| 14 | | | 14 | | | 14 | | | 14 | | |
| 14.5 | | | 14.5 | | | 14.5 | | | 14.5 | | |
| 15 | | | 15 | | | 15 | | | 15 | | |
| 15.5 | | | 15.5 | | | 15.5 | | | 15.5 | | |
| 16 | | | 16 | | | 16 | | | 16 | | |
| 16.5 | | | 16.5 | | | 16.5 | | | 16.5 | | |
| 17 | | | 17 | | | 17 | | | 17 | | |
| 17.5 | | | 17.5 | | | 17.5 | | | 17.5 | | |
| 18 | | | 18 | | | 18 | | | 18 | | |
| 18.5 | | | 18.5 | | | 18.5 | | | 18.5 | | |
| 19 | | | 19 | | | 19 | | | 19 | | |
| 19.5 | | | 19.5 | | | 19.5 | | | 19.5 | | |
| 20 | | | 20 | | | 20 | | | 20 | | |
| 20.5 | | | 20.5 | | | 20.5 | | | 20.5 | | |
| 21 | | | 21 | | | 21 | | | 21 | | |
| 21.5 | | | 21.5 | | | 21.5 | | | 21.5 | | |
| 22 | | | 22 | | | 22 | | | 22 | | |
| 22.5 | | | 22.5 | | | 22.5 | | | 22.5 | | |
| 23 | | | 23 | | | 23 | | | 23 | | |
| 23.5 | | | 23.5 | | | 23.5 | | | 23.5 | | |
| 24 | | | 24 | | | 24 | | | 24 | | |
| 24.5 | | | 24.5 | | | 24.5 | | | 24.5 | | |
| 25 | | | 25 | | | 25 | | | 25 | | |
| 25.5 | | | 25.5 | | | 25.5 | | | 25.5 | | |
| 26 | | | 26 | | | 26 | | | 26 | | |
| 26.5 | | | 26.5 | | | 26.5 | | | 26.5 | | |
| 27 | | | 27 | | | 27 | | | 27 | | |
| 27.5 | | | 27.5 | | | 27.5 | | | 27.5 | | |
| 28 | | | 28 | | | 28 | | | 28 | | |
| 28.5 | | | 28.5 | | | 28.5 | | | 28.5 | | |
| 29 | | | 29 | | | 29 | | | 29 | | |
| 29.5 | | | 29.5 | | | 29.5 | | | 29.5 | | |

**Table 8. Discard sampling form used in English crab vessels fishing in the Channel.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Vessel name: | | | | Date | | | |
| Weight of discards OR | | | Proportion of catch discarded | | | | |
| Reason for discarding* | Undersized | No. | Softshell | No. | Claws missing | No. | Diseased |
| Male | | | | | | | |
| Female | | | | | | | |
| * please choose the first 100 discarded crabs | | | | | | | |

#### 2.3.2.3 Scotland

The self sampling trial was carried out from March to November 2009. Participating vessels were provided with a logbook for recording data and a pair of callipers for measuring crabs. The logbook included detailed instructions regarding the types of information to be provided. In summary, over this period vessels were asked to collect

1. Discard information (monthly): to record the reason for discarding and the sex for each of the first 100 crabs discarded from a fleet of creels.

2. Size measurements (quarterly): to record carapace length, sex and whether crab were retained or discarded for the first 200 crabs removed from a fleet of creels.

For each fleet sampled, participants were asked to record the amount of crab landed and the number of creels on each fleet. They were also asked to record the total crab landed and number of creels hauled for each day on which sampling took place. Finally, they were asked for an estimate of the percentage of the catch that had been discarded on the day of sampling. Information about the type of creel, bait and how long the creels had been soaked was also requested.

Logbooks were returned to Marine Science Scotland's Marine Laboratory on a regular basis (monthly) in prepaid envelopes. This allowed for continuous data entry and also aimed to pick up any problems encountered or misunderstandings regarding the data provided.

*Data treatment and evaluation*
Catch rates (kg/pot) were calculated for each sampled fleet and compared with catch rates for the day on which sampling took place.

Size measurements were used to estimate discard proportions. The numbers at length retained or discarded were converted to weight using existing sex specific length-weight relationships and weights discarded expressed as percentages of the total. These were compared with discard percentages as estimated by skippers.

Using the discard reason information, for each fleet sampled, the proportion of discarded crab in each (discard) reason category was calculated and compared across samples.

*Communication and feedback on data collection*
Personal contact was maintained with participants throughout the data collection phase. In November 2009, towards the end of the project each participant was sent a summary of the data they had contributed and subsequently consulted over the phone regarding its accuracy, interpretation and presentation. Opinions on the process of collecting the different types of data were also sought.

For the GPS logger data fishermen were sent detailed monthly maps with estimated fishing locations and asked how accurately these reflected the fishing activity of their vessel over the study period. They were also shown plots of speed profiles and asked to comment on the use of these to derive fishing locations from the vessel tracks.

Monthly summaries of days on which fishing took place and fleets hauled per month were also provided. Fishermen were asked to comment on their accuracy and whether the values and trends in catch rates estimated for their vessel looked realistic. Finally, they were asked about sensitivity of positional and catch rate information and what level of detail they would be comfortable in terms of final (external) presentation.

#### 2.3.2.4 France

The six volunteer skippers (4 inshore) were give instruction on how to realise the self-sampling. For the inshore boat, the quantity of discard is important mainly due to the small size of crab. These vessels were asked to measure all crab caught for a one day trip. The offshore potters, were asked to measure all the crab on 50 pots in one string during one trip if they did not change fishing zone. For all the crab higher than the MLS, we asked to note the reason (softshell, white, claw missing, or disease) for discarding.

## 2.4 Results

### 2.4.1 Collection of information on fisheries and fleet behaviour and activity that can be integrated into the management process

#### 2.4.1.1 EU Logbook data

The EU logbook data provides information on landings resolved to ICES statistical rectangle. The effort (pot hauls) associated with this landing is not recorded so effort or catch per effort cannot be estimated. The EU logbook data is, therefore, useful only in showing the distribution of fishing activity and where the landings originate. Data on crab landings for Ireland, Northern Ireland and Scotland from 2004-2008 are shown in Fig. 4

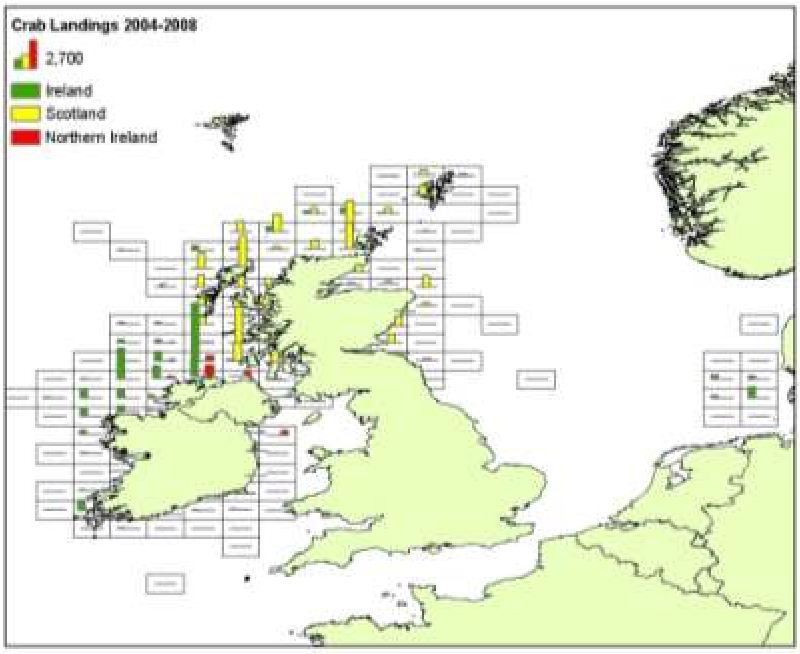



Figure 4. **Distribution of landings (cumulative 2004-2008) by the Irish, Northern Irish and Scottish fleets by ICES rectangle. Sources: SFPA (Ireland), Marine Scotland Science (Scotland), Department of Agriculture Northern Ireland (DARD) (Northern Ireland).**

#### 2.4.1.2 Private diaries

##### 2.4.1.2.1 Ireland

Private diary information from Irish vivier vessels have provided highly resolved and accurate data on catch, effort and catch per unit effort standardised for soak time for the period 1990-2008 (Fig. 5 & 6). Data collected during this project in 2008 was mainly for north and west of Scotland.

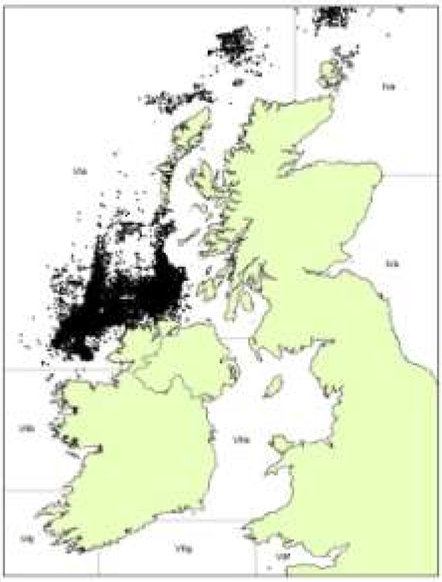


**Figure 5. Distribution of fishing activity, derived from private diaries for the Irish reference vivier fleet for the period1990-2008. Data north of Scotland is for 2004-2007 only.**

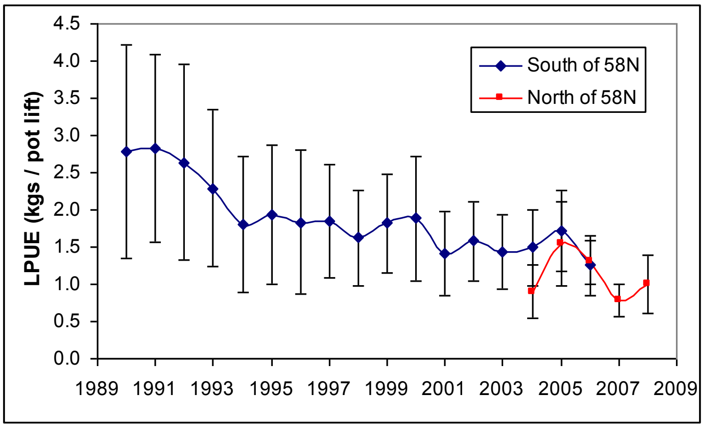



**Figure 6. LPUE derived from private diaries of reference vivier vessels for the period 1990-2008.**

There was good correspondence between the VMS data and GPS data derived from private diaries (Fig. 7). The GPS data from the vessel diaries were extracted in aggregate form; a data record was created for units of gear hauled on a particular day and that had similar soak time. The position of the vessel for such gear units was recorded by taking the average of the minimum and maximum recorded GPS of the vessel when hauling these gear units. As such it is a slightly aggregated form of the VMS data. The number of fishing days reported by the vessel in 2008 in the diaries was 201. The number of VMS pings was 3619 for the year which corresponds to 273 days of fishing activity and 219 days with more than 6 hours of activity using a filter to include VMS records between 0.1-5knots vessel speed. This filter may, according to the Scottish data below, overestimate the fishing activity of potters.

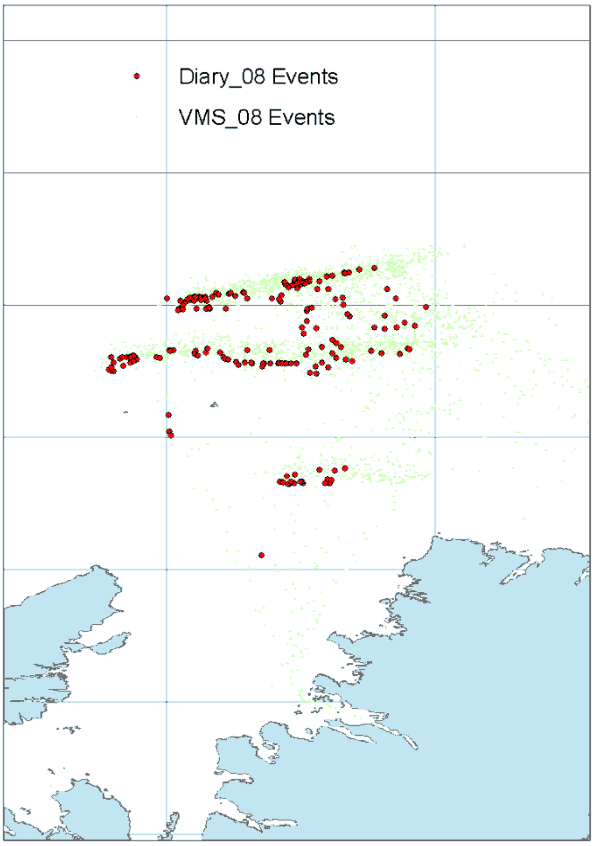



**Figure 7. Overlay of GPS data (number of data points =356 for 201 fishing days) derived from a private diary of an Irish vessel fishing north of Scotland in 2008 and VMS data (n=3619) for the same vessel in 2008. The GPS data is the average fishing position of the vessel for gear with similar soak times per day of fishing.**

#### 2.4.1.3 Voluntary logbooks

##### 2.4.1.3.1 Ireland

A total of 301 vessel fishing days were reported in voluntary logbooks by 5 inshore vessels fishing off the north west coast of Ireland participating in the project. Monthly reported activity was highest in the period June to August and lowest in January and December (Table 9). This activity represented a total of 145,967 trap hauls (Table 10). Monthly average catch rate of crab, from gear targeting crab, ranged from 1 – 2.78 kgs.pot$^{-1}$ (Table 11). A high average figure of 5.88 kgs.pot$^{-1}$ in July was due to a catch of discarded spider crab by vessel 5, giving a monthly average of 15 kgs.pot$^{-1}$. Monthly landings per pot haul ranged from 0.7 in January to 1.92 kgs.pot$^{-1}$ in July (Table 12). Lobsters were caught as by catch by all vessels and varied from 0.35 lobsters per 100 pot hauls in January to 2.44 in September (Table 13)

**Table 9. Number of vessel fishing days reported by 5 Irish inshore vessels in 2009**

| | Month (2009) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total |
| 1 | | | | | 1 | 11 | 6 | 12 | 5 | 7 | 7 | 4 | 53 |
| 2 | | | | | | | 10 | 8 | 8 | 9 | 7 | 1 | 43 |
| 3 | | 5 | 5 | 7 | 4 | 4 | 11 | 16 | | | | | 52 |
| 4 | 6 | 13 | 7 | 11 | 12 | 17 | 14 | 10 | 4 | | | | 94 |
| 5 | | 1 | | | 1 | 13 | 15 | 14 | 6 | 9 | | | 59 |
| Grand Total | 6 | 19 | 12 | 18 | 18 | 45 | 56 | 60 | 23 | 25 | 14 | 5 | 301 |

**Table 10. Number of pot hauls by month and vessel reported by 5 Irish inshore vessels in 2009**

| | Month (2009) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total |
| 1 | | | | | 550 | 3430 | 5350 | 7250 | 4900 | 9650 | 5400 | 1600 | 38130 |
| 2 | | | | | | | 2600 | 2960 | 3200 | 3600 | 2800 | 400 | 15560 |
| 3 | | 1400 | 1440 | 2280 | 1280 | 1360 | 4920 | 7520 | | | | | 20200 |
| 4 | 2500 | 5450 | 2800 | 4800 | 4850 | 7550 | 6950 | 5000 | 1800 | | | | 41700 |
| 5 | | 80 | | | 40 | 570 | 1757 | 7010 | 5920 | 9640 | 5360 | | 30377 |
| Total | 2500 | 6930 | 4240 | 7080 | 6720 | 12910 | 21577 | 29740 | 15820 | 22890 | 13560 | 2000 | 145967 |

**Table 11. Catch rate (kgs per pot) of crab by month and vessel reported by 5 Irish inshore vessels in 2009**

| | Month (2009) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total |
| 1 | | | | | 1.33 | 1.98 | 1.55 | 1.43 | 1.27 | 1.82 | 1.57 | 1.80 | 1.63 |
| 2 | | | | | | | 2.63 | 2.26 | 1.84 | 2.88 | 1.93 | 2.50 | 2.35 |
| 3 | | 1.46 | 1.16 | 1.20 | 1.86 | 2.09 | 1.78 | 1.54 | | | | | 1.57 |
| 4 | 1.00 | 1.54 | 1.57 | 1.81 | 1.57 | 2.66 | 3.49 | 3.05 | 3.28 | | | | 2.27 |
| 5 | | 5.00 | | | 1.88 | 4.02 | 15.97 | 1.72 | 1.50 | 2.09 | 2.11 | | 4.89 |
| Grand Total | 1.00 | 1.70 | 1.40 | 1.57 | 1.62 | 2.78 | 5.88 | 1.90 | 1.75 | 2.15 | 1.88 | 1.94 | 2.66 |

**Table 12. Landing rate (kgs per pot) of crab by month and vessel reported by 5 Irish inshore vessels in 2009**

| | Month (2009) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total |
| 1 | | | | | 0.98 | 1.35 | 1.14 | 1.01 | 0.92 | 1.38 | 1.21 | 1.11 | 1.63 |
| 2 | | | | | | | 1.55 | 1.71 | 1.36 | 2.30 | 1.50 | 1.94 | 2.35 |
| 3 | | 1.09 | 0.81 | 0.85 | 1.23 | 1.43 | 1.24 | 1.09 | | | | | 1.57 |
| 4 | 0.70 | 1.13 | 1.13 | 1.26 | 1.00 | 1.34 | 1.73 | 1.49 | 1.47 | | | | 2.27 |
| 5 | | 4.38 | | | 0.63 | 3.33 | 3.32 | 0.50 | 0.49 | 0.90 | 1.10 | | 4.89 |
| Grand Total | 0.70 | 1.29 | 1.00 | 1.10 | 1.02 | 1.86 | 1.92 | 1.08 | 0.96 | 1.37 | 1.23 | 1.28 | 2.66 |

**Table 13. Landing rate (numbers per 100 pots) of lobster caught as by-catch by month and vessel reported by 5 Irish inshore vessels in 2009**

| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 0.17 | 1.08 | 0.59 | 0.66 | 0.76 | 0.21 | 0.13 | 0.13 | 0.51 |
| 2 | | | | | | | 1.42 | 1.68 | 0.66 | 1.97 | 1.21 | 2.50 | 1.43 |
| 3 | | 0.13 | 0.53 | 0.04 | 0.16 | 0.16 | 1.53 | 2.91 | | | | | 1.31 |
| 4 | 0.35 | 0.40 | 0.24 | 0.75 | 2.54 | 1.91 | 0.90 | 1.46 | 1.98 | | | | 1.23 |
| 5 | | 2.50 | | | 0.00 | 0.77 | 2.25 | 2.43 | 5.55 | 1.94 | 3.63 | | 2.59 |
| Total | 0.35 | 0.44 | 0.36 | 0.47 | 1.65 | 1.24 | 1.39 | 1.92 | 2.44 | 1.28 | 1.84 | 0.60 | 1.43 |

#### 2.4.1.3.2 England

*<10m vessel:*

The daily landings for the <10m vessel are typically in the order of 320 kg per day although the highest value of 690 kg was caught on 28th October 2009 and the lowest catch of brown crabs was only 15 kg on 21st September 2009 from 3 fleets of gear usually set to target lobsters (Fig. 8). The numbers of pots hauled on each fishing day range from 80 to 360 but are typically around 320 (Fig. 9). The daily LPUE vary from 12 to 202 kg per 100 pot hauls but 100 kg/100 pots was typical for the study period (Fig. 10). Daily LPUE was generally highest in June and October.

Monthly landings demonstrate that the overall catches of crab were highest in June and October of 2009 at just over 5 and 5.5 tonnes (Fig. 11). Of those months where data are available November was the poorest month for crab landings, likely due to the poor weather conditions and the resultant lack of activity. Over the study period from 28th April 2009 to 22nd December 2009 25 tonnes of crabs were recorded as landed, but this excludes the crab landed in late June/July. The numbers of days fished per month shows the reduction in the number of trips made in the autumn, with only 2 days spent at sea in November compared to 17 in September (Fig. 12). The number of days fished in April, June and December are incomplete and those for July missing but overall the total number of days fishing during the study period was 83. This level of fishing activity reflects on the total number of pots hauled per month which is typically over 3000 and up to 3910 in September, but only 670 in November (Fig. 13). Monthly LPUE was typically around 100 kg/100 pots, highest in October at 146 kg/100 pots and lowest in April at 54 kg/100 pots (Fig. 18).

*>10m vessel:*

Daily landings from 9th May 2009 to 31st January 2010 show that landings of brown crabs are typically in the order of 800 kg (Fig. 8). The lowest daily landing of 0 was on the 12th May (when the vessel was targeting lobster and spider crab) and the highest daily landing of 1590 kg was on the 25th October. This vessel usually fishes 600 pots on a daily basis but on occasions has fished as few as 180 and up to a maximum of 780 pots (Fig. 9). Daily LPUE was typically highest in June and July and again in towards the end of October and in November reaching 265 kg/100 pots (Fig. 10). LPUE was often below 100 kg/100 pots in May, August to September and December.

The highest monthly landings totalling 20.8 tonnes of crab were in June and the poorest month where complete records were available was December with 6.7 tonnes (Fig. 11). Over the study period from 9th May 2009 to 31st January 2010, 93 tonnes of brown crab was landed. The highest numbers of days fished per month was 22 with lower values being typical (Fig. 12). Only seven days were spent at sea in November because of bad weather. A total of 132 days were fished over the course of the study period. Monthly pot hauls were typically around 10000 with the highest of over 12000 in June and lowest at 4500 in November (incomplete months excluded, Fig. 13). Monthly LPUE were typically a little over 100 kg/100 pots but were highest in July at 169 kg/100 pots and lowest in December at 93 kg/100 pots (complete months only, Fig. 14). They were very similar to those of the smaller vessel, although the value for July showed how good this month was for catch rates in the absence of data from the smaller vessel.

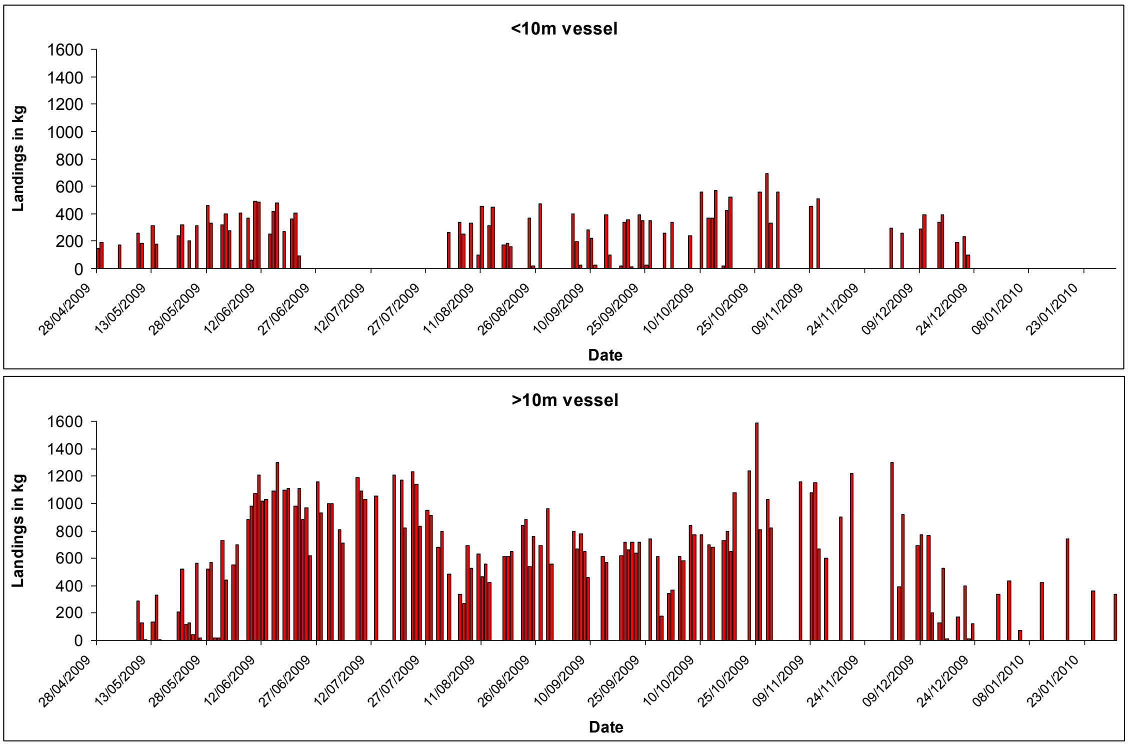



**Figure 8. Daily landings of brown crab for <10m vessel (top panel) and >10m vessel (lower panel) from voluntary logbook data**

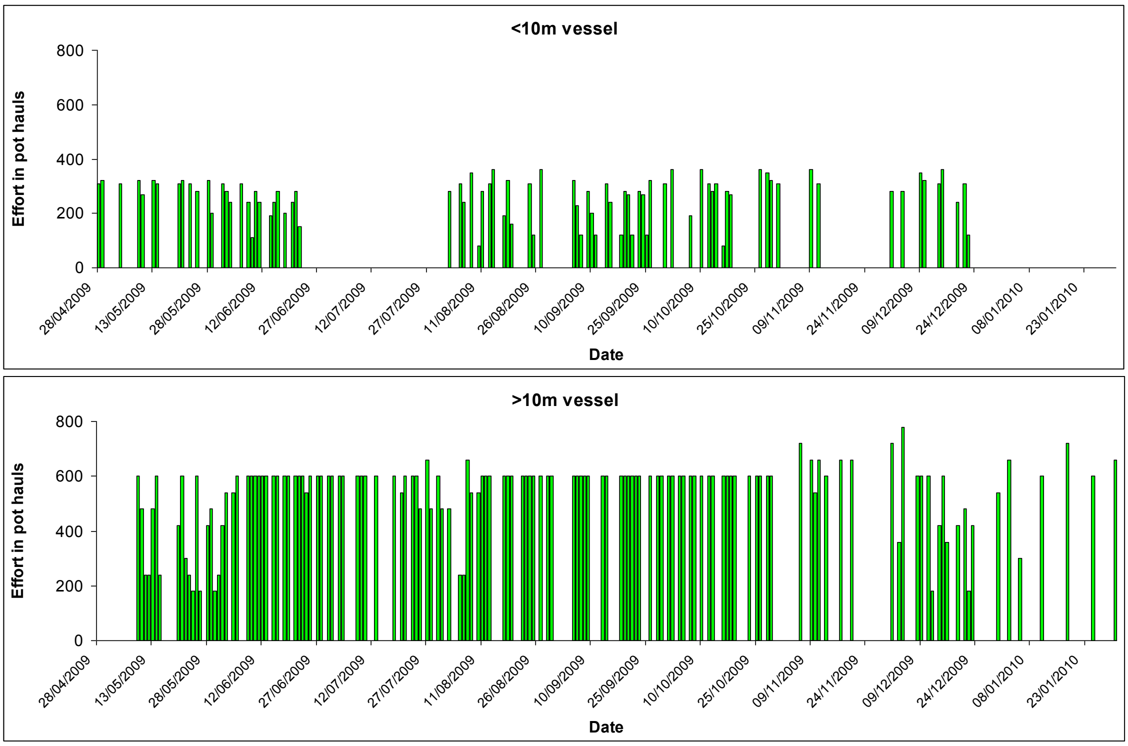
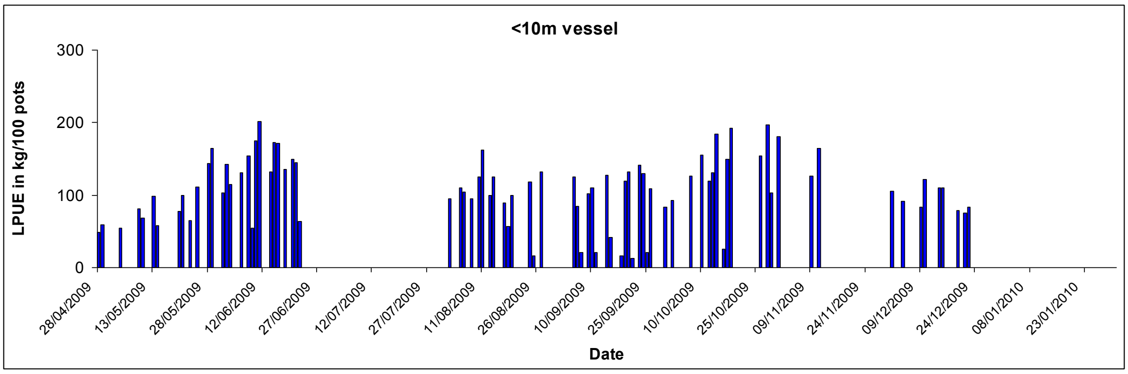



**Figure 9. Daily number of pots hauled for <10m vessel (top panel) and >10m vessel (lower panel) from logbook data.**



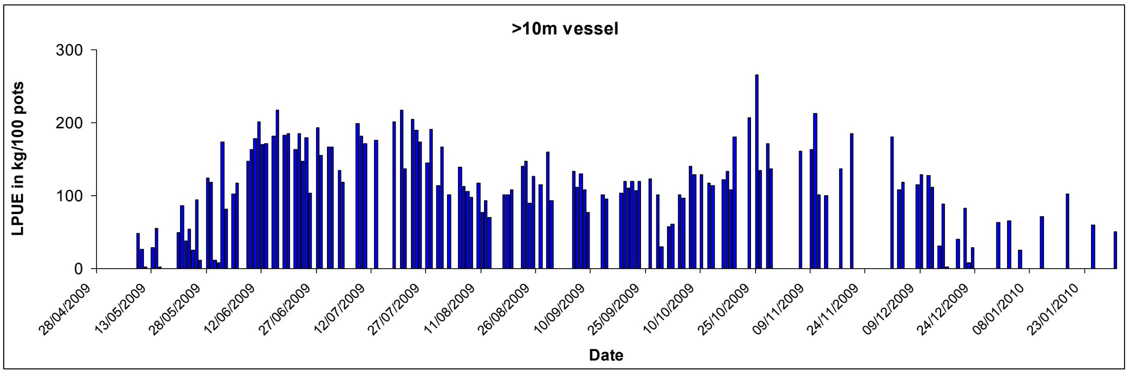




**Figure 10. Daily LPUE for brown crab for <10m vessel (top panel) and >10m vessel (lower panel) from logbook data.**

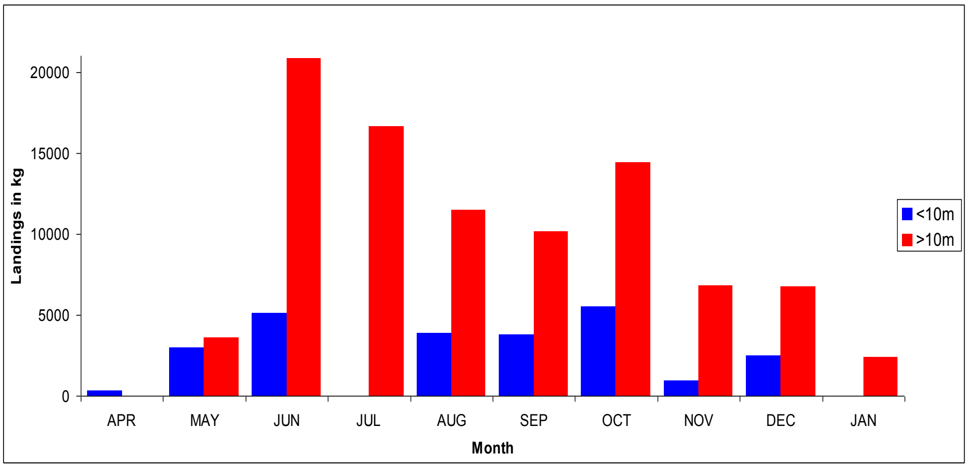



**Figure 11. Monthly landings of brown crab for <10m vessel (blue) and >10m vessel (red) from logbook data.**

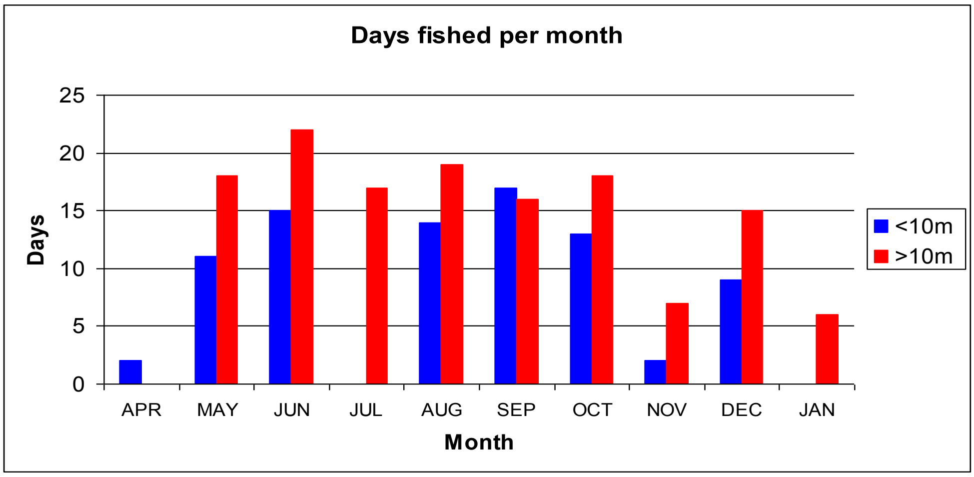



**Figure 12. Number of days fished per month for <10m vessel (blue) and >10m vessel (red) from logbook data.**

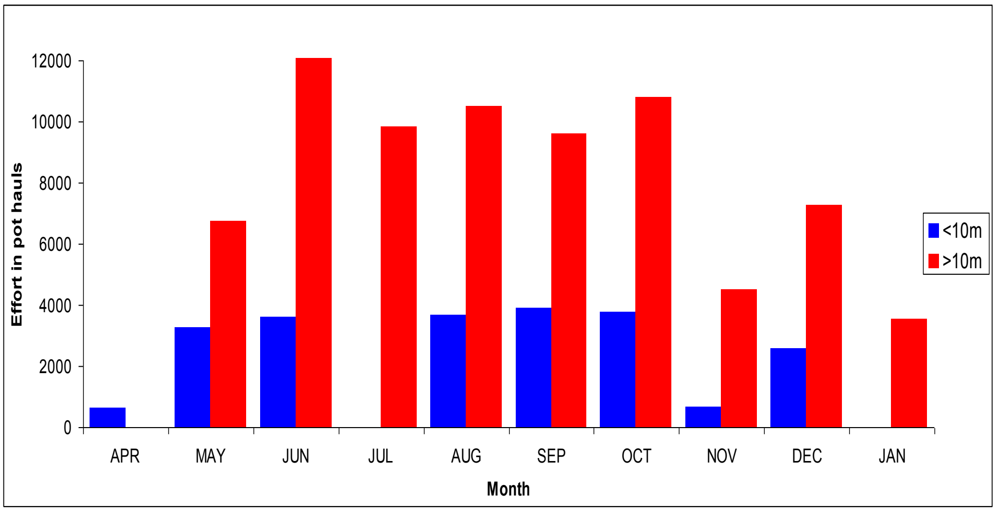



**Figure 13. Monthly number of pots hauled for <10m vessel (blue) and >10m vessel (red) from logbook data.**

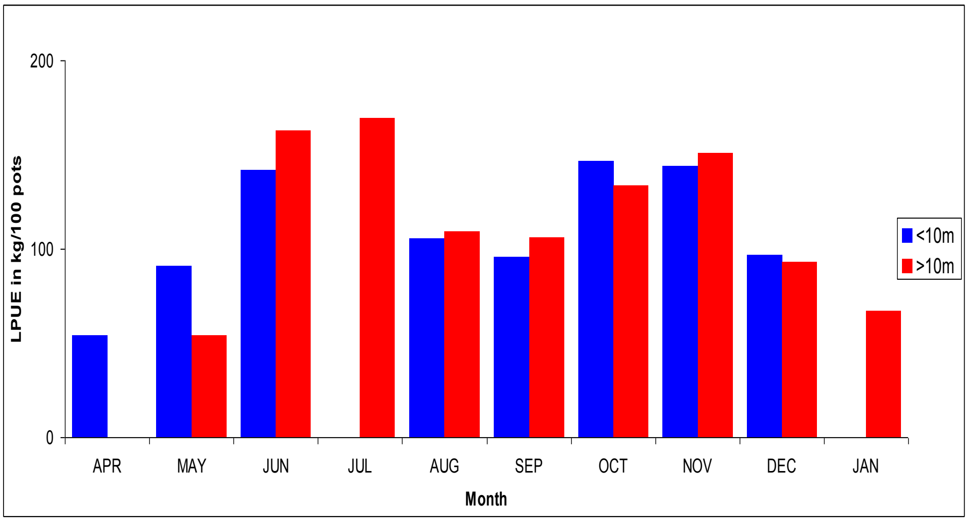



**Figure 14. Monthly LPUE for brown crab for <10m vessel (blue) and >10m vessel (red) from logbook data.**

*Comparison of data types*

Potting vessels in the UK with an entitlement to land shellfish are required to declare their landings of crab to the authorities. Vessels <10m are required to complete a monthly declaration called a Monthly Shellfish Activity Return or MSAR form and >10m vessels are required to complete an EU logbook. Information from both these documents is entered onto the official database by Marine and Fisheries Agency staff, either as daily records or monthly summaries. In addition copies of the MSAR forms are sent to Cefas who have entered a selected number of these including those for our <10m vessel volunteer. Although these alternative sources of data do not have the spatial resolution offered by the log books completed as part of this project they offer a valuable opportunity to corroborate these data.

The landings, effort and LPUE for the <10m vessel from the period 28th April 2009 to 30th September when activity data from both sources is available show very similar trends (Fig. 15). The values for late June and July available from the MSAR forms shows how important this period was for the crab fishery. The effort data is almost identical and any differences in landings are possibly attributable to the log book data being estimates of landed weight whilst those from the MSAR forms are likely actual landed weights measured at the quayside. The MSAR interpretations are daily records as acquired by Cefas, those available on the official database are generally aggregated to monthly summaries.

The equivalent information for the >10m vessel is split into two time periods for clarity and shows that there is some discrepancy with the two sources of data (Figs. 16 & 17). This is most noticeable in the landings and LPUE on the 23rd October where much higher landings and LPUE are recorded in the official FAD data. This is not unusual in fisheries data where varying levels of aggregation and interpretational differences can accrue. In this case it is noticeable that significantly lower landings were recorded on the official database immediately prior to this landing and it is likely that the practise of store potting where the catch is accumulated in keep pots before landing later accounts for this anomaly. To reiterate, the log books as part of this project record estimates of landed weights by each fleet of gear whilst the MSAR forms or EU log books may record actual landed weights at the quayside in a more aggregated summary.


**Figure15. Comparison of daily activity for the <10 m vessel as recorded on log books as part of this project (red) and on the MSAR's (blue). Landings (top), effort in pot hauls (middle panel) and LPUE in kg/100 pots (lower panel).**

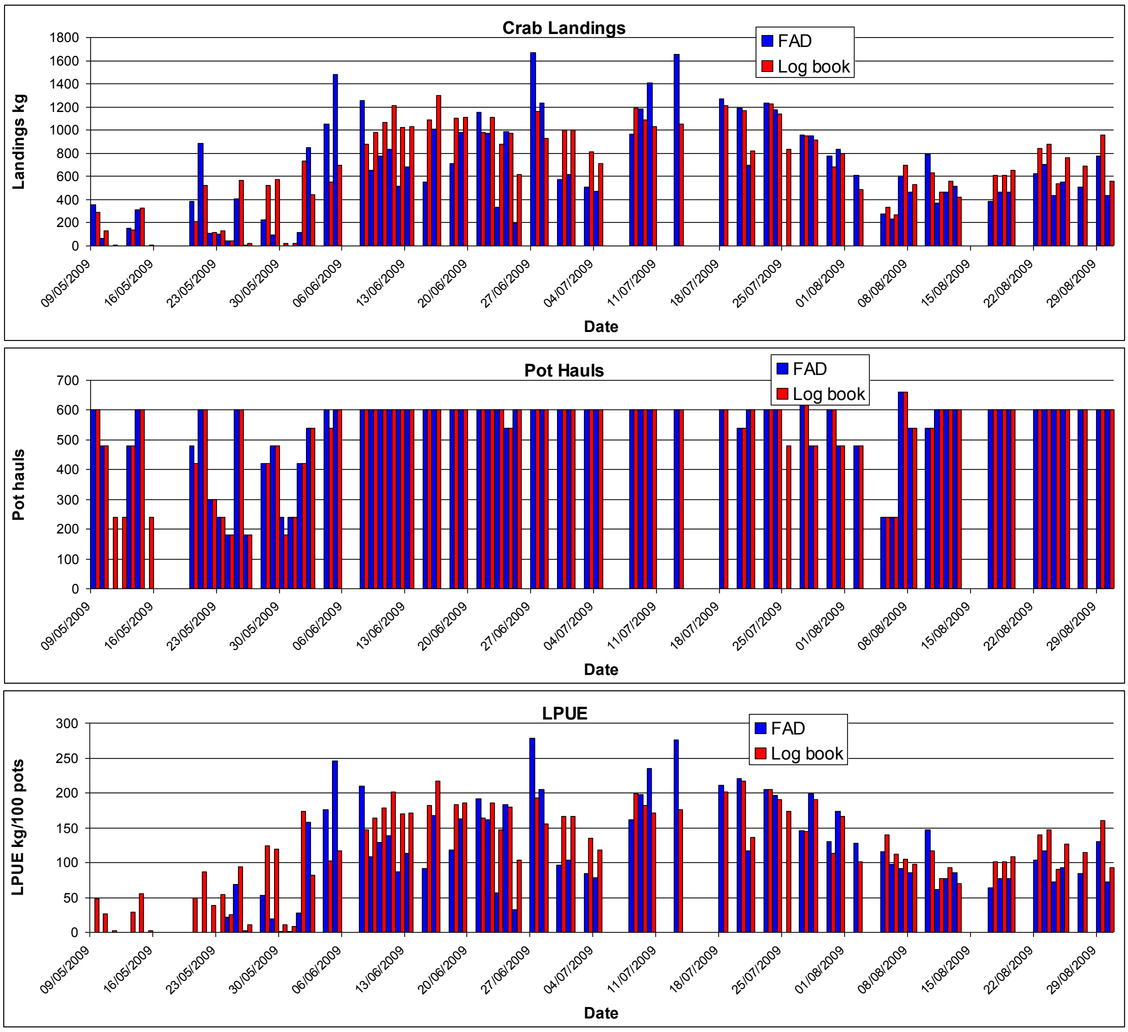



**Figure 16. Comparison of daily activity for the >10 m vessel as recorded on log books as part of this project (red) and on the official Fishing Activity Database, FAD (blue) from the start of the project to end of August 2009. Landings (top), effort in pot hauls (middle panel) and LPUE in kg/100 pots (lower panel).**

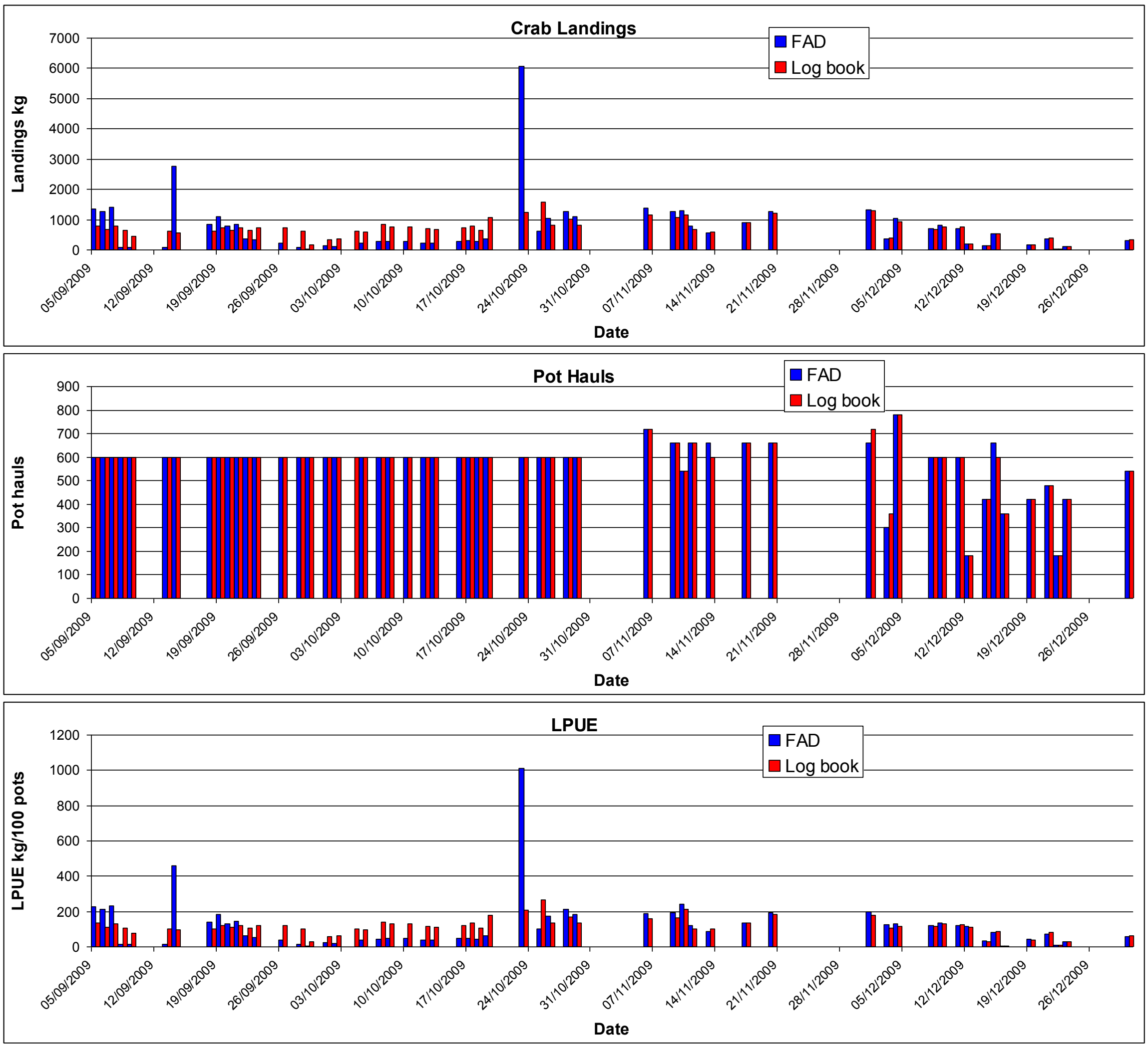



**Figure 17. Comparison of daily activity for the >10 m vessel as recorded on log books as part of this project (red) and on the official Fishing Activity Database, FAD (blue) from the start of September 2009 to the project end. Landings (top), effort in pot hauls (middle panel) and LPUE in kg/100 pots (lower panel).**

#### 2.4.1.3.3 Scotland

The fleet catch rates calculated from logbook records were highly variable, ranging from 0.5 to nearly 4.0 kg per pot (Fig. 18). These were more variable than those estimated for the entire day (several fleets). There were insufficient data to investigate season, location or vessel effects or variation of catch rate related to bait type or soak time.

The proportions of the catch discarded as estimated by skippers and as derived from sample measurement and length weight conversions, on each sampling occasion, are shown in Fig. 19). Skipper estimates varied from 8% to 70% and averaged 34% overall. The discard proportion calculated from measured samples ranged from 22% to 62% with an average of 41%.

Catch rates calculated by combining the effort estimated from GPS logger data and landings from FIN, for the four vessels that had mainly targeted brown crab showed a similar pattern of a steady decline from June 2008 until the lowest levels in March – May 2009 and then increased up to December 2009 (Fig. 20).

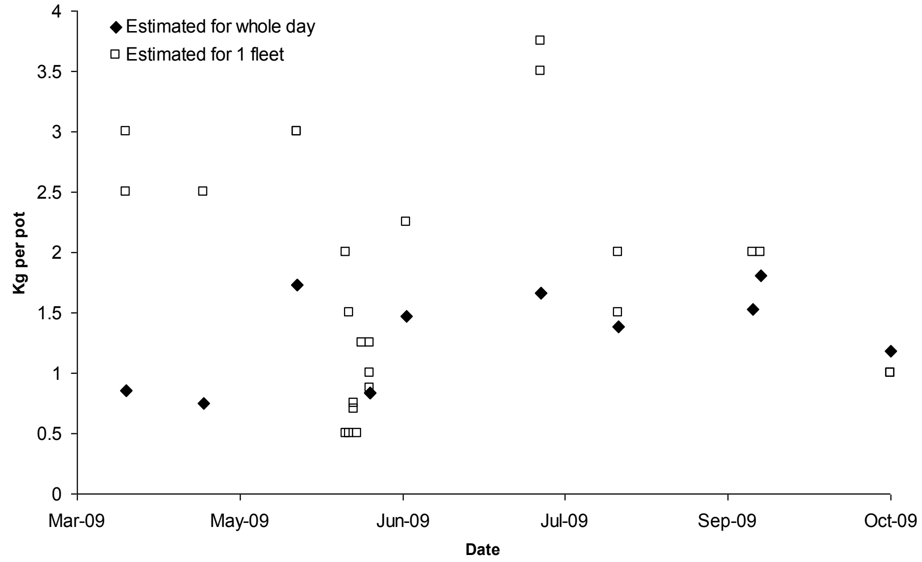



**Figure 18.Brown crab catch rates in kg caught per pot for each day of sampling at two different scales. Open symbols represents catch rates calculated from the number of creels and kilos of crab caught on one fleet of creels for each of the 25 fleets sampled. Filled symbols represents catch rates calculated from total catch and number of creels set for the entire day's fishing on the days sampling took place (16 days).**

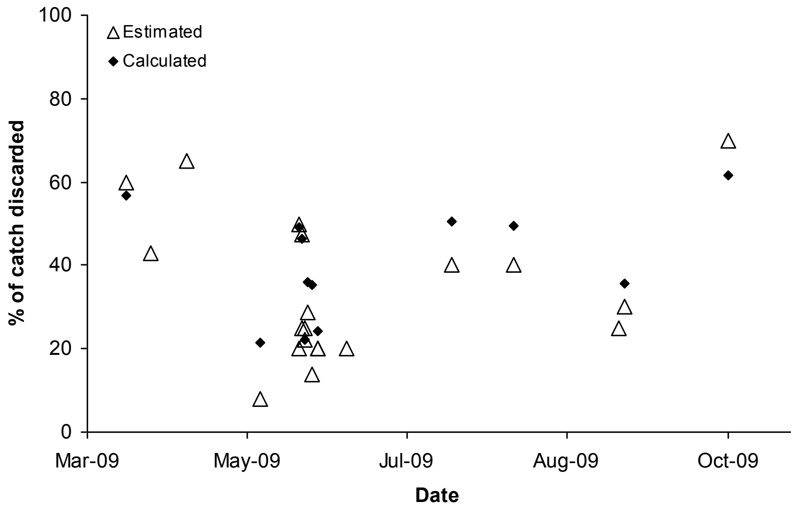



**Figure 19. Proportion of catch discarded on the days sampling took place. Open symbols represents discard proportion estimated by skipper for the entire day of fishing (20 estimates). Closed symbols represents discard proportions by weight calculated from the measured samples (12 samples).**

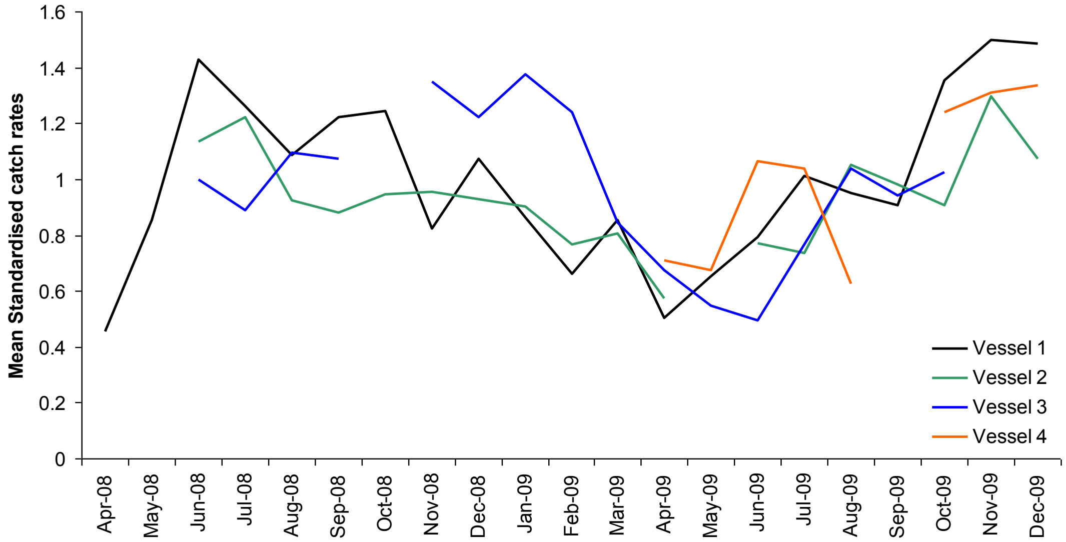
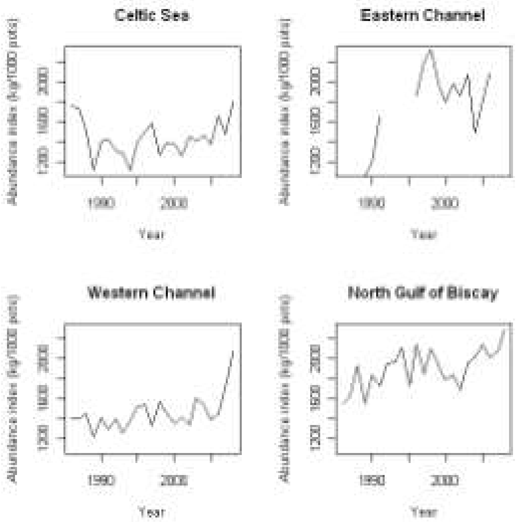



**Figure 20. Trends in estimated catch rates for four of the participating vessels. Catch rates were estimated as kg brown crab per fleet of creels for each trip and then averaged for each month based on which month the trip ended in. Amount of crab landed each trip was obtained from FIN databases and effort was estimated from the GPS logger data.**

#### 2.4.1.3.4 France

Direct and regular contact with the skippers of the offshore potters were established in order to validate the data. During the project, we specifically compare the fishing day data in the database with the private diaries for 2 vessels. This work confirmed the high quality of the declaration in the logbook. From this data, we estimate an abundance index by area (Figure below). These data can be improved by recording the daily fishing position from the private diary as in Ireland. In parallel, some fishermen agree that the VMS could be used to analyse the data. For vessels equipped with the Recopesca products.




*Evolution of the abundance index in the main brown crab fishing area for French potters.*

### 2.4.1.4 VMS and GPS

#### 2.4.1.4.1 Scotland

The GPS loggers were deployed for a total of 2292 days across the 5 project vessels to 31 December 2009 (Table 14). The difference in length of deployment amongst vessels was mainly due to differences in starting date and technical problems encountered along the way requiring the replacement of some loggers. Deployments for individual vessels ranged from 247 to 650 days. The vessels were fishing on a total of 1334 logged days, ranging from 123 to 446 days for individual vessels. The difference between days fished and days deployed is not an accurate estimate of days not fished, as it also includes days where the logger was deployed but where data were not received due to technical problems.

The plots in Figure  shows the different data display options for a logged trip stored in the GEM database at Marine Scotland-Science in Aberdeen. Days on which fishing took place (days fished) can be identified and enumerated from the top right panel of Fig. 21 as periods where the speed of the vessel alternates repeatedly between high and low. The vessel was hauling gear on 6 days on the trip displayed. One of the days fished has been shown in detail on the bottom right panel to demonstrate how periods of hauling individual fleets can be identified from the speed profile of the vessel based on both the speed and the shape of the profile. On this particular day the vessel hauled 14 fleets, one for each of the periods marked in green.

Figure 22 shows the vessel track, position logged every 5 minutes and haul positions from the same trip. It demonstrates how very fine scale information on effort distribution in a creel fishery can be obtained using this method, right down to the position of individual fleets of creels.

The number of fleets hauled estimated from GPS logger data correlated well with the actual number hauled as reported by two participants' additional records of effort (Fig. 23). This is encouraging and lends credibility to using this method of extracting haul positions to give a more detailed description of fishing distribution rather than using the full vessel tracks.

Figure 24 shows the distribution of fishing by the participating for all the trips successfully logged. Colour intensity indicates number of fleets hauled within each 1/16 of a standard ICES rectangle. The raw data on which this representation is based are not shown due to commercial sensitivity. However, even at this level, this representation still gives a much more detailed picture of distribution of fishing activity than evident from reported landings (left panel Fig. 24).

Seasonal patterns in distribution of fishing by the three offshore vessels for which the longest logger deployments were available are shown in Fig. 25. Over the sampling period, it appears that in the summer, effort extends further slightly offshore than in the winter, in both westerly and northerly directions.

In winter, effort is concentrated on grounds closer to shore, reflecting both a move to positions closer to shelter but also to some extent seasonal changes in crab availability

The GPS logger approach of mapping brown crab fishery distribution could to some extent compromised when vessels target other species. To examine this we extracted landings data from FIN and looked at the proportion of brown crab in the monthly landings of participating vessels (Fig. 26). It is evident that vessel 5 did not target brown crab exclusively over the study period.

*Catch rates*

Catch rates calculated by combining the effort estimated from GPS logger data and landings from FIN, the four vessels that had mainly targeted brown crab (see above) are shown in Fig. 20). They showed a similar pattern of a steady decline from June 2008 until the lowest levels in March – May 2009 and then increased up to December 2009. A similar trend in catch rates was evident in data extracted from the private diary made available by one of the vivier skippers (not presented)

**Table 14. The duration of deployment of loggers on 5 fishing vessels fishing brown crab in area VIa. The deployment refers to the number of days the logger has been fitted on the vessel and number of fishing days refer to the number of days the logger was working and the vessel was at sea fishing. Fishing days were identified as days were the speed profile of the vessel showed a typical pattern of alternating between high and low speeds.**

| Vessel | Deployment period | Deployment (days) | Number of fishing days tracked |
|---|---|---|---|
| 1 | 10/03/2008 – 31/12/2009 | 650 | 446 |
| 2 | 02/06/2008 – 31/12/2009 | 568 | 385 |
| 3 | 03/06/2008 – 31/12/2009 | 567 | 217 |
| 4 | 23/04/2009 – 31/12/2009 | 247 | 123 |
| 5 | 10/04/2009 - 31/12/2009 | 260 | 163 |

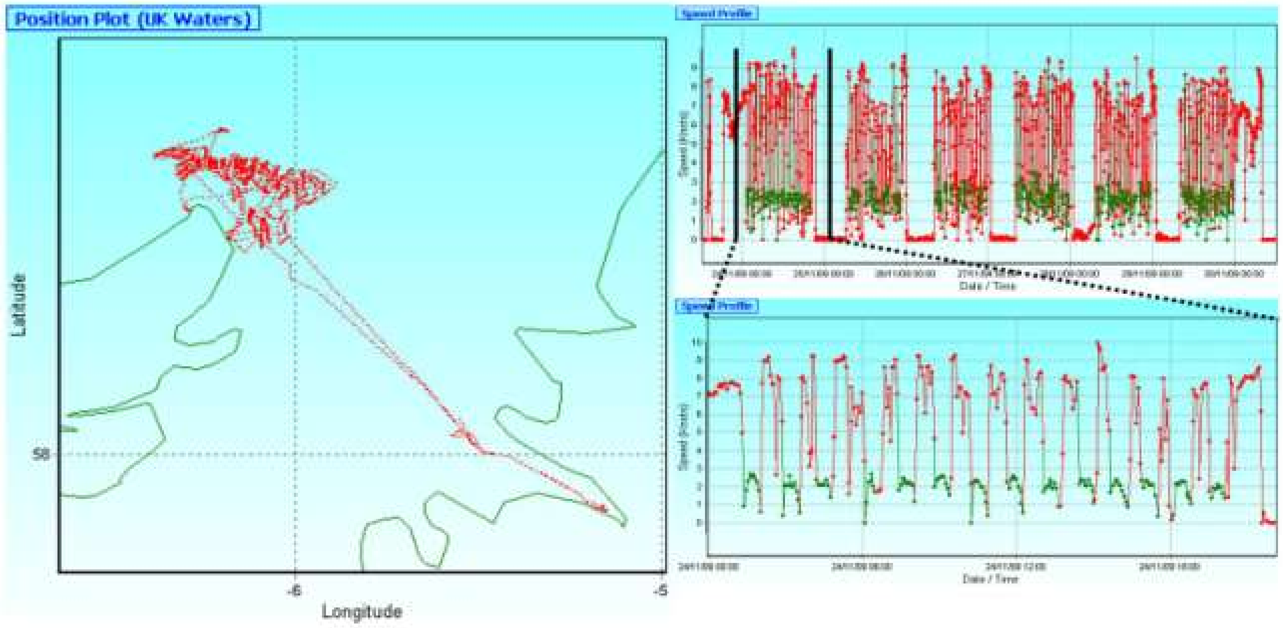



**Figure 21 GEM database screen shots. Position and speed information logged on one fishing trip on which fishing took place on 6 days. Left hand panel shows positions plotted for the entire trip. Top right hand panel shows the vessel speed against time for the entire trip and bottom right hand panel shows the speed profile for the first day of the trip. Periods marked in green on the speed profile are periods marked as hauling gear.**

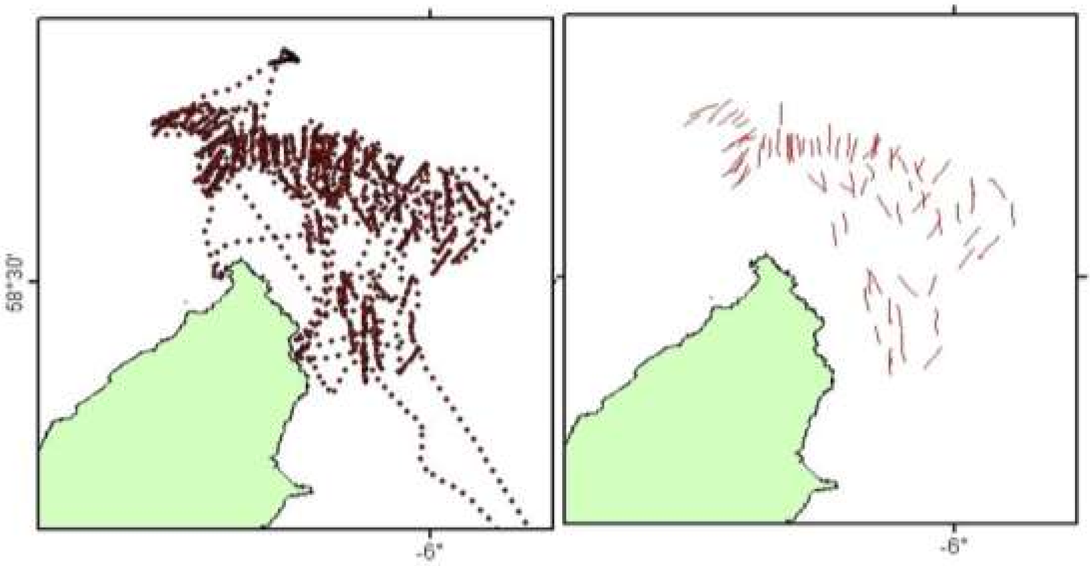



**Figure 22 Full track and (left) and hauls extracted (right) for the same fishing trip**

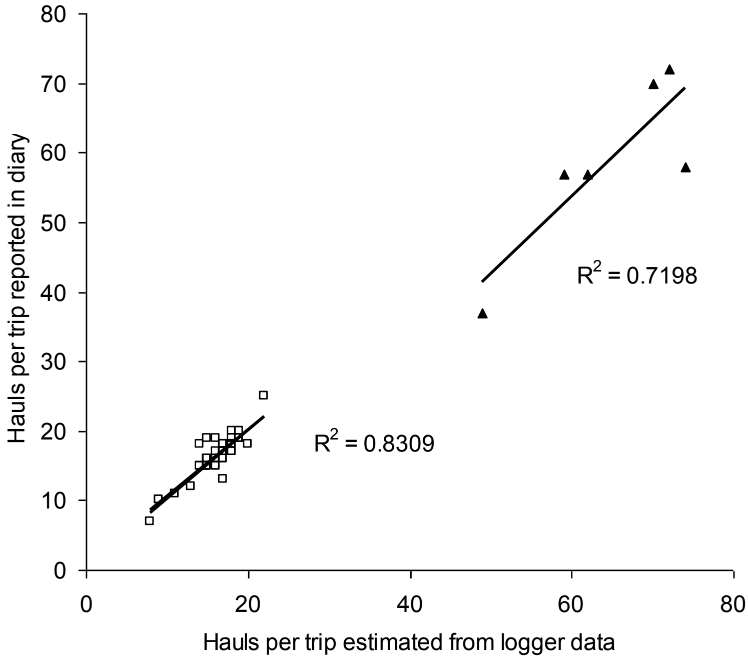



**Figure23. Comparison of number of hauls estimated from logger data to number of hauls reported in diaries for same trip. Open squares are from small inshore vessel doing one trip a day, filled triangles are from a large offshore vivier where a trip lasts ~6 days. Solid lines are trend lines fitted for each series and the strength of the correlation is indicated by the $R^2$ values displayed on the chart.**

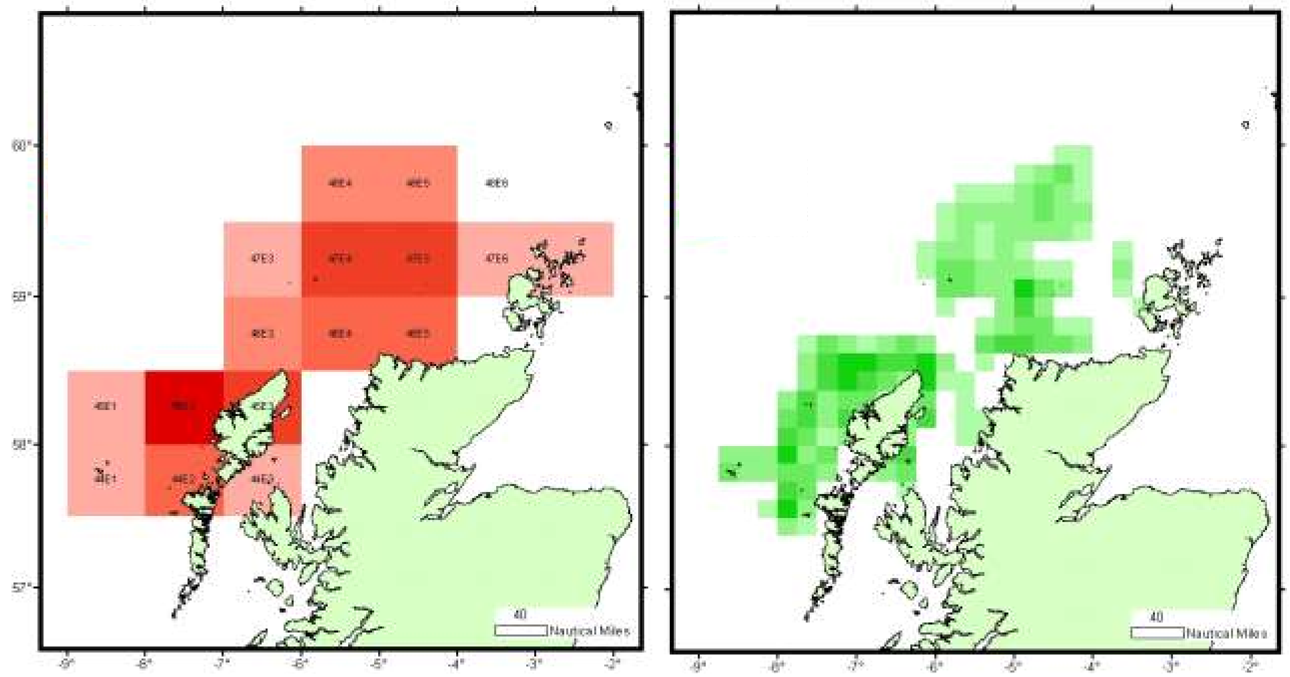



**Figure 24. Distribution of brown crab fishing by participating vessels during fishing trips successfully logged between March 2008 and December 2009. Panel on left shows the distribution of fishing deduced from landings data available in FIN for trips tracked by GPS loggers. The colour code indicates intensity of fishing as amount of kg landed per ICES rectangle. On the right is shown the fishing distribution estimated from GPS logger data for the same trips. Colour code corresponds to intensity of fishing as number of hauls within 1/16 of an ICES rectangle.**

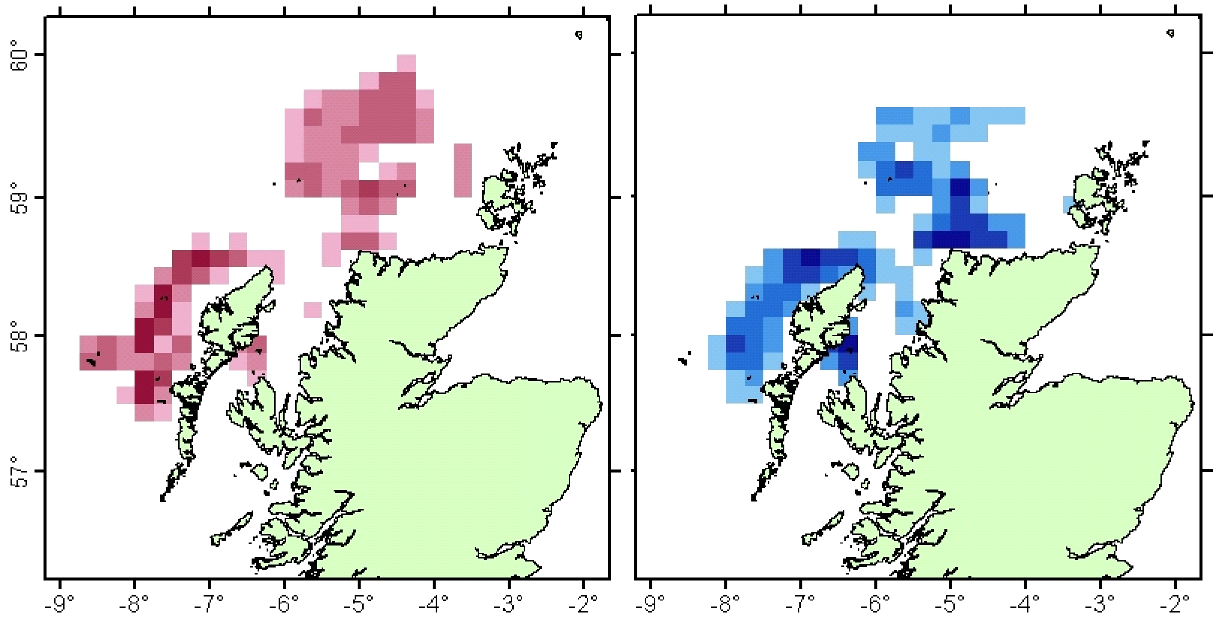



**Figure 25 Distribution of fishing from June 2008 to December 2009) of three of the Scottish vivier vessels participating in the project. The panel on the left shows the distribution of effort over the summer months (April-September) and the panel on the right shows the distribution of effort in the winter months (October – March). Colour intensity indicates density of hauls located within each 1/16 of an ICES rectangle.**

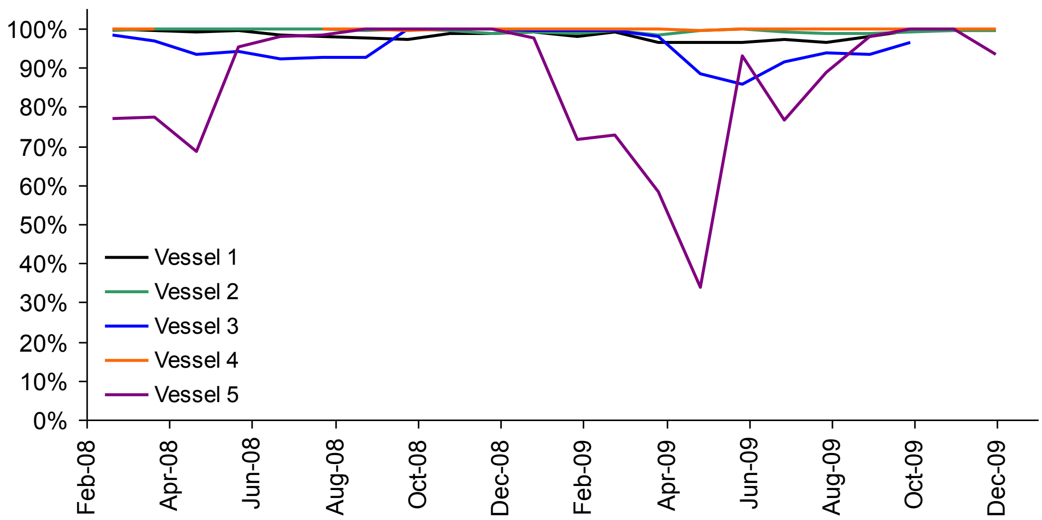



**Figure 26. Catch composition for vessels taking part in the lot1 project. Composition is expressed as percentage of total weight landed in a given month that was brown crab.**

#### 2.4.1.4.2 England

<10m vessel:

Throughout the period April to October 2009 the <10m vessel operated exclusively inside 9 miles in an area to the west of Bolt Head (Fig. 27). The fishery is a mixed one prosecuting brown crab, lobster and spider crab and these were targeted using different gear and at different locations. The sites close to the coast off the Outer Hope and Bigbury-On-Sea (Bigbury Bay) were targeted for lobster using soft eyed creels. The sites farthest offshore were areas where brown crabs were targeted usually with inkwell and parlour pots. One site between these two areas and outside the summer months was used to target spider crabs using a fleet of 30" inkwell pots. In August the track positions suggested the vessel travelled to two regions over 12 miles off the coast but there were no spatially concentrated coordinates to suggest that any time was spent hauling gear here. The skipper of this vessel recorded time of hauling on his daily log sheets and this was linked directly to the time and date recorded by the GPS logger enabling catches to be matched with spatial coordinates by each fleet of gear (Fig. 28). Although this skipper also recorded the positions of each fleets whenever they were moved to an alternative location by matching merging the GPS data with the time and date on the daily logs provided an alternative and verifiable source of spatial data. The daily spatial data presented for the few days at the end of Aril and beginning of May 2009 as an example shows clearly the alternate fishing areas used this time of the year.

>10m vessel:

The >10m vessel specialises in fishing for brown crab although will target lobsters and spider crabs at different times of the year (Fig. 29). There are two main sites where this vessel targeted brown crabs, one is about 9 miles off Salcombe along a wide stretch of the contour where the skipper has differentiated into West and East, and the other is about 35 miles off the coast (Channel Potting zone block 2). This offshore ground was fished in the summer months and although data from the GPS receiver appears to be incomplete the daily logbook confirms fishing in this area from May to July. The vessel targeted spider crab using inkwell pots in the inshore site around the Burgh Island area of Bigbury Bay, especially in May. The vessel also targeted lobsters using mainly parlour pots or creels at inshore sites like The Rutts and Bigbury Bay particularly in the winter in the run up to Christmas.

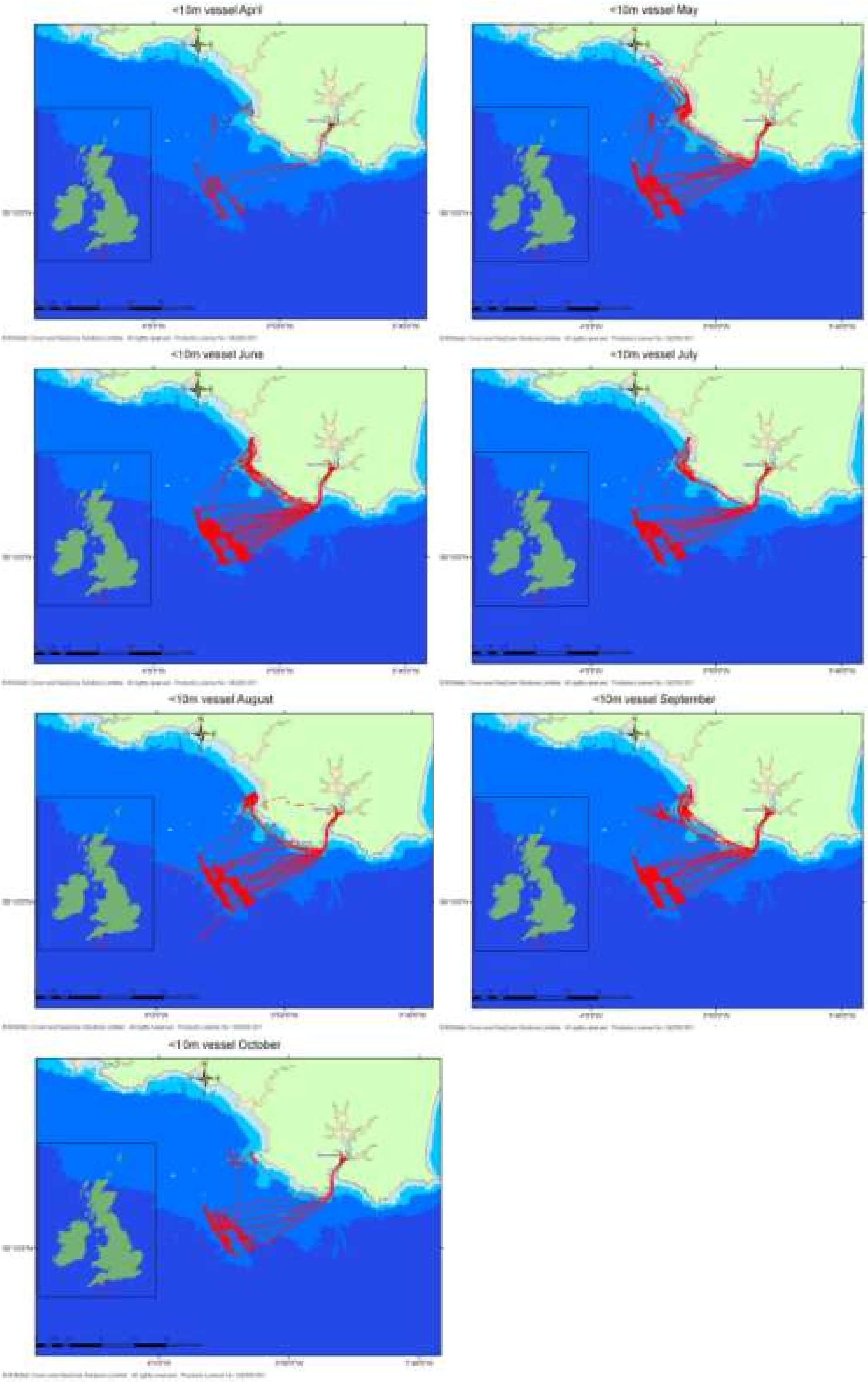



**Figure 27. Track positions as recorded by GPS logger for <10m vessel, aggregated to month, for the months April to October 2009.**

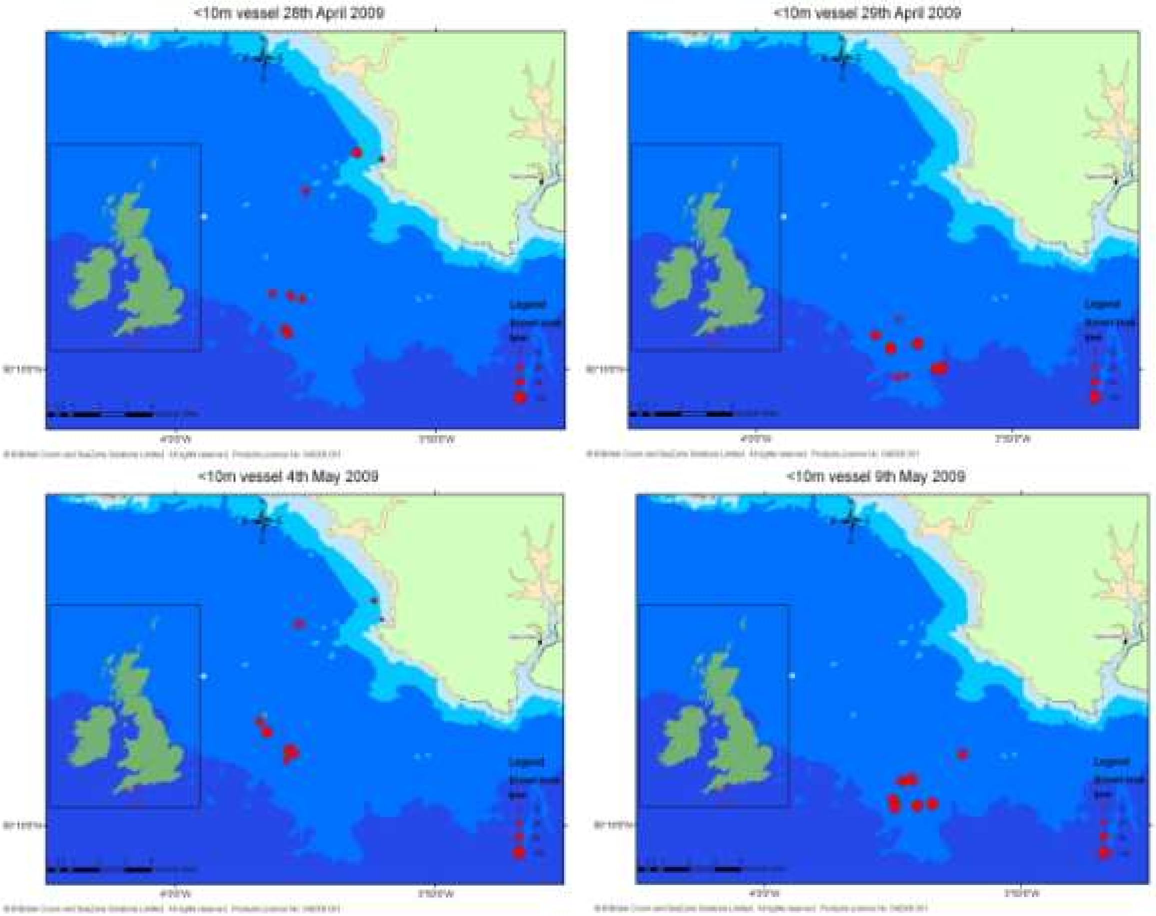



**Figure 28. Examples of daily LPUE for <10m vessel presented as daily bubble plots**

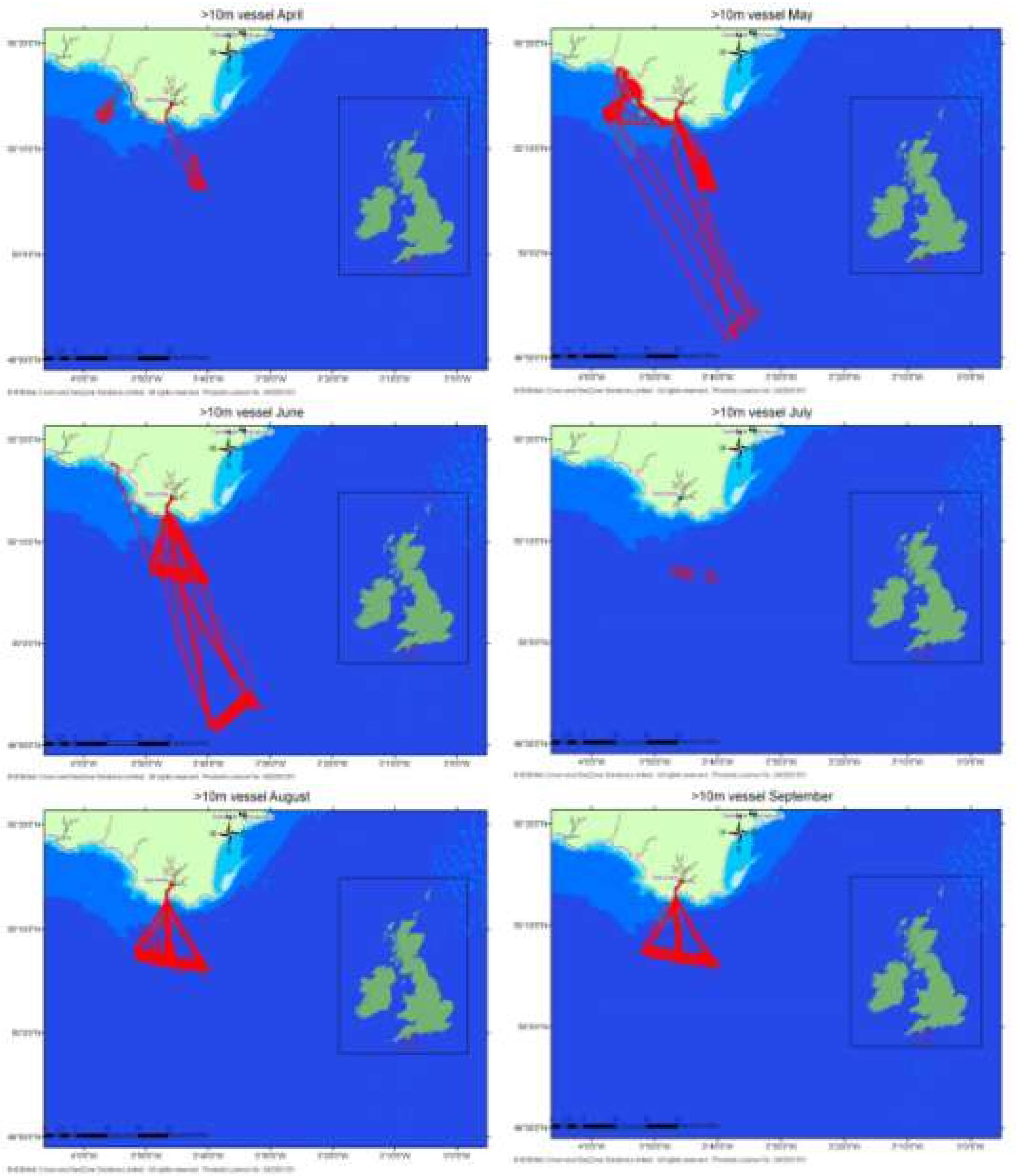
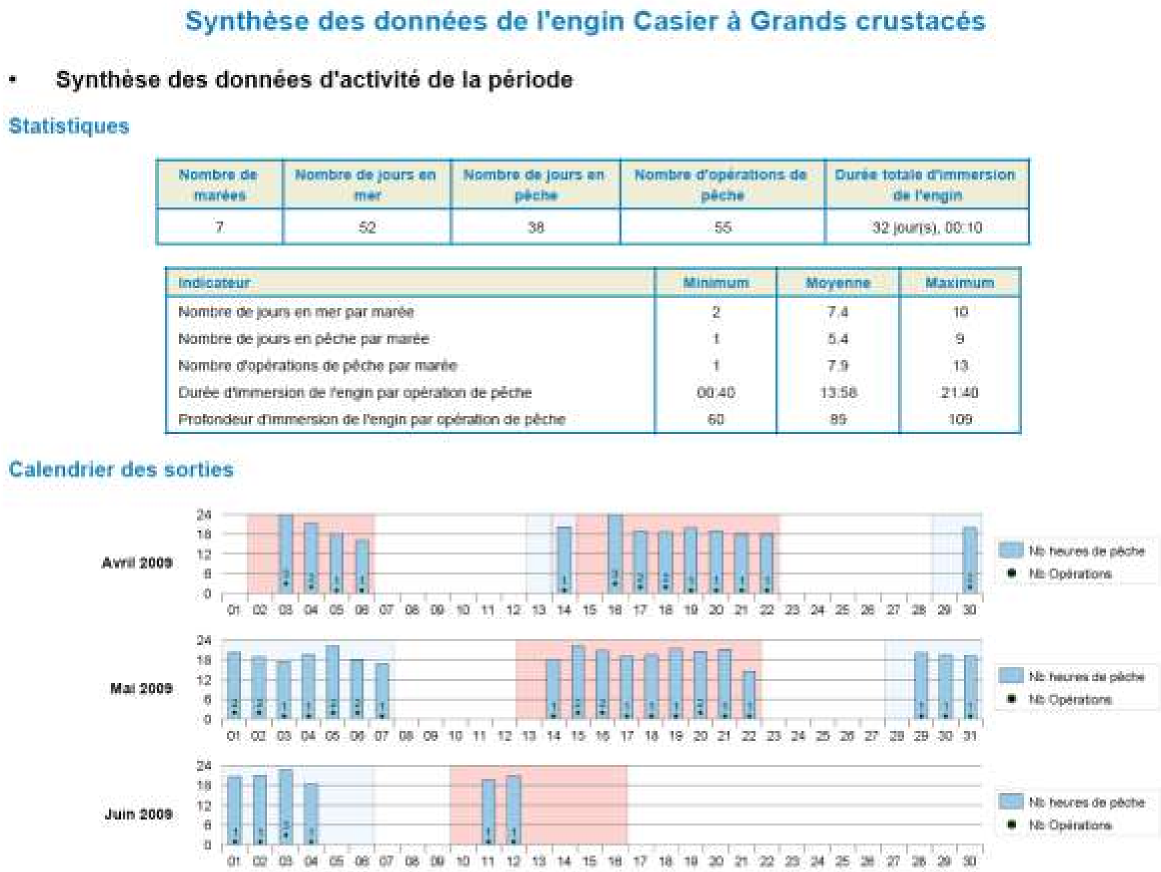



**Figure 29. . Track positions as recorded by GPS logger for >10m vessel aggregated to month for April to September.**

#### 2.4.1.4.3 France

Using the data from one boat, a synthesis of the data available from a GPS and a sensor fixed to the gear is possible. From the GPS position, a definition of each trip is given (Fig. 30). A report is obtained automatically for a given period. A first part presents the synthesis of the fishing activity (Statisques) where the number of trips, the number of days at sea and the number of fishing operations is presented. In the second part of the report (Fig. 31), the fishing activity by month is presented as a map and in tabular format The chronology of each trip allows the fishing activity on board to be visualised (Fig. 32). From the GPS ping rate (15 minutes), the fishing time estimated with a threshold of 4.5 knots for fishing is really relevant. With the VMS data using the same rule, the fishing time is overestimated. At the moment, we are just linked the daily catch declaration to the fishing position. The activity of the boat presented here shows the evolution of the strategy in April where the skipper changes the fishing area. He stops targeting lobster and starts the brown crab season on hard seabeds.
The development of such equipment in a large number of boats will bring a lot information on various stocks. For the moment, the temperature from the sensor are not used to analyse the evolution of the CPUE at the beginning of the season even if the fishermen think it influences the catchability .



Synthèse des données de l'engin Casier à Grands crustacés

- Synthèse des données d'activité de la période

Statistiques

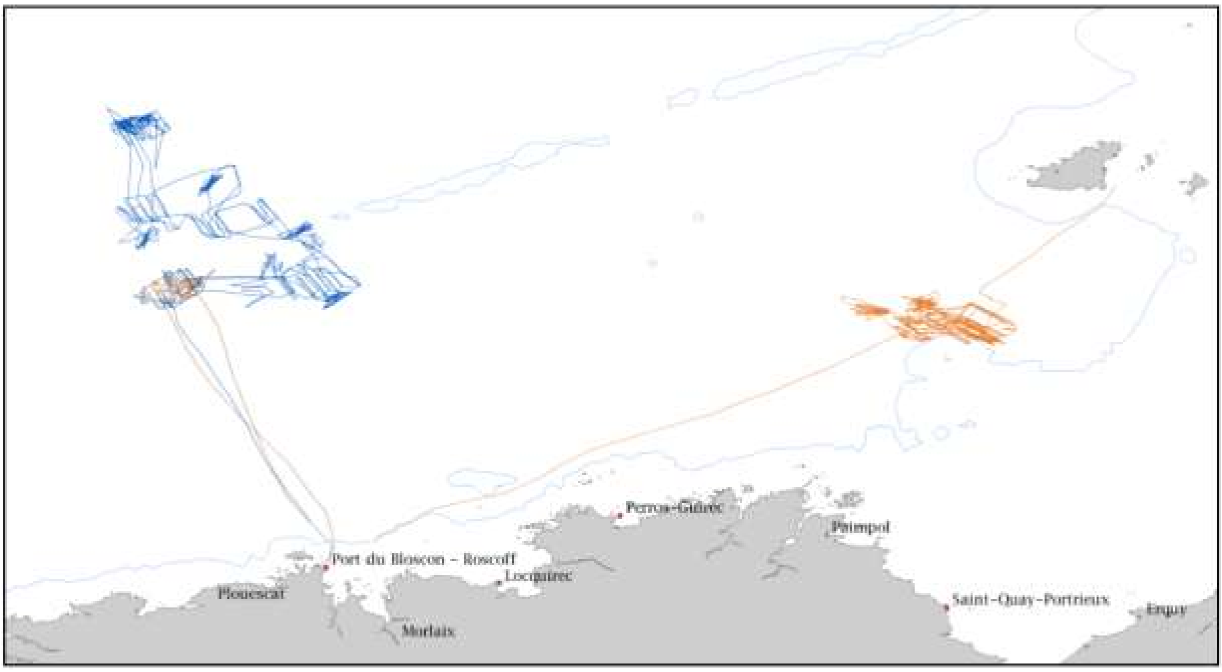
| Nombre de marées | Nombre de jours en mer | Nombre de jours en pêche | Nombre d'opérations de pêche | Durée totale d'immersion de l'engin |
|---|---|---|---|---|
| 7 | 52 | 38 | 55 | 32 jour(s), 00:10 |

| Indicateur | Minimum | Moyenne | Maximum |
|---|---|---|---|
| Nombre de jours en mer par marée | 2 | 7.4 | 10 |
| Nombre de jours en pêche par marée | 1 | 5.4 | 9 |
| Nombre d'opérations de pêche par marée | 1 | 7.9 | 13 |
| Durée d'immersion de l'engin par opération de pêche | 00:40 | 13:58 | 21:40 |
| Profondeur d'immersion de l'engin par opération de pêche | 60 | 89 | 109 |

Calendrier des sorties



Figure 30. Synthesis of activity of 1 offshore potter for a specified time period.




**Liste des opérations de pêche par marée**

| # | Caractéristiques générales de l'opération | | | | | Paramètres moyens au fond | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Filage | | Virage | | Durée (hh:mm) | | | | |
| | Date | Position | Date | Position | | Durée (hh:mm) | Prof. (mètres) | Temp. (° C) | Salinité (PSU) |
| ***Marée du 02/04/2009 à 01:27 jusqu'au 06/04/2009 à 08:37*** | | | | | | | | | |
| 1 | 02/04 07:43 | 49.19°N, 2.90°W | 03/04 03:23 | 49.17°N, 2.92°W | 19:40 | 19:10 | 64 | 9 | |
| 2 | 03/04 03:29 | 49.17°N, 2.92°W | 03/04 07:39 | 49.19°N, 2.84°W | 04:10 | 04:06 | 62 | 9 | |
| 3 | 03/04 07:48 | 49.19°N, 2.84°W | 03/04 12:38 | 49.18°N, 2.90°W | 04:50 | 04:30 | 64 | 9.1 | |
| 4 | 03/04 12:44 | 49.18°N, 2.90°W | 04/04 07:44 | 49.20°N, 2.77°W | 19:00 | 18:57 | 65 | 9 | |
| 5 | 04/04 07:54 | 49.18°N, 2.78°W | 04/04 10:44 | 49.14°N, 2.90°W | 02:50 | 02:20 | 62 | 9.1 | |
| 6 | 04/04 11:57 | 49.16°N, 2.89°W | 05/04 06:17 | 49.19°N, 2.83°W | 18:20 | 17:55 | 65 | 9.1 | |
| 7 | 05/04 08:00 | 49.19°N, 2.85°W | 06/04 00:20 | 49.17°N, 2.86°W | 16:20 | 16:00 | 60 | 9.1 | |
| ***Marée du 13/04/2009 à 05:09 jusqu'au 14/04/2009 à 14:24*** | | | | | | | | | |
| 8 | 13/04 09:31 | 49.26°N, 4.25°W | 14/04 06:21 | 49.26°N, 4.25°W | 20:50 | 20:15 | 92 | 10.1 | |
| ***Marée du 14/04/2009 à 16:10 jusqu'au 22/04/2009 à 04:19*** | | | | | | | | | |
| 9 | 15/04 09:41 | 49.24°N, 4.21°W | 16/04 04:01 | 49.23°N, 3.98°W | 18:20 | 17:55 | 92 | 10.1 | |
| 10 | 16/04 05:57 | 49.25°N, 3.99°W | 16/04 08:17 | 49.23°N, 4.00°W | 02:20 | 02:16 | 89 | 10.1 | |
| 11 | 16/04 08:20 | 49.23°N, 4.00°W | 16/04 13:00 | 49.27°N, 3.96°W | 04:40 | 04:10 | 90 | 10.1 | |
| 12 | 16/04 14:56 | 49.21°N, 3.97°W | 17/04 08:16 | 49.26°N, 3.95°W | 17:20 | 17:16 | 87 | 10.1 | |
| 13 | 17/04 08:26 | 49.26°N, 3.95°W | 17/04 10:26 | 49.28°N, 3.95°W | 02:00 | 01:30 | 89 | 10.1 | |
| 14 | 17/04 14:15 | 49.33°N, 4.04°W | 18/04 08:25 | 49.39°N, 4.10°W | 18:10 | 18:06 | 87 | 10.1 | |
| 15 | 18/04 08:32 | 49.39°N, 4.10°W | 18/04 09:22 | 49.33°N, 4.17°W | 00:50 | 00:20 | 88 | 10.1 | |
| 16 | 18/04 11:29 | 49.36°N, 4.16°W | 19/04 07:29 | 49.41°N, 4.13°W | 20:00 | 19:46 | 89 | 10.2 | |
| 17 | 19/04 12:12 | 49.36°N, 4.25°W | 20/04 07:32 | 49.40°N, 4.30°W | 19:20 | 18:55 | 92 | 10.2 | |
| 18 | 20/04 11:58 | 49.54°N, 4.34°W | 21/04 05:58 | 49.55°N, 4.33°W | 18:00 | 17:46 | 88 | 10.1 | |
| 19 | 21/04 09:05 | 49.56°N, 4.28°W | 22/04 03:05 | 49.52°N, 4.25°W | 18:00 | 17:46 | 85 | 10.1 | |

**Figure 31. Geographic and tabular details of fishing trips during April of a French crab vessel**

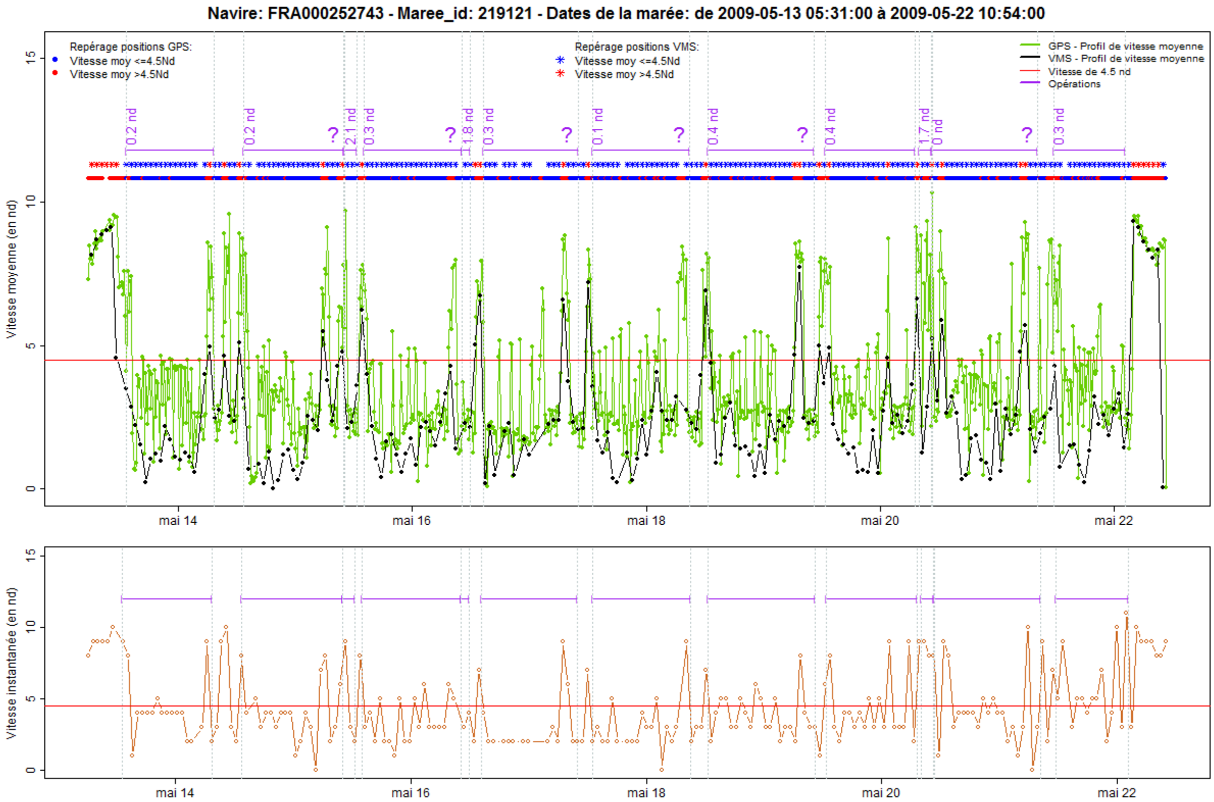



**Figure 32. Chronology of a fishing trip of a French crab vessel in May 2009 with the average speed for the VMS and GPS ping rate and the duration of the fishing operation**

### 2.4.1.5 E-logbooks

#### 2.4.1.5.1 Ireland

Although, due to technical problems, no data were reported from the electronic logbooks distributed to Irish vessels for this project the potential of this method of acquiring highly resolved catch and effort data is significant. Essentially it combines all relevant data elements into a single record and can parse this record automatically to a database. Data is recorded and transmitted per haul, fleet or string of traps and gives the following information; date, time, GPS start, GPS end, the GPS track (stored in the unit and not transmitted), gear units, soak time, bait, gear spacing, landings, discards, by catch.. Essentially it automates the integration of VMS/GPS data with logbook type data on catch and effort.

### 2.4.1.6 Questionnaire

#### 2.4.1.6.1 Ireland

In Ireland a total of 12 questionnaires were completed; 9 by owners of under 12m vessels and 3 by owners of vivier vessels. A comparison of change in effort, working conditions, catches and earnings potential between the 1980s and 2009 shows dramatic and negative trends (Table 15). Daily effort per vessel increased 3 fold, the fishing season, steaming time to grounds and gear soak time all at least doubled. Working hours increased by 38%. Vessel tonnage and kws increased mainly due to change from dry hold to vivier vessel. Although, using the autumn fishery, landings were stable the catch per unit effort declined by 74% between the 1980s and 2009 and gross profit per unit of effort was 39% of the 1980s value. Market price was 22% higher than in the 1980s (well below cost of living increases). Other fishing opportunities, predominantly salmon and whitefish in the 1980s, declined in 2009 to 28% of their 1980s value.

The trends in the Irish fishery are very clear from the questionnaire; between the 1980s and 2009 vessels became larger and more specialised as other fishing opportunities dwindled. This decline in fishing opportunity coincided with a dramatic increase in fishing effort per vessel, increased costs and a significant decline in catch rate. In addition market prices declined in real terms all of which resulted in a significantly less profitable fishery in 2009 compared with previous years.

Comments on crab quality also showed indicated that there may be a more prolonged moult season. The period when crab quality was highest was reported as September-October in both the 1980s and 2009. The period when crab quality was low was reported to be February or 'spring' in 1980s but responses on the period of lowest crab quality in 2009 were extremely variable among respondents suggesting that it was difficult to detect a clear pattern. Some respondents indicated that low quality crab could be found at any time and for a more prolonged period compared to previously. This is consistent with the responses from the Scottish fishermen (below).

**Table 15. Change in effort and profitability in the Irish north west crab fishery between the 1980s and 2009.**

| Variable | 2009 value / 1980s value. Values > 1 indicate increase |
|---|---|
| Pot hauls per day | 3.06 |
| Steam time | 2.84 |
| Boxes landed Summer | 2.46 |
| Fishing months | 2.26 |
| Gear sets | 2.2 |
| Soak time | 2.1 |
| Vessel GTs | 1.9 |
| Vessel Kws | 1.78 |
| Working hours | 1.38 |
| Market price € | 1.22 |
| Boxes landed Autumn | 1.08 |
| Crew size | 0.98 |
| Boxes landed Winter | 0.79 |
| Gross profit per unit effort | 0.39 |
| Other fisheries | 0.28 |
| CPUE Autumn | 0.26 |

The drivers behind the declining trend in the performance of the fishery and the consequences for the current fleet are apparent in the response of vessel owners to the questionnaire. Fishing activity by the inshore fleet in recent years is affected by market price, weather and low catch rates (Fig. 33). Very few respondents had other fishing opportunity or other employment possibility. In the vivier sector market price, weather and catch rate also affect activity. Availability of crew is also 'often' important and these vessels and their owners also have few other fishing or non-fishing related economic opportunities.

The factors relevant to choice of vessel were multiple (Fig. 34). In the inshore sector working conditions, crew size and costs were more important than national or EU regulations. In the vivier sector vessel costs, competition for ground, grant aid and working conditions were regarded as very important.

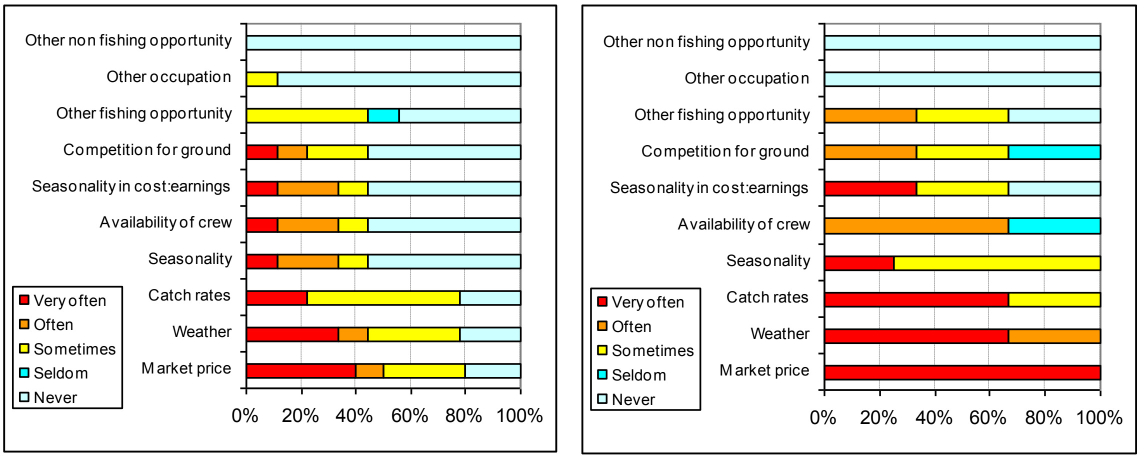



**Figure 33. Response of Irish crab fishermen to the question "What factors affected the activity of your vessel in 2007-2008?". Left: vessels under 12m, Right: vivier vessels**

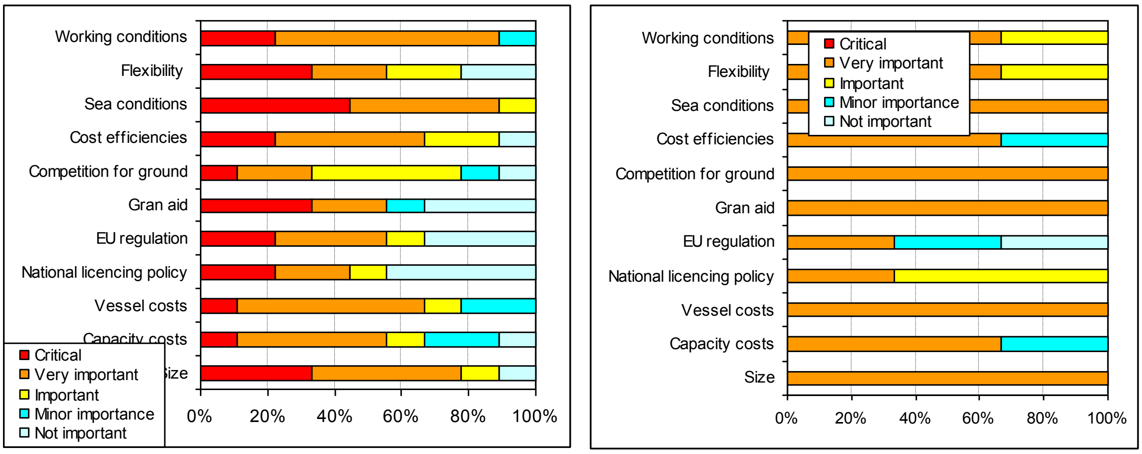



**Figure 34. Response of Irish crab fishermen to the question "What influenced your choice of vessel?" Left: vessels under 12m, Right: vivier vessels**

The significance of the decline in profitability outlined above was reflected in the response to the question "What circumstances would influence you to leave the fishery? (Fig. 35). Any further decline in market price or catch rate would influence owners of inshore vessels to leave the fishery. Internal competition for ground, lack of fishery management or leaving to take up other employment is seen as less important. In the vivier sector lack of management, decline in catch rate, increased costs and declining crab prices are regarded as critical or very important. These responses, when viewed against the reasons for entering the fishery (Fig. 36), indicate that the current operators are in a very difficult position. At least 80% of respondents had a perception or actual information that the fishery was profitable when they decided to invest in it. There were few other employment opportunities and a strong tradition of fishing in their families. Grant aid, transfer from other fisheries, the prospect of good fishery management or agreed market prices were less important.

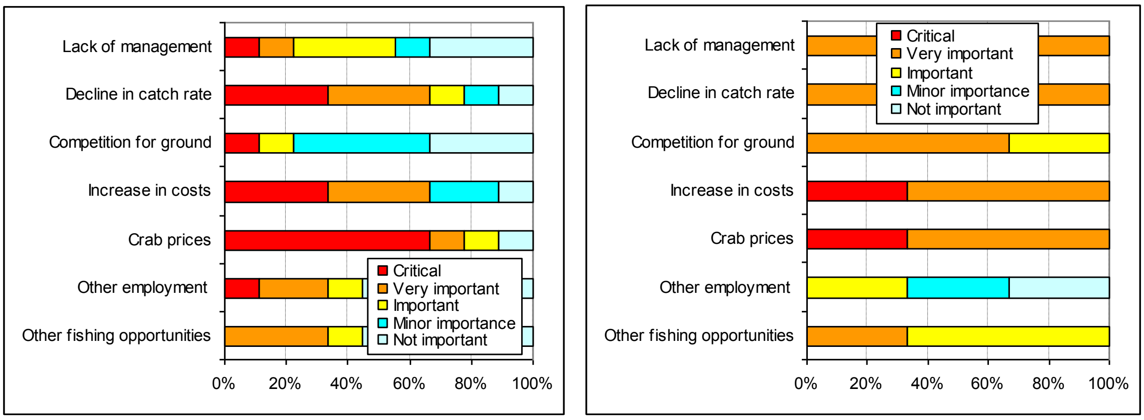



**Figure 35. Response of Irish crab fishermen to the question "What circumstances would influence you to leave the fishery?" Left: vessels under 12m, Right: vivier vessels**

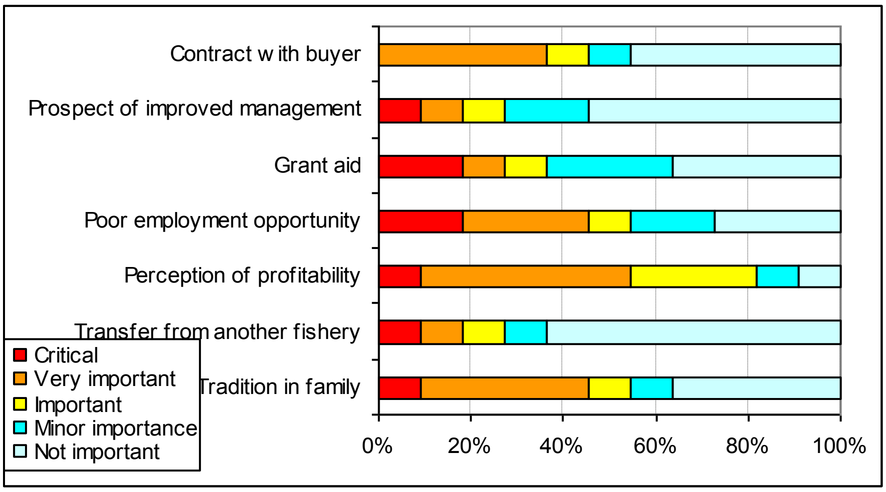



**Figure 36 Response of Irish crab fishermen to the question "What influenced your decision to enter the fishery?"**

#### 2.4.1.6.2 England

Response to the questionnaire was disappointing with only four completed. The responses were scored and ranked in order of importance and bar charts used to summarise the responses to the questions.

When asked what factors have affected their vessels activity in the 2007-2008 season the most significant responses were weather, catch rates and other fishing opportunities although market price, crew availability, competition for ground and profit margins were also very important. Vessel choice was influenced strongly by vessel size, weather constraints, flexibility of working and working conditions with initial cost and operating costs proving limiting. Low crab prices and high operating costs were the most significant factors when asked what would influence your decision to leave the fishery. Low stock levels and catch rates were also very important. Only one of the four respondents had been in the fishery for less than five years and his sole reason for entering the fishery was that it was a family tradition. Minimum landing size was suggested as a management measure which influenced activity although most respondents used this question to emphasize the point that weather was the single most important factor for controlling the amount of fishing effort (Figs. 37 – 41).

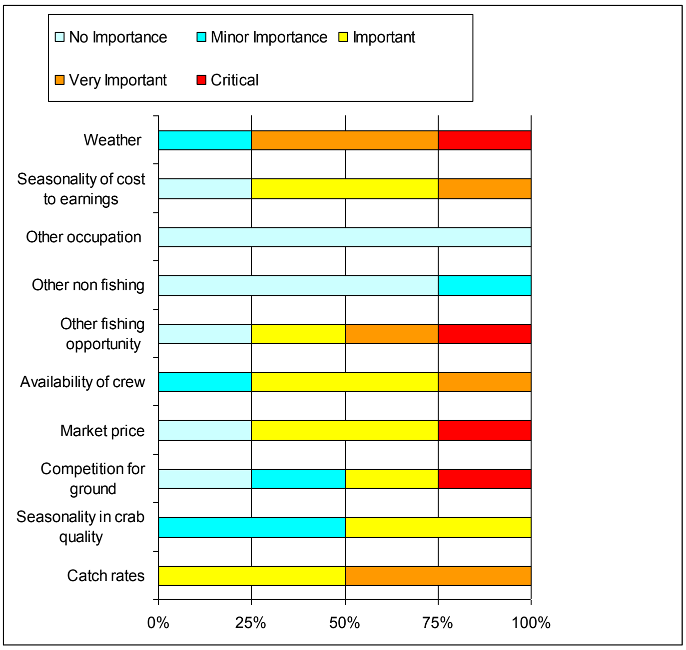



**Figure 37. Responses to question "What other factors have affected the activity of your vessel in 2007 – 2008?" for English vessels.**

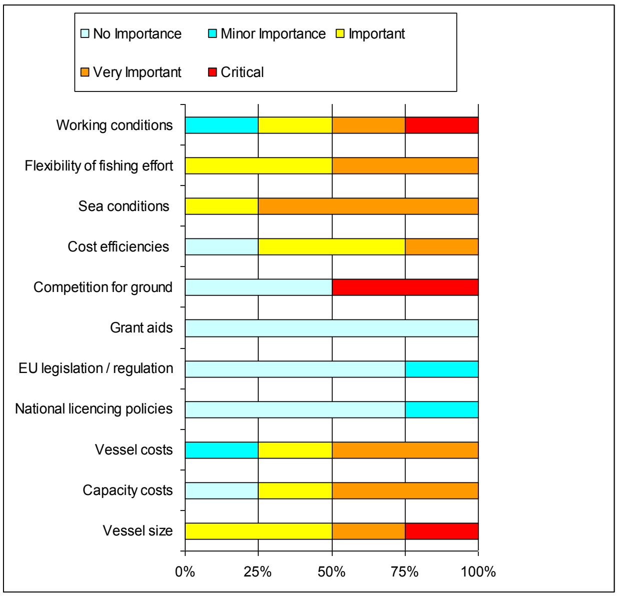



**Figure 38. Responses to question "What influenced your choice of vessel?" by English vessels**

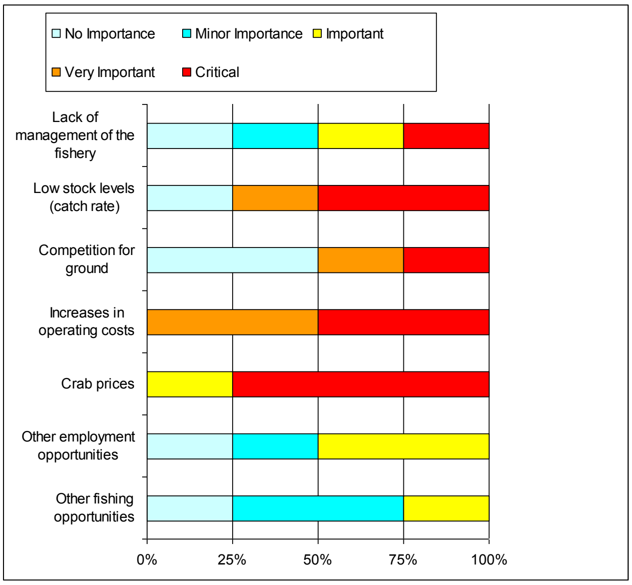



**Figure 39. Responses to question "What circumstances would influence you to leave the fishery?"by English vessels**

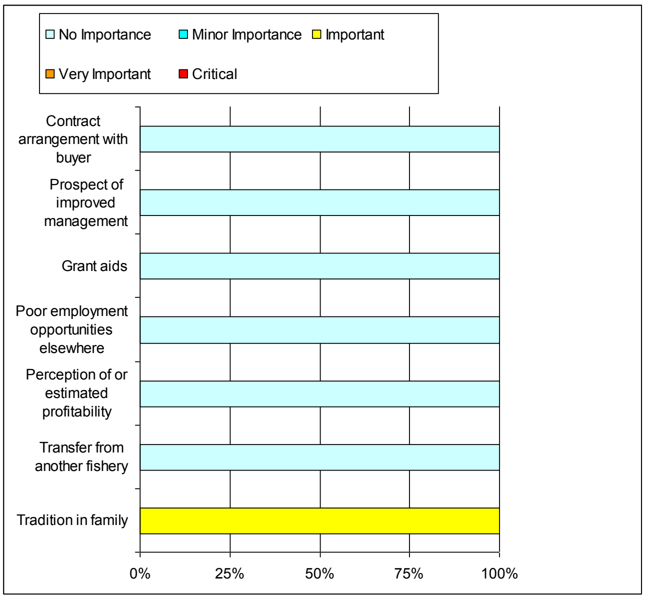



**Figure 40. Responses to question "What influenced your decision to enter the fishery (if less than 5 years in the fishery)?" by English vessels**

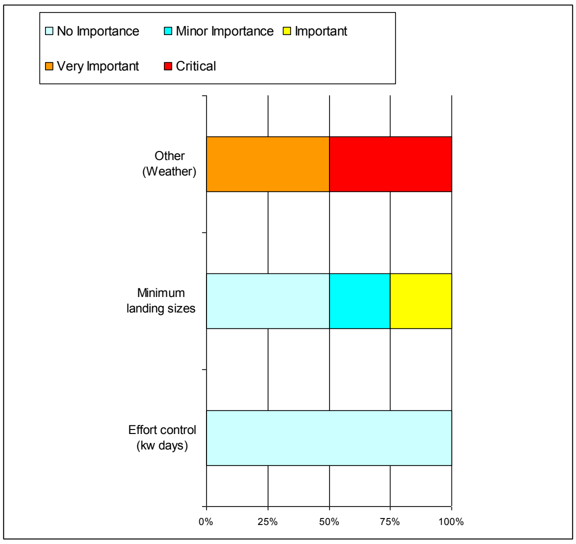



**Figure 41. Responses to question "What influenced your decision to enter the fishery (if less than 5 years in the fishery)?" by English vessels**

#### 2.4.1.6.3 Scotland

*Question 1. Vessel profile and activity*

Seventeen skippers/owners from the Scottish fleet were interviewed for the project. Thirteen of these were <15m in length and four were >15m. The vessel profile and activity of interviewees, based on responses to Question 1, is shown in Fig. 42. Responses to Questions 2 to 6, with rankings where appropriate, are summarised in Figs. 43-47. Other responses and explanatory comments are summarised below.

*Question 2. Did management measures affect your vessels activity in 2007-08?*

None of the Scottish skippers in the 15m and above vessel category indicated that their fishing activity was directly affected by management measures (Fig. 43). Three commented on the indirect effects of KW days regulation, which caps international fishing which had resulted in increased competition for fishing offshore grounds to the north and west of Scotland because of new activity in this area by Irish vessels. It was evident from their responses, that this competition has caused a certain amount of unease between the two fleets in recent years, particularly in the "Windsock" where trawling is prohibited. Of the smaller vessels, one skipper identified Minimum Landings Size (MLS) as a factor that sometimes affected the activity of the vessel - this in the context that he had to fish more to land the same volume.

Overall, most fishermen indicated that the Scottish fishery was influenced more by the market than by management measures. Several commented that the lack of management measures (any control on the quantities of crab landed) was affecting them adversely. This comment related to the general problem of oversupply to the market and to the experience of inshore fishermen whose catch rates were affected by larger vessels periodically fishing on their grounds.

*Question 3. What other factors have affected the activity of your vessel in 2007-08?*

Responses differed between skippers of large and small vessels regarding factors affecting fishing activity in 2007-2008 (Fig. 44). For the small vessels, weather was by far the most important factor, followed by competition for ground and other fishing opportunities. Competition for ground was mainly related to other gears, (*Nephrops* trawling and scallop dredging) at certain times of the year. That other fishing opportunity ranked so highly, reflects the versatility of this segment of the fleet with many of the smaller vessels targeting other species over the course of the year. Fishing patterns were area and season specific. For example, weather precludes fishing west of the Hebrides in winter, whereas in the summer vessels target (high value) lobster in the area, with a by catch of brown crab. Around September or October many vessels shift their focus to east of the Hebrides, with brown crab as the main target species.

Market price was reported as affecting the activity of 50% of the respondents, ranked from seldom to very often. Many skippers said that in 2008 they did not target brown crab as much as they would normally do, because of the poor market prices. For the large vessels, the market price was the highest ranked factor, followed by weather and the seasonality of their cost to earnings ratio. These factors were followed closely by catch rates and seasonality in quality, both of which directly affects the cost to earnings ratio. It was evident that 2008 was a particularly difficult year for the brown crab industry, with very low prices and supply exceeding demand to a degree that some vessels could not sell their catch or ended up selling their landings for whelk bait.

The two lowest ranked factors were other occupation of the skipper and other non-fishing opportunity for the vessel. This applied equally to large and small vessels.

*Question 4. What influenced your choice of vessel?*

Factors influencing the choice of vessel were similar for both small and large vessels (Fig. 45). Sea conditions, vessel size, working conditions and vessel costs were ranked as most important, followed by cost efficiency and flexibility of fishing effort.

Vessels which could work rougher weather and return quickly to safety if necessary were favoured. Vessel size was a factor here as was vessel type (eg shallow bottom vessels suitable for shallow tidal harbours, catamarans for increased stability) and construction - wood versus fibreglass. A faster vessel allowed more time on the fishing grounds regardless of whether they worked inshore or offshore and many skippers said they had bought the biggest and best they could afford. Most had been purchased before fuel prices increased, so running costs had not influenced vessel choice in a major way.

Vessel size was also important in terms of licensing. There are differences in systems for under 10 m vessels targeting whitefish and some had chosen a smaller vessel to keep their options open.

Competition for ground, EU legislation and grant aids were considered less important by both groups overall. None of the skippers interviewed had received a grant towards the cost of a vessel and the question promoted a laugh from most.

*Question 5. What circumstances would influence you to leave the fishery?*

The factors most likely to influence fishermen in both vessel categories to leave the fishery were (falling) crab prices, increases in operating costs and declining catch rates (Fig. 46).

These three factors directly affect the profit margin of the vessel and have to be balanced to run a successful business.

Other employment opportunities were ranked of least importance by skippers in both vessel categories. Competition for fishing ground was ranked very important or critical by fishermen directly affected by this, but overall was not ranked very highly. Competition for ground did not appear to be an issue amongst local creel vessels: people knew where others in the area usually fish and respected this. Problems arose mainly when new vessels without "track record" arrive in an area. This included larger nomadic viviers, a particular problem for inshore areas around the Hebrides and offshore in the Windsock area), and local fishermen who have upgraded to larger vessels and worked more gear than they did previously.

The lack of effective management of the fishery was of concern to most fishermen in both categories.

*Question 6. What influenced your decision to enter the fishery? (if in the fishery less than 10 years)*

Only three of the fishermen interviewed had entered the fishery in the last 10 years (Fig. 47). All were skippers of small vessel (under 10m) and all came from families with a background in crab fishing, a factor which had influenced their decision to some extent. Two had worked in the whitefish fleet but moved to the brown crab fishery with a view to spending more time onshore with their families. One had been influenced by the assurance of the presence of a market for his crab catch.

*Question 7. Can you describe changes in practice in the crab fishery over the past 30 years?*

*Perspectives of owners of vessels 15m and above:*
Interviewees recalled developments in the brown crab fishery in Scotland. In the 1980s there was no live market for crab and the most fishing took place between Easter and October. Most vessels were engaged in a mixed fishery, dependent on season and location. Typically, brown crab was a by-catch in the lobster fishery. The vessels were wooden and the catch was kept in dry holds or on deck in bins or boxes. The 1990s saw the arrival of vivier trucks, capable of transporting the catch live and a year round, targeted brown crab fishery developed. Steel vessels became more common, capacity (KW and GRT) increased and vessels started exploring fishing grounds further offshore. Daily steaming distances increased and working hours were longer.

With the development of vivier fishing vessels the offshore grounds were truly opened up. Vivier crabbers could stay on the fishing grounds for up to a week, keeping the catch alive in the hold. In addition, freezer capacity meant that there was no longer a need to return to port to obtain bait. Steaming time decreased, but the ability to haul more gear on a daily basis meant that working hours were the same for most or longer for some. Bait bags which replaced the bait string in the 80s allowed for longer soak times and the type of pot used to catch crab changed in the early 90s from top entrance type with hard entrance "eyes" to soft eyes and side entrance. The type of bait also changed, from salted bait used when targeting lobster to fresh or frozen fish which is considered the best bait to use for brown crab.

Other technological advances were identified, including the introduction of rollers in the late 1990s which made hauling faster and less heavy going. This, and automatic shooting of gear significantly increased the number of pots which could be deployed and hauled in a day. For example, in the 80s a vessel would be fishing 400 to 500 pots which, weather permitting, were lifted daily. Nowadays, larger vessels work between 3,000 and 4,000 pots rotating them in two or three sets, lifting between 1,000 and 1,200 pots each day. The increase in soak time, and the practice of soaking for two to three days was also seen as a factor increasing effort. Fishers recognised that their landings have increased over the years as have fishing capacity and effort. The majority of respondents indicated that catch rates were lower now compared to 90s.

Most vivier vessels fishing in offshore areas focus almost exclusively on brown crab as lobster is not abundant in those areas. However some still seasonally target other species (such as lobster) in more remote inshore areas, offshore pinnacles, reefs and islands at certain times of the year.

Some of the fishers interviewed commented on the quality of the catch and the times of year at which they caught soft or recently moulted crab. They recalled a distinct season for moulting but commented that nowadays they caught soft crab all year round, albeit in varying amounts. Others commented that the time of year that crab catch rates start to increase seems to have shifted to later each year.

*Perspective of owners of vessels under 15m*

The inshore fishery remains mainly the preserve of small vessels under 10m in length which land the catch daily either directly to a buyer or to ‘keep creels’ for later sale. The main changes identified by skippers related to onboard equipment and engine power. Automatic shooting and rollers, which were introduced in the 90s, increased the number of fleets it was feasible to set and haul during a working day. Gradually more and more gear was used and although working hours increased, fewer people were required and many smaller vessels now operate with only one or two fishermen instead of three.

The soak time has also changed from one to two or three days and it is common for vessels to work several sets of gear on alternating days. Some target brown crab exclusively but more often they fish for a mixture of species including velvet crab, lobster, crayfish and *Nephrops* depending on season and location. The exposed west coast grounds are fished in summer months, when the weather allows it, and fishing moves to the more sheltered east coast in winter. Decisions to target different species are based on availability, price, licensing and quota (for quota species), weather and location.

Although many smaller vessels are diverse in their fishing compared to the large vessels, legislation and licensing mean that some traditional ‘side line’ fisheries are no longer pursued. These include netting for dogfish and skate, hand line for herring and mackerel and dredging for scallops.

Overall, skippers perceive that the amount of crab landed per day has not changed dramatically over the last 30 years but the fishing effort has increased. With prices similar to those of 20 years ago and higher operating costs it is much harder making money from brown crab fishing than it used be.

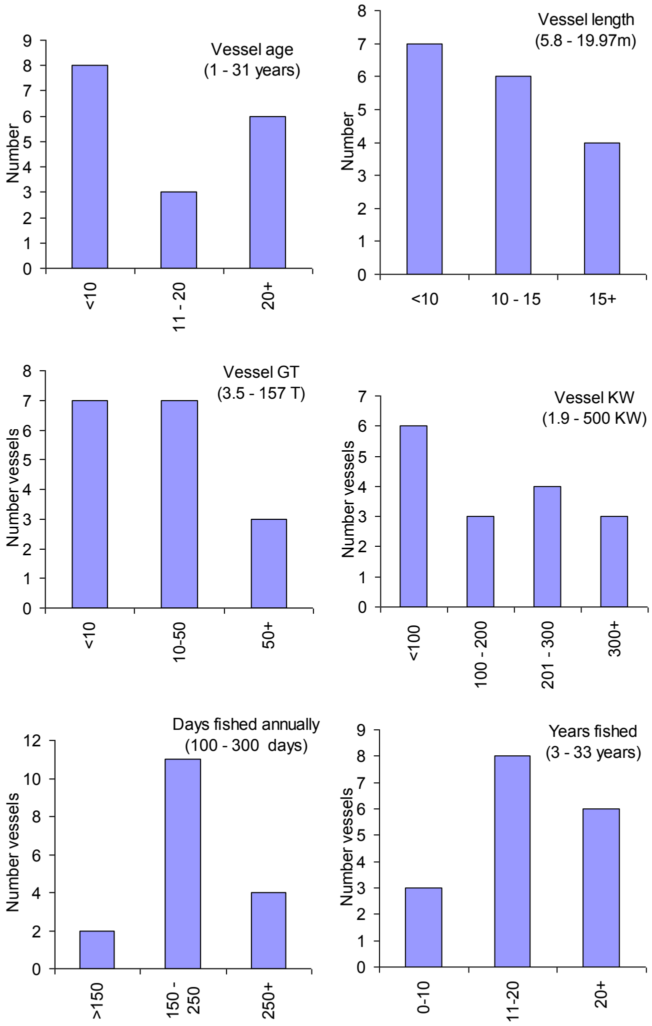



**Figure 42. Profile of vessels and skippers from questionnaires**

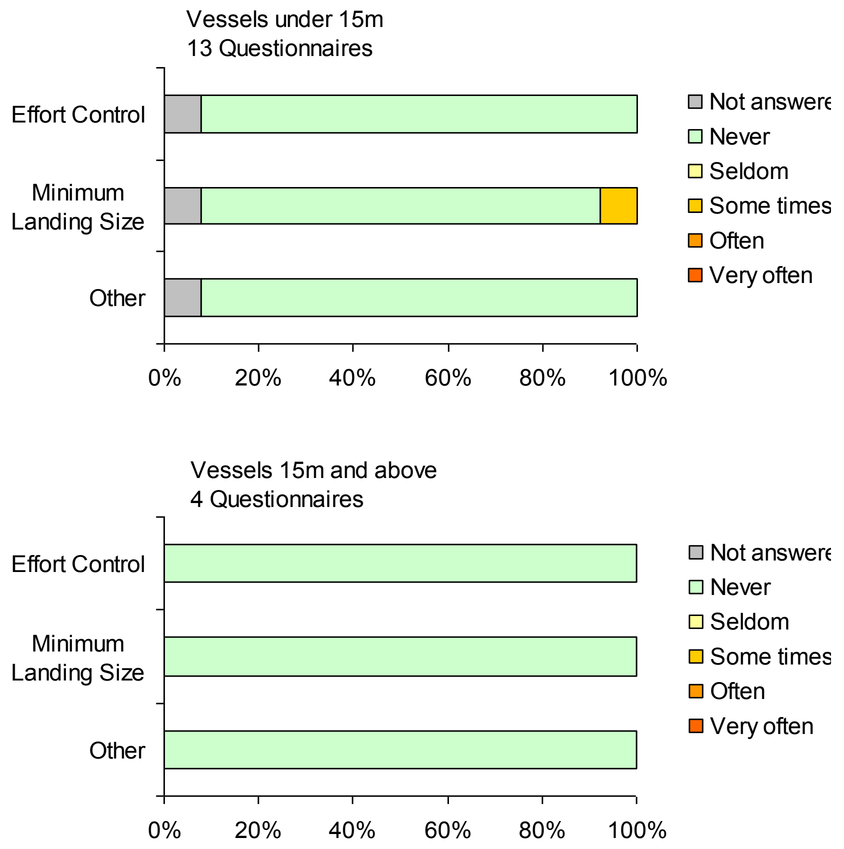



**Figure 43. Responses to question 2 in the questionnaire survey: Did management measures affect your vessels activity in 2007-08?**

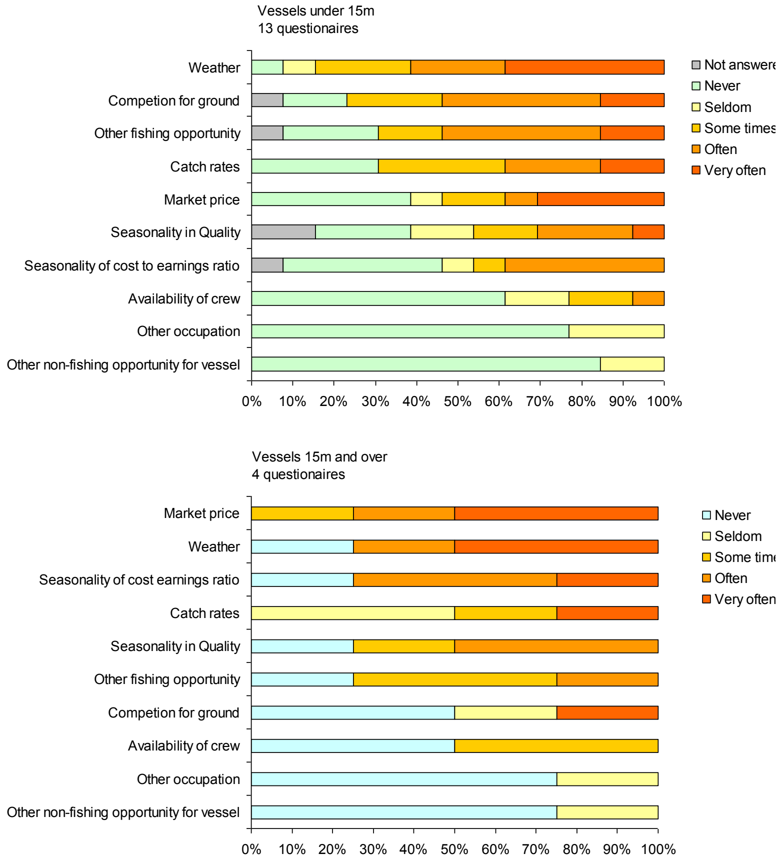



**Figure 44. Responses to question 3 in the questionnaire survey: What other factors have affected the activity of your vessel in 2007-08? Factors have been sorted within vessel category to reflect ranking with highest ranked factors highest on the list.**

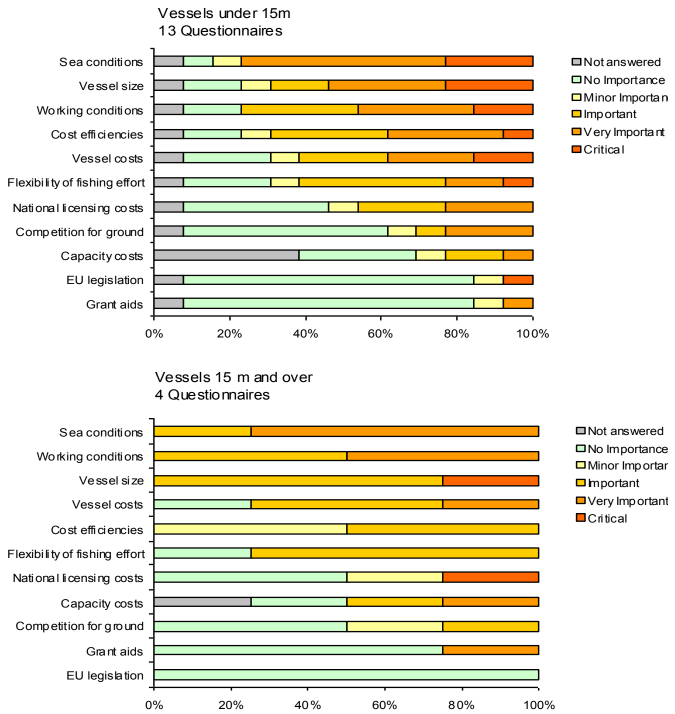



**Figure45. Responses to question 4 in the questionnaire survey: What influenced your choice of vessel? Factors have been sorted within vessel category to reflect ranking with highest ranked factors highest on the list.**

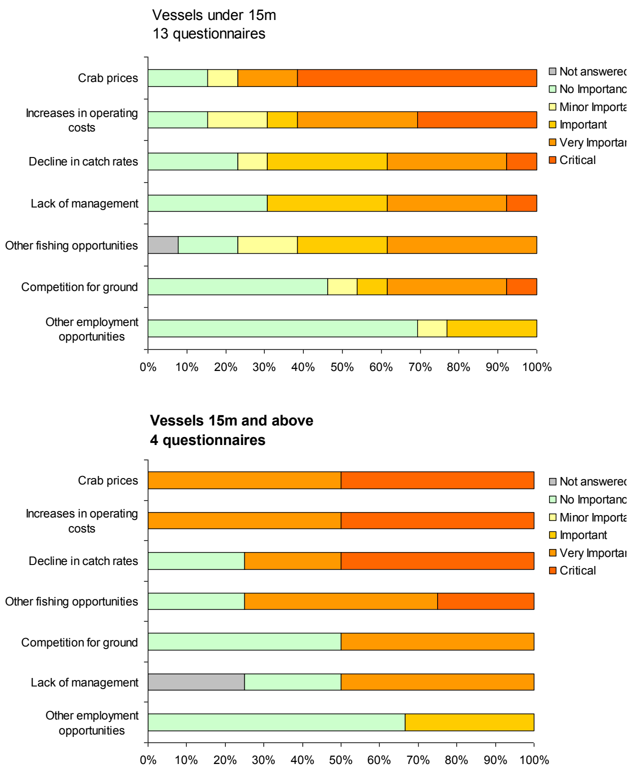



**Figure 46. Responses to question 5 in the questionnaire survey: What circumstances would influence you to leave the fishery? Factors have been sorted within vessel category to reflect ranking with highest ranked factors highest on the list.**

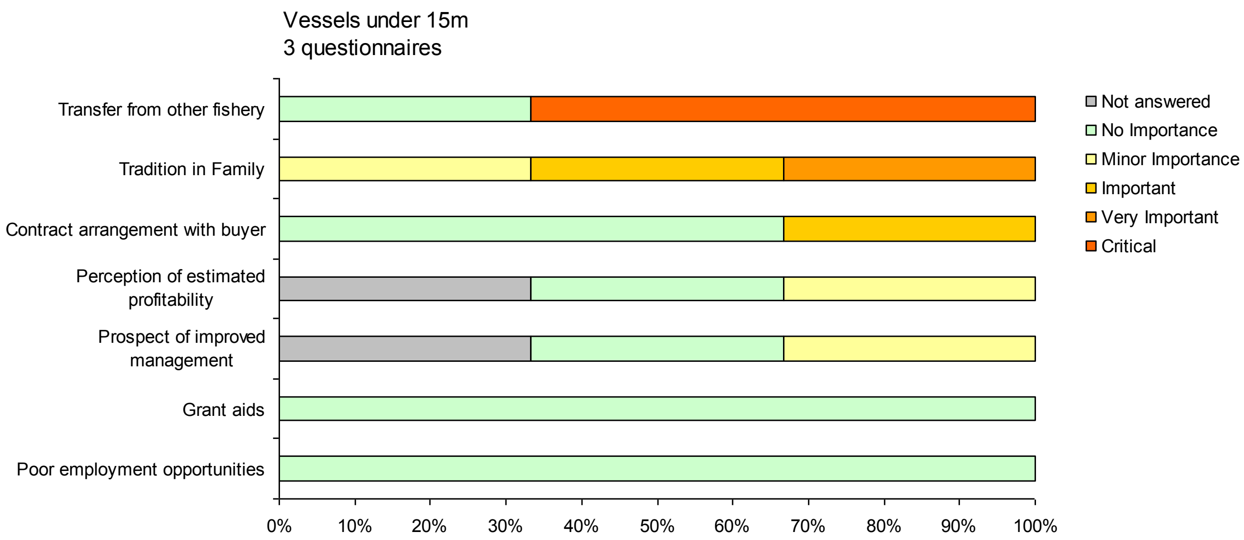



**Figure 47. Responses to question 6 in the questionnaire survey: What influenced your decision to enter the fishery? (if in the fishery less than 10 years). Factors have been sorted to reflect ranking with highest ranked factors highest on the list.**

#### 2.4.1.6.4 France

The important element is the fact that the skipper of the offshore potters with vivier are very involved in this fishery. In fact, the brown crab is the only species they target. On the 8 responses to the questionnaire, 6 vessels are offshore potters. The 2 others are potter vessels with one-day trips. The general evolution for 30 years (Text table below) indicate that daily and the trip effort have increased by vessels. But in the same time, the number of potters has decreased. The second point is the technological improvement with the GPS development of various navigation products.

**Change in effort and profitability in the French north west crab fishery between the 1980s and 2009**

| VARIABLE | 2009 VALUE / 1980S VALUE. VALUES > 1 INDICATE INCREASE |
|---|---|
| Fishing location | 1 |
| Distance from shore | 1 |
| Steaming distances | 1 |
| Daily working hours | 1,28 |
| Duration (months) of fishing season | 1 |
| Daily pot hauls | 1,35 |
| Soak times used | 1 |
| Bait used | 1 |
| GPS plotter installed | 2 |
| Crew size | 1 |
| Pot entrance type | 1 |
| Pot size | 1 |
| Pot Weight | 1,3 |
| Trip duration | 1,21 |

Among the elements that have influenced the activity of the potter during the period 2007-2008, we find general reasons, the weather conditions, the quality of crab at the beginning at the season, price market and a new preoccupation, the availability of crew (Figure 48).

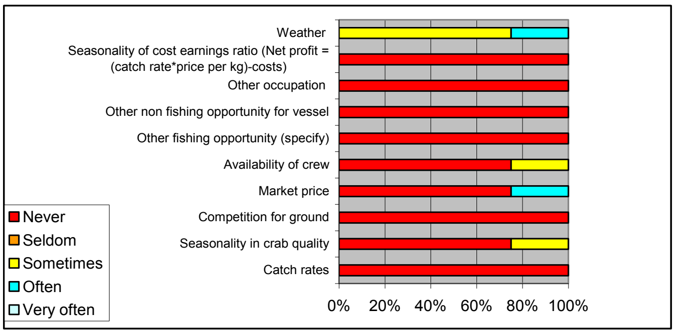



**Figure 48 Response of French crab fishermen to the question "What factors affected the activity of your vessel in 2007-2008?".**

The choice of the vessel is linked to the work they must to do in board and the sea condition in the area where they fish (Figure 49). In parallel, the vessel costs are really important in order to have a good profitability. For few years, the working conditions are considered as important and several vessels have been improved with automatic system to move pot. It is an element to keep a stable crew. In the 2009 context, the main element that will influence skipper to leave the fishery is the market price (Figure 50). We can really synthesis the preoccupation of this fishery by the market price today.

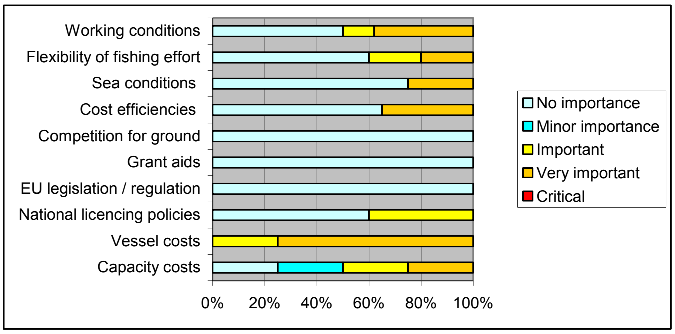



**Figure 49. Response of French crab fishermen to the question "What influenced your choice of vessel?"**

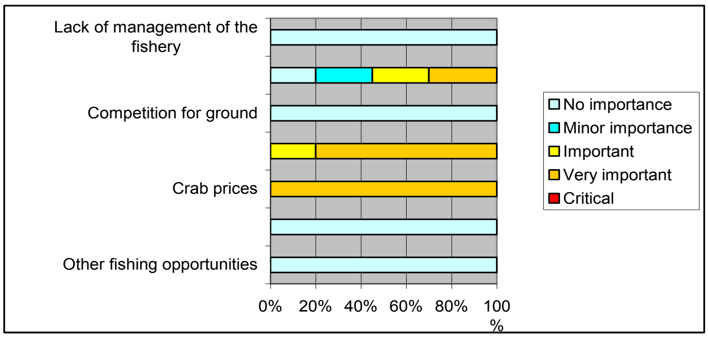



**Figure 50. Response of French crab fishermen to the question "What circumstances would influence you to leave the fishery?"**

Among the elements that influence the catch rate, the seasonality is the first following by the fishing ground and the sea condition (Figure 51). In autumn 2009, during one month it was impossible to fish due to weather condition.

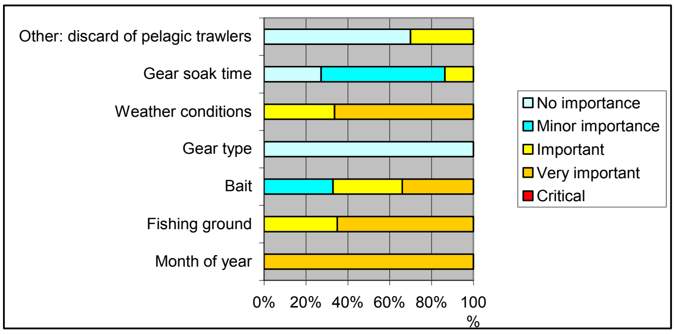



**Figure 51. Response of French crab fishermen to the question What factors do you think affect your catch rate ?**

### 2.4.2 Self-sampling of biological characteristics of crab

#### 2.4.2.1 Ireland

Biological sampling of the catch was provided by 5 Irish inshore vessels working off Malin Head in Co. Donegal. Fishing in 2009 was seasonal because of poor market conditions so fishing activity was more restricted than expected. Monthly samples were obtained in 11 of 12 months during 2009. Total monthly sample size varied from 14-211 crabs and 5 to 88 lobsters. The average sample size provided by each vessel varied from 35-49 crabs and 11-22 lobsters (Table 16)

**Table 16. Numbers of crabs and lobsters measured per vessel per month during 2009 for Irish inshore vessels.**

| Crab | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total | Average |
| 1 | | | | | | 38 | 20 | 53 | 32 | 54 | 33 | 14 | 244 | 35 |
| 2 | | | | | | | 67 | 36 | 36 | | 36 | | 175 | 44 |
| 3 | | 36 | 17 | 39 | 46 | 24 | 48 | 107 | | | | | 317 | 45 |
| 4 | | | | | | | | 15 | 55 | 81 | 45 | | 196 | 49 |
| 5 | | | | | | | | | | | | | | |
| Total | | 36 | 17 | 39 | 46 | 62 | 135 | 211 | 123 | 135 | 114 | 14 | 932 | 85 |
| Lobster | | | | | | | | | | | | | | |
| Vessel | J | F | M | A | M | J | J | A | S | O | N | D | Total | Average |
| 2 | | | | | | | | | 18 | 18 | | | 36 | 18 |
| 3 | | | | 18 | 5 | 14 | 8 | | | | | | 45 | 11 |
| 5 | 8 | 9 | 5 | 17 | 32 | 74 | 13 | 22 | 21 | | | | 201 | 22 |
| Total | 8 | 9 | 5 | 35 | 37 | 88 | 21 | 22 | 39 | 18 | | | 282 | 28 |

Carapace width of crabs caught was higher for female (n= 488) than male (n=305) with a mode at 150mm in the case of females and 100mm for males (Fig. 52). Vessels did not report whether the crabs were discarded or landed as these measurements were taken outside of 'normal' fishing operations, usually on steaming home to port. The actual reasons for discarding under commercial conditions were not provided. The modal size for female crab, which accounts for the majority of the catch, is similar to that obtained from port sampling of the landings.

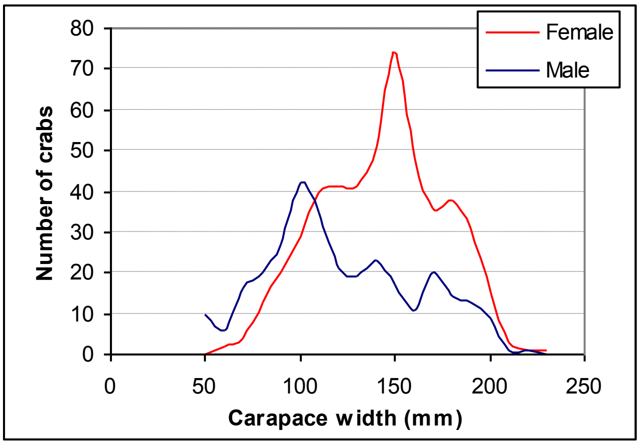



**Figure 52. Carapace width distributions of male and female crab catch from data provided by vessel operators on Irish inshore potting vessels**

The size composition of lobsters ranged from 70mm to 130mm which corresponds to reported size range previously reported by scientific observers (Fig. 53). The sex of a proportion of lobsters was not reported. These were smaller than reported male and female sizes.

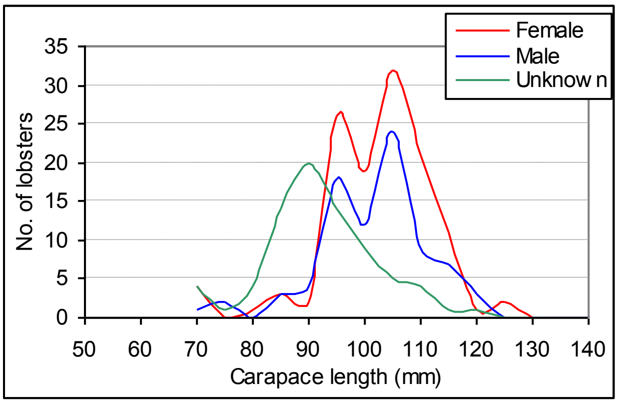



**Figure 53 Carapace length distributions of male and female lobster catch from data provided by vessel operators on Irish inshore potting vessels**

#### 2.4.2.2 England

Although one of the volunteers had hoped to carry out the discard and catch sampling and indeed on one occasion attempted to measure some crabs he was unable to find the time in his busy schedule. As such there was no discard or catch sampling undertaken for this project

#### 2.4.2.3 Scotland

Participants provided 17 discard samples and 14 measured samples over the data collection period (Table 17-Table 19), providing reasonable coverage of grounds around the Hebrides (Fig. 54). Only vessel 2 sampled catches regularly and accounted for half of the data provided. Of the other vessels, one did not do any sampling and three sampled periodically. Vessel 4 collected 10 samples over a one week period. A disproportionate amount of sampling was carried out in June (14 of a total of 31 samples). This was largely due to the presence of a crew member keen to help with the sampling on board one of the vessels over this period.

Overall, the number of crab sampled for discard information (946 crabs) fell short of the 4,500 crabs anticipated assuming that all vessels had adhered to the regime of one sample of 100 discarded crabs per month over the sampling period. The total number of crabs measured, 2163 crabs was closer to the 3,000 anticipated. This was mainly due to two vessels that collected more than the expected number of samples. The average number of crabs measured in each sample, 155, fell short of the 200 expected.

On the basis of average values, most discards were undersized (40%) followed by soft (26%), diseased (22%) and crippled crab (12%) (Fig. 55). The ‘undersized’ category refers to crab deemed too small for the market, which is not necessarily the same as below the Minimum Landing Size (MLS) of 140mm. The proportion of crab in each discard category however varied widely amongst samples. This may relate to the area from which the samples were obtained – a higher proportion of discards were of undersize crab in samples from the east of the Isle of Lewis (Hebrides) - or the time of year.

Females made up between 69 and 99% of the landed crab (by weight) and between 61 and 88% (average 78%) of the discards (Fig. 56).

Crab body size ranged from 80 to 220 mm CL (Fig. 57). Most landed females were between 160 and 180 mm CL whilst males tended to be smaller, in the 150 to 175 mm size range. In the majority of samples females predominated in both the landed and discarded components of the catch. The length distributions of the landed component of the catch are similar to those obtained on MSS market sampling trips.

Samples 2, 3, 4 and 30 were from inshore grounds east of Isle of Lewis. Relative to other samples, these had more males in the landed component and a higher proportion of the catch consisted of smaller (discarded) animals. Unfortunately, no data were provided on discards from samples 3 and 4. Sample 11 also had a relatively large proportion of smaller discarded crabs but was otherwise similar to the other samples from more offshore west coast areas.

**Table 17. Number of discard samples, number of crabs sampled and the average number of crabs in each sample. At the bottom of the table is the number of samples and crabs sampled that would have been expected according to the proposed sampling regime of 100 crabs every month during the period of sampling (March to November 2009).**

| DISCARD | Number of samples per vessel | Total number of crabs Sampled per vessel | Average number of crabs per sample |
|---|---|---|---|
| Vessel 1 | 2 | 155 | 78 |
| Vessel 2 | 9 | 417 | 46 |
| Vessel 3 | 1 | 57 | 57 |
| Vessel 4 | 5 | 317 | 63 |
| Vessel 5 | 0 | 0 | 0 |
| All vessels combined | 17 | 946 | 56 |
| Expected per vessel | 9 | 900 | 100 |
| Expected total | 45 | 4500 | 100 |

**Table 18. Number of measured samples collected by each vessel as well as the number of crabs sampled and the average number of crabs in each sample. At the bottom of the table is the number of samples and crabs sampled that would have been expected according to the proposed sampling regime of 200 crabs every 3 months during the period of sampling (March to November 2009).**

| MEASURED | Number of samples per vessel | Total number of crabs sampled per vessel | Average number of crabs per sample |
|---|---|---|---|
| Vessel 1 | 2 | 215 | 108 |
| Vessel 2 | 6 | 1066 | 178 |
| Vessel 3 | 1 | 221 | 221 |
| Vessel 4 | 5 | 661 | 132 |
| Vessel 5 | 0 | 0 | 0 |
| All vessels combined | 14 | 2163 | 155 |
| Expected per vessel | 3 | 600 | 200 |
| Expected total | 15 | 3000 | 200 |

**Table 19. Temporal coverage of sampling effort.**

| Month | Number of samples | Total number of crabs |
|---|---|---|
| April | 7 | 727 |
| May | 2 | 278 |
| June | 14 | 1076 |
| July | 2 | 224 |
| August | 2 | 243 |
| September | 2 | 280 |
| October | 2 | 255 |

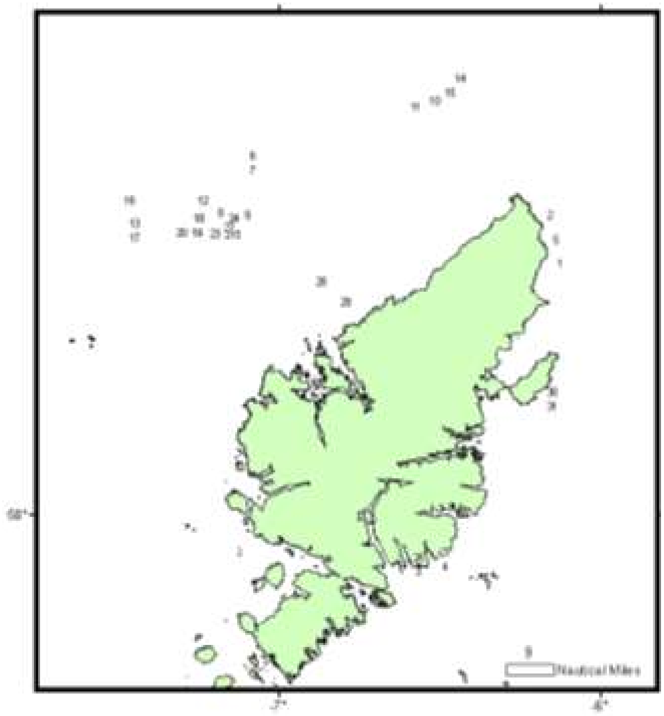


**Figure. 54 Location of all samples of crab provided by Scottish vessels**

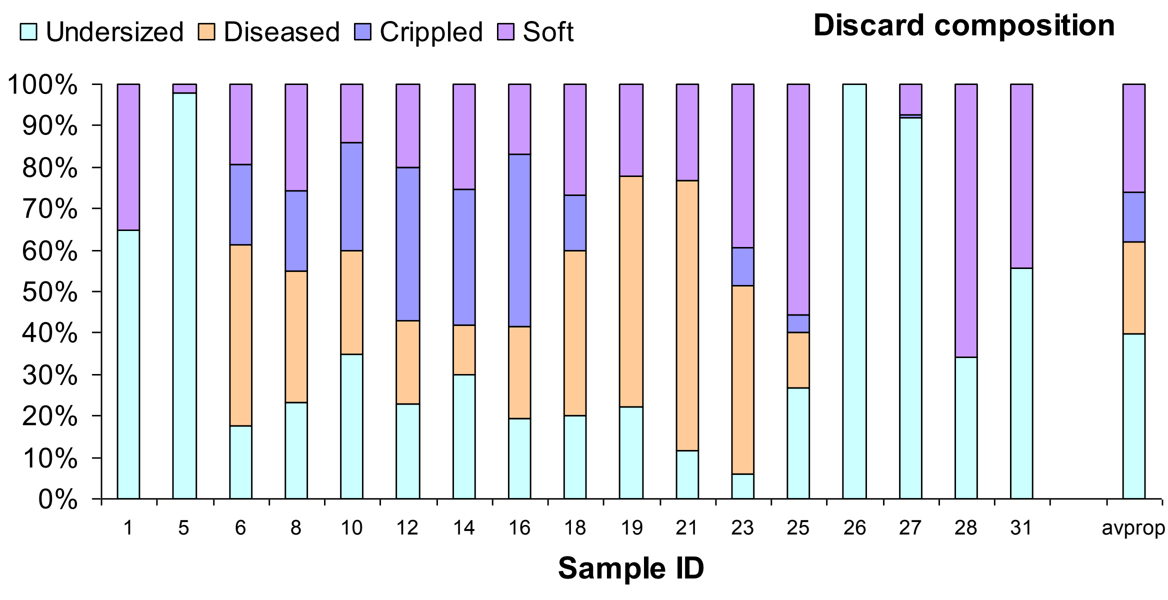



**Figure 55. The proportion of crab in each discard category in each sample of discarded crab provided by participating Scottish vessels. The average composition of all discard samples is shown in column on far right. . The number of crabs in each sample ranges from 11 to 135 (See Table 17 for number of crabs in each sample).**

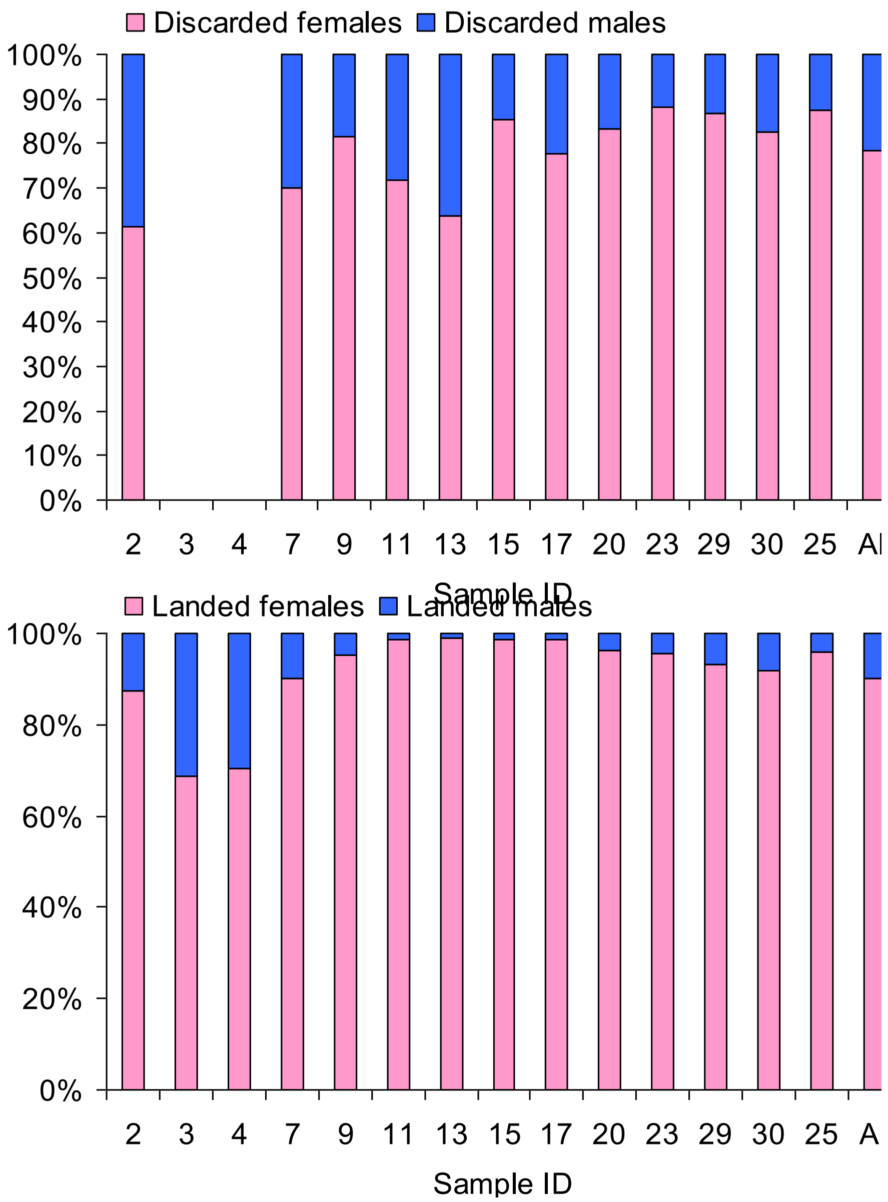



**Figure 56. Proportion of males and females in the discarded (top) and landed (bottom) component of the measured samples (by number).**

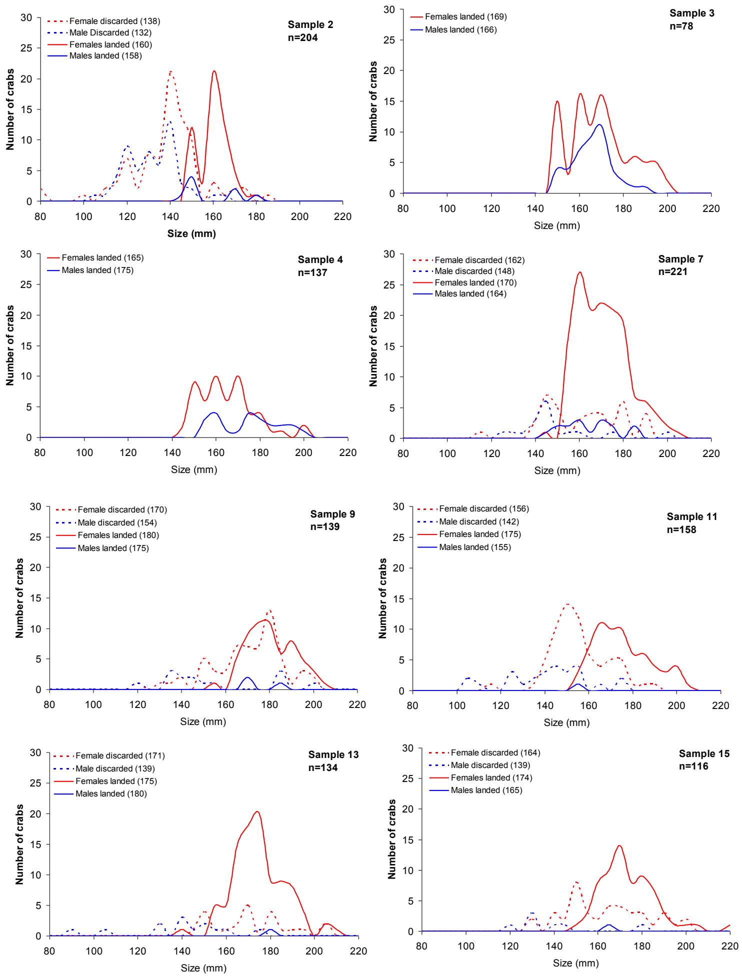



**Figure 57. The length composition of landed (solid line) and discarded (dotted line), female (red) and male (blue) crab in the samples measured by participating vessels. Sample number and the total number of crabs measured in each sample are also shown. Discarded animals were not measured for samples 3 and 4 (continues)**

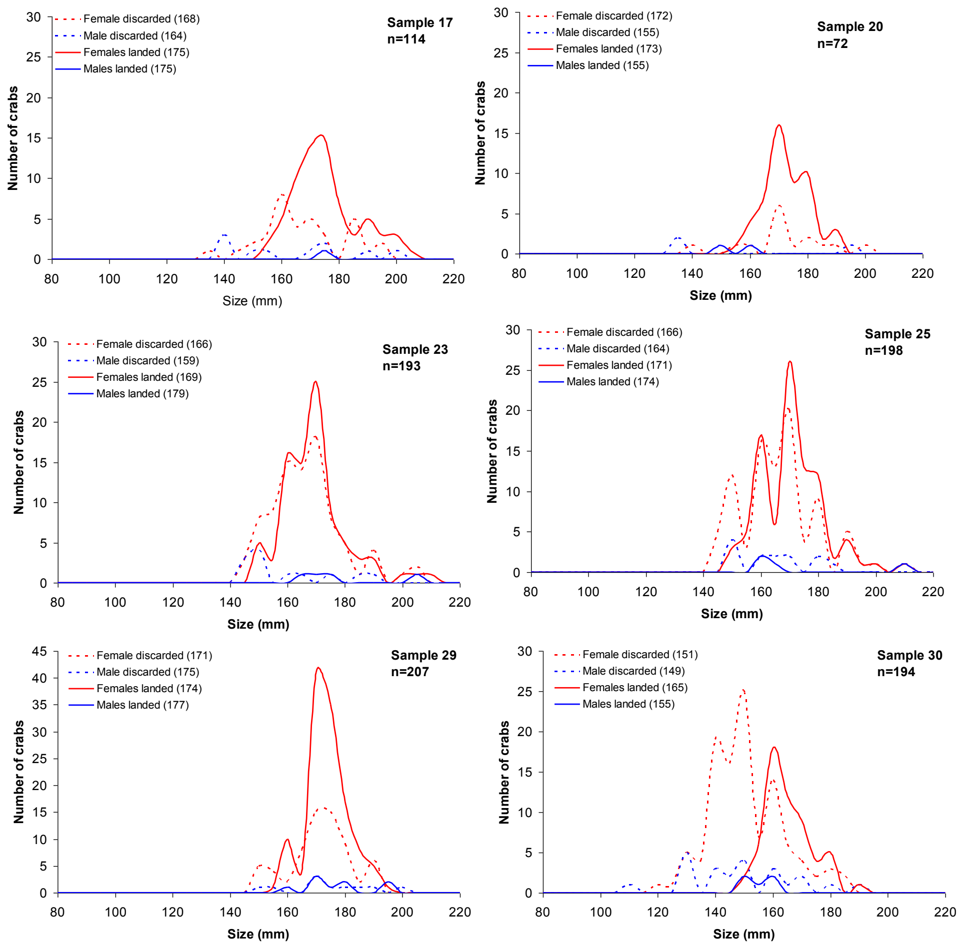



**Figure 58. The length composition of landed (solid line) and discarded (dotted line), female (red) and male (blue) crab in the samples measured by participating vessels. Sample number and the total number of crabs measured in each sample are also shown.**

#### 2.4.2.4 France

From offshore potters, two self-sampling events were realised during June 2009, one in the North Bay of Biscay and one in the Western Channel ((Fig. 59). The first observation is the low number of male in the catches (8 % and 18%). The structure is a little different between the 2 areas. These 2 observations confirm what we obtained from port sampling of the landings.

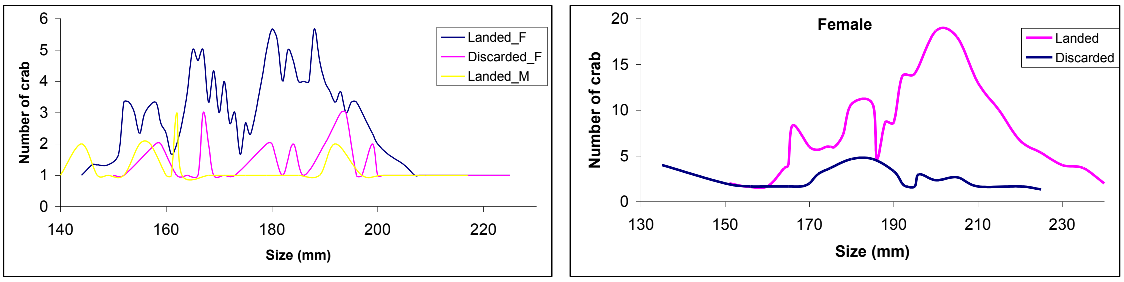



**Figure 59. Size structure of crab from French self sampling in Western Channel. (n=268 for 100 pots). right, Size structure from self sampling in North Bay of Biscay. (n=288 for 120 pots).**

For the females, the percentage of discard is similar between the 2 areas and we note that a lot of crab are discarded due to claw missing (Table 20). The other important element is the low percentage of crabs under the MLS which is a characteristic of this ground

**Table 20. Composition of discards in western channel and in Biscay.**

| | AREA | % | TOTAL | WHITE | CLAW MISSING | UNDER MLS |
|---|---|---|---|---|---|---|
| Discard_F | W Channel | 0,20 | 45 | 5 | 30 | 0 |
| Discard_M | W Channel | 0,22 | 10 | 5 | 5 | 0 |
| Discard_F | B Biscay | 0,20 | 54 | 13 | 36 | 5 |
| Discard_M | B Biscay | 0,55 | 11 | 3 | 4 | 4 |

In the inshore fishery the size structure is different to that offshore. A lot of crab are below the MLS (Fig. 60).

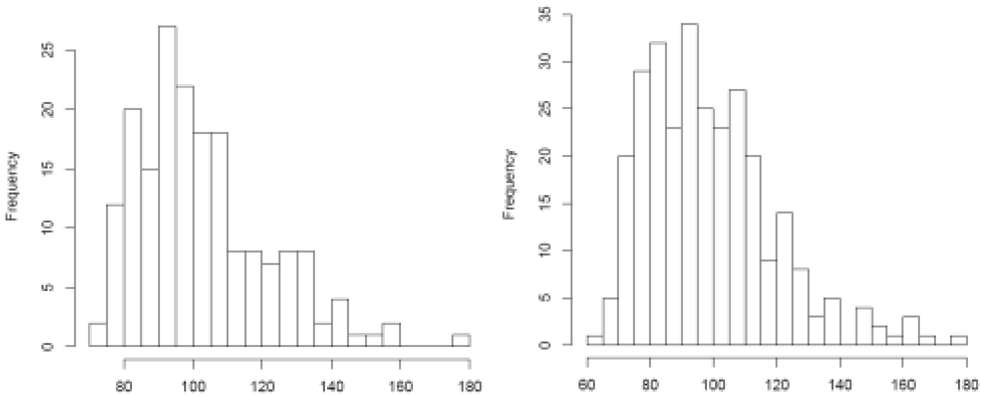



**Figure 60. Size structure of crab from inshore vessels off Fininstere**

### 2.4.3 Feedback on self sampling from vessel operators and scientists

#### 2.4.3.1 Ireland

For the most part participating vessel operators found self sampling difficult. The volume of crab in 10 pots could be high making the task time consuming in an already busy schedule. In some cases the skipper decided to decrease the sample size to 5 instead of 10 pots to cut down on the work. Some vessels who gave good catch and effort data in the voluntary logbooks failed to keep up the self sampling.

Self-sampling requires more training than was given during this project. Sometimes the need for the self sampling and its importance was 'lost in translation' when the task which had been explained to the skipper was subsequently explained by the skipper to whichever crew member got the job. The lobster data is self evident of this, in that when the skipper was filling in the data himself and when he was unsure he rang project personnel to check, so he could even make a correction as he progressed with the task. Where a crew member was doing the recording the situation deteriorated as time went on or a mistake of interpretation at the outset was replicated throughout. A bonus of some type for the individual concerned should be considered.

#### 2.4.3.2 England

Self sampling was not regarded as feasible by vessel operators in the Channel crab fishery

#### 2.4.3.3 Scotland

*Self sampling*

All participants agreed that data collected through the self sampling part of the project were a good reflection of the patterns expected. The self sampling component of the program was positively received, although not all participants had managed to contribute fully to the sampling. All agreed it was a rational way to collect data for use in the assessments, and would like to see it rolled out on a larger scale. The main reasons given for not contributing as much data as planned were they ‘just never got in the habit of doing it’, there was ‘always something else to do’ and ‘having to do measurements gets in the way of fishing’. Most said they would prefer to provide space for a scientist to work alongside the crew and conduct the sampling. Fishermen also commented that if the self-sampling route was pursued, data contributors should be selected carefully to ensure that the data returned was of high quality.

*Fishing positions and catch rates*

The GPS logger data received considerable interest and was perceived by the participants as an easy way for them to contribute highly relevant information. All agreed that that inferring fishing locations from the vessel tracks based on patterns in speed was sensible and that the fishing locations mapped for their vessel gave a very accurate picture of their fishing activity over the study period. They also made suggestions as to why tracks could sometimes be misinterpreted. In rough weather for example, vessels would travel at relatively slow speeds, similar to those associated with hauling, but the speed would be sustained for longer periods. Also if creels were set close together especially inshore, the vessel might not speed up between hauling fleets and the characteristic pattern in vessel speed would be less evident or absent.

Most participants said that the estimated catch rates were within the right range, and that seasonal trends were accurately reflected. One fisherman commented that the fishing locations and catch rates seemed to be accurate, but the effort (estimated number of creels hauled) seemed too low. This could be due to the aforementioned problem with distinguishing individual hauls if the vessel tracking data lacks the pronounced changes in speed.

The accuracy of the inferred fishing locations and catch rates estimated caused some of the participants to request that all results for this pilot study to be presented in aggregated form (so that actual fishing locations remained confidential). Most of the participants indicated, however, that they would have been happy to continue carrying GPS loggers with the proviso that data were only presented in an aggregated form.

#### 2.4.3.4 France

Self sampling of the catch is considered difficult and has to be regarded as a ‘new job’ for one of the crew. A lot of interaction is necessary to get these data. On the other hand vessels are happy to carry technology (GPS and sensors) whish automatically deliver data from the vessel.

## 2.5 Discussion

### 2.5.1 Comparison of data types

This pilot project collected catch, effort and biological data on a crab fishery from a variety of sources and involved varying degrees collaboration between fishermen and scientists. The objective was to assess the feasibility of acquiring and using data from different sources from the fishing industry and from scientists. Although there is currently no agreed framework for assessing crab stocks in the study area, various approaches are applied and it is evident that catch, landings, discards, effort, size composition data and trends in various indicators derived from these statistics are central to assessment of the stocks. Other data related to participation in the fishery, fishing opportunities and economic performance of crab fishing are important in developing policy and to ensure viable and sustainable fisheries. What then are the constraints and possibilities surrounding the collection of good quality catch, effort and biological data in this fishery? Good quality in this context could be regarded as quality assured, high spatial and temporal resolution, inclusive of data elements that can be developed into indicators of stock or fishery status or otherwise used in a quantitative analysis. The costs of acquisition and management of data are also important if such programmes are to be sustainable.

Some properties of data acquired from different sources during this project and the pros and cons of the different approaches are compared in Table 21 . The following conclusions can be drawn:

1. The format of acquiring data in currently mandatory reporting schemes is generally inadequate and different across jurisdictions although these fleets may fish the same stock
    - EU log data do not contain meaningful measures of fishing effort
    - National under 10m effort reporting is either non-existent or has varying spatial and temporal resolutions
2. The format of data reported in voluntary logbooks is flexible and 'fit for purpose'. However the take up of voluntary schemes is generally low. Given that the catch and effort performance of inshore vessels is highly variable, a high take up would be needed to ensure precision and accuracy and that the data was representative of a given geographic area.
3. VMS and GPS type logging of vessel position is useful but limited
    - VMS ping rate is low relative to the duration of fishing events of crab vessels
    - GPS and VMS data have to be integrated with logbook reporting to provide useful indicators of catch per unit effort
    - Data management time is significant and costly
4. Electronic logbooks that integrate the acquisition and transmission of data on fishing position, catch, discards and effort are an effective means of collecting data. Data acquisition costs may be high, but subsequent data management/integration costs are low
5. Private diary data is a valuable source of information and has been shown to provide useful indicators of trends in stock abundance
    a. There may be a significant lag between recording of data by skippers in diaries and sourcing and compiling these data.
6. Self-sampling of biological information by some vessel operators may be feasible in some cases but there are a number of significant constraints
    a. Sample sizes must be reasonable

   b. Contact between scientist and the actual operator who is doing the work is important
   c. The operator may need to be incentivised
   d. Feedback on data and data usage is important
7. Questionnaires provide a flexible and cost effective way of rapidly acquiring various types of 'soft' data
   a. Fisher's memory can be useful in re-constructing the historic time series of trends in the fishery where no hard data exists.
   b. It is easy to standardise the approach across broad geographic regions in different fleets fishing the same stock
   c. Issues relevant to policy and fishery management can be identified and can inform development of policy
8. The objectives costs and sustainability of data collection programmes for fisheries such as crab are important to consider in deciding what approach to take.
9. The assessment and management objectives for data collection needs to be clear.
   a. Vessel owners legitimately ask the question 'Why?' when asked to undertake sampling or to complete questionnaire. The answer has to be very clear and convincing. It can only be so if there is a clear path from collection of data to assessment, management and policy. If fishermen are to collaborate on data collection they cannot be regarded as partners just in the first step and not in subsequent steps that influence the direction of policy and management. In this regard co-management models of management may be more conducive to self-sampling than centralised or top down systems
   b. Feedback on the results of data collection is important if self-sampling and self-reporting is to be sustained.
   c. Ideally the model should be one of 'co-ownership' of data, between fishermen and scientists.
   d. 'Tiredness fatigue' and reduction in participation is a significant issue if data are collected in a vacuum for no clear purpose

**Table 22. Comparison of resolution, capacity to involve fishermen, costs and limitation in the approach to collection of catch, effort and biological data in crab fisheries**

| Data | Use of data | Spatial resolution | Temporal resolution | Involvement of fishermen | Cost of data acquisition | Cost of data management | Limits |
|---|---|---|---|---|---|---|---|
| EU log & other mandatory logbook reporting | Distribution of landings | ICES rectangle >10m LOA, sub-rectangle inshore | Daily >10m LOA, monthly or other frequency <10m | Mandatory >10m LOA, mandatory in some cases <10m | Low | Low | >10m LOA poor effort data, low resolution; <10m poor temporal and spatial resolution |
| Voluntary log | Landings, effort and catch rate index | Variable, per operation or day averaged | Per operation or daily | Take up is low, incentives and management context needed to encourage collective action | Low | Medium | Large reference fleet required as variability in performance between inshore vessels is usually very high |
| Voluntary E-log | Geographically referenced landings, effort and catch rate indicators | Per operation | Per operation | Take up is dependent on the technology, feedback important, has benefits for the vessel | High | Low | Large reference fleet required as variability in performance between inshore vessels is usually very high |
| Private diaries | Geographically referenced landings, effort and catch rate index | Per operation | Per operation | Management context and feedback important, assurance and confidentiality needed | Low | High | Large reference fleet required as variability in performance between inshore vessels is usually very high |
| VMS | Fishing position and effort index | Depends on vessel speed | 2 Hour ping rate | Mandatory >15m LOA | Medium | High | Needs to be combined with catch data (Logbooks) for catch rate indicators |
| GPS | Fishing position (high resolution) | Potentially very high | Can be set | Positive response in this project. Feedback important | Medium | High | Needs to be combined with catch data (Logbooks) for catch rate indicators |
| Questionnaire | Historic trends, drivers of effort, understanding data, management issues | By fishing area | Annual or multi-annual | Positive response in this project. Usually eager to identify and describe issues | Low | Low | Qualitative or at best semi-quantitative time series. Useful in management context |
| Self sampling of catch | Biological indicators, analytical assessment | Per fishing operation sampled | Sample per month | Time and resource constraints, training, incentive | Low | High | May be difficult to achieve sufficient sampling rate or area coverage |
| Scientist sampling of catch | Biological indicators, analytical assessment | Per fishing operation sampled | Sample per month | Deck space, working conditions may be an issue | High | High | Only very low sampling rate is feasible |

## 2.6 Conclusions regarding added value to DCF data collection

The success of the brown crab project in addressing some specific questions posed by the European Commission is considered below:

*What information is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management? What types of information can be collected by the catching sector?*

Gap areas are at both a local and regional seas level in the provision of indicators of fishing effort, catch rate and fishing mortality. There are also significant information gaps at the assessment-management interface in economic data, the relationship between policies and fishing strategies and management preferences within industry.

The case study has demonstrated that the catching sector can collect and provide various types of biological, fishery performance and economic data and information on management preferences. Furthermore these data can be of very high spatial and temporal resolution in cases where it is generally not feasible to collect such data using ‘normal’ approaches. Given that there is significant spatial and temporal variability in the fishery performance and biological data high resolution coverage is necessary to provide sufficient precision and accuracy. Data from interviews can be used to reconstruct the historic profile and trends in a fishery where no hard data exists. These ‘softer data’ have been shown to correspond well to the trends which are known have occurred in a number of fisheries. It seems that it may not be feasible to collect significant volumes of data on size structure of the catch on small inshore vessels with limited workspace carrying small crew and that is time consuming to collect.

*Merging and standardising data at regional level*

At a regional seas level, corresponding to stock distribution, the case study has shown that the various institutes can easily develop a standardised approach to the collection of data. The characteristics of the fishing operation and fishing behaviour of crab fleets at a regional level are similar and facilitate standardising of data. This also extends to interview data as demonstrated in the crab case study. A common, indicator based approach, to data collection and assessment would seem feasible at a regional level based on the shared experiences from the crab case study

*Management drivers for new data*

Management drivers for new data in the crab sector are currently weak. This in itself constrains the development of a standardised approach to data collection and merging and also to the development of self-sampling programmes at a regional level. Management drivers in the future in the crab fishery are likely to the related to effort and/or catch control. These issues are currently being discussed by industry representative organisations and national administrations. The case study has also demonstrated that management preferences within industry can be collected and quantified using questionnaire techniques. Biological and economic indicators will be needed to inform development of such management initiatives. This project has shown that, on a pilot scale, industry can provide these data even if the relevance of such data to industry is 'academic' given that such data are not currently being used in the management context. Stronger management, supported by industry, would establish the conditions under which larger scale self-sampling programmes could be developed. Scientific efforts could then concentrate on facilitating and validating the self-sampling process rather than on generating separate data using the normal routes.

*"Added value" provided to the recurrent data collection under the EU Data Collection Framework*

Data requirements of the DCF are unlikely to satisfy assessment requirements of species such as crab where a significant portion of the fleet may be under 10m in length, where catch and effort performance varies spatially and temporally and where the biological characteristics of stocks also varies at regional and local level. The DCF programme for crab does not therefore provide the 'full picture' from which a sufficiently precise and accurate profile of a range of indicators can be developed. The "added value" provided to the DCF of a full scale self-sampling programme, using techniques demonstrated in this pilot study, is in the provision of information necessary for integrated (biological, social, economic, environmental) management of crab stocks and fisheries using a greater diversity and quantity of data.

## 2.7 Recommendations

1. A clear management context is required for self-sampling and self-reporting.
2. The assessment framework or set of indicators needs to be established and agreed with stakeholders prior to self-sampling.
3. If a strong reliance is to be placed on self-sampling and self-reporting frequent communication between fishermen and scientists is required. The scientists must become teachers and facilitators. Integration of fishers in to the assessment process is then the next logical step
4. Strong feedback mechanisms to 'self samplers' is required

# 3 Pilot Project 2: Development of a fishery information report for demersal fisheries in the Celtic Sea and western Channel.

## 3.1 Introduction

### 3.1.1 General background to project

The Celtic Sea (Defined here as ICES Divisions VIIf,g,h & j; Fig. 3.1.1), and the Western Channel (ICES Division VIIe) support a diversity of species and fisheries for demersal fish stocks assessed by the ICES Working Group on the Celtic Seas Ecoregion, the Working Group on Hake, Monk and Megrim and the Working Group on Elasmobranch Fishes. Many of the assessments are of poor quality, and are heavily dependent upon data from commercial fisheries. The fishery data currently collected according to the requirements of the EU Data Collection Framework provide part of the information base for development of stock assessment procedures. However, as the name suggests, this is a framework for collection of basic data and is on its own not always sufficient to develop accurate assessments and management advice without suitable dialogue with fishermen to help interpret the data they have provided. This is particularly the case with time-series data such as fishing effort and landings-per-unit-effort due to the changes over time in vessels, gear, species targeting etc. that may not be fully quantifiable from EU logbook data. The Celtic Sea pilot project largely focused on examples of collaboration to help interpret basic fishery data.

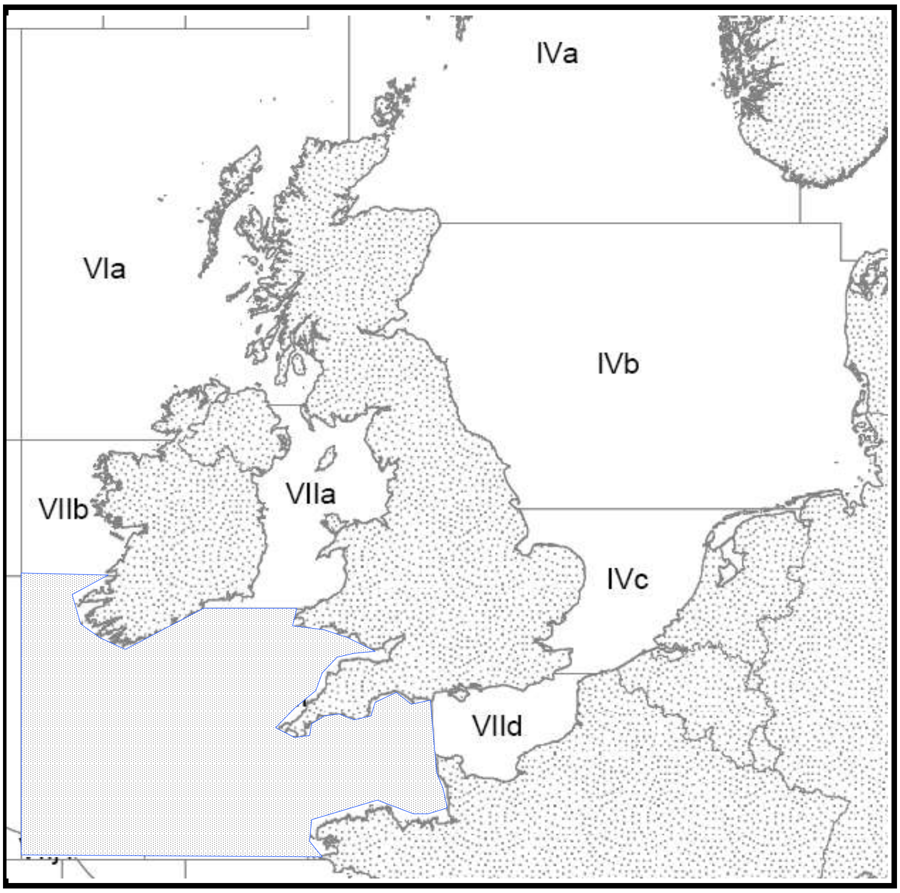



**Fig. 3.1.1**. Celtic Sea (VIIf,g,h&j) and western Channel (VIIe) sea areas covered by the Lot 1 Celtic Sea pilot project report.

The North Western Waters Regional Advisory Council (NWWRAC) has established separate Working Groups for the Celtic Sea and the western Channel. The Working Groups consider aspects of fisheries management in these two areas, for example management of the VIIe-k cod fishery which is currently exempt from the long term cod management plans imposed in other areas around the British Isles. The development of NWWRAC responses to EU proposals, and development of industry-led proposals, requires access to an information base on the activities of international fishing fleets in the area that is not readily available. The Lot 1 Celtic Sea pilot project brings together fishery information for a range of fishing methods, to give examples of how data at a relatively high spatial and temporal resolution could be presented in a readily understandable format.

#### 3.1.2 Data requirements for assessment

The European Commission posed a number of specific questions in reviewing the first draft of this report. These are considered below in the context of the Celtic Sea demersal fisheries, and the success of the project in addressing these is reviewed in section 3.6.

*What information exactly is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?*

As in any other sea area, effective management of the Celtic Sea and Western Channel fisheries requires sufficient, accurate knowledge of trends in abundance and fishing mortality of the stocks, together with accurate information on the nature of the fisheries such as fleet structure and dynamics, fishing practices, and responses to management measures. Current knowledge of the stocks and fleets in the Celtic Sea area is deficient in many aspects, and this impedes both the assessment and management processes. A number of these gaps can be filled through appropriate collaboration between scientists, the fishing sector, and fishery managers.

ICES currently provides scientific advice on stocks of cod, whiting, haddock, plaice, sole, hake, anglerfish, megrim, *Nephrops*, spur-dogfish and other elasmobranchs that have stock ranges that are either confined to the Celtic Sea and western Channel (e.g. VIIe and VIIfg sole and plaice) or cover a larger area (e.g. hake)[1]. Assessments for some other species found in the Celtic Sea and western Channel are in development through ICES WGNEW (e.g. bass and John Dory). The track record for providing scientific assessments and advice for Celtic Sea demersal stocks is relatively poor. Analytical assessments and catch forecasts are available for VIIe and VIIfg sole and plaice, and for hake. There is currently no scientific assessment of VIIe-k cod due to lack of data on high-grading by some fleets in recent years, and a lack of adequate survey data due to low catches of adult cod in existing DCF surveys. The assessments of haddock and whiting are considered suitable only for general trends due in large part to imprecise estimates of discards, whilst only basic fishery and survey trends are provided for area VII&VIII anglerfish and megrim stocks due to deficiencies in fishery data (particularly discards) and uncertainties in ageing.

[1] http://www.ices.dk/advice/icesadvice.asp

The assessments of a number of Celtic Sea and western Channel stocks still rely on commercial fishery landings per unit effort (LPUE) to "tune" the trends in abundance from the assessment models. There are often conflicting trends from survey and fishery data that can result from inaccurate historical fishery data and/or lack of appropriate correction for "efficiency creep" due to changes in vessel size, power, gear design or technological aids, or due to changes in species targeting over time. For example, in addition to using research survey data, the ICES assessments of plaice and sole in the Celtic Sea and western Channel include lengthy time series of commercial fishery LPUE from UK and Belgian commercial beam trawlers and UK otter trawlers, and the assessments of cod, whiting and haddock in the same area use commercial otter trawl LPUE from UK, French and Irish fleets depending on species. The interpretation of the fishery data can be hindered by relatively poor understanding of how decisions are made on fishing gear, species targeting and areas fished, the magnitude of "technology creep", and how the fleets have reacted to management measures such as the Trevose cod closure, and the implications of these adaptations.

As the Celtic Sea lies close to a biogeographic boundary, the fisheries encounter a diverse mix of cooler-water species such as cod, herring and plaice, and warmer-water species such as John Dory, bass, red mullet, sea bream etc. This can lead to considerable spatial and seasonal variability in target and by-catch species compositions in a variety of otter trawl, beam trawl, fixed/drift net and line fisheries. This variability is poorly documented. In addition, climate change is expected to lead to an increase in the occurrence of warmer water species. Significant fisheries take place for non-assessed TAC species (e.g. pollack and ling), and a range of other non-TAC species for which data collection is required under the EU Data Collection Framework although the stocks are not assessed by ICES. The bulk of the species are taken from waters subject to CFP management controls, but also extend into inshore waters under national jurisdiction and hence subject to additional national measures where appropriate. Some countries (e.g. Belgium) mainly have fleets of relatively large vessels operating in the Celtic Sea and western Channel, whilst other countries (e.g. the UK) have fleets of larger offshore vessels as well as large numbers of small, inshore vessels with more limited mobility and poorer ability to adapt to spatial management measures.

The combination of relatively poor documentation of the nature of the Celtic Sea international fisheries, and problems with the scientific assessment data and advice for a number of stocks, has several important consequences for fishery management under the CFP:

- Evaluations of existing management measures, for example the Trevose cod closure, and implementation of mixed-fishery analysis, are impeded by poor knowledge of the fishing mortality exerted on different species by different fleets and the way in which fishermen alter their behaviour in response to controls;
- The ability of the NWWRAC, STECF or other bodies to propose new conservation and management measures or evaluate the impact of new proposals is impeded by poor documentation and knowledge of the stocks and fisheries at an international level, as well as the likely responses of fishermen to control measures.

These difficulties apply both to management at the European Community level, as well as to national initiatives in inshore waters.

*What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?*

The fishing sector has shown willingness to participate in formal partnerships such as the UK Fisheries Science Partnership and similar initiatives in Ireland and elsewhere, in order to provide additional survey data using fishing vessels and commercial fishing gears, or to conduct specific studies on gear selectivity, catch compositions, exploratory studies on potential new fisheries etc. Such studies have the potential to cover stock assessment data needs, if conducted with sufficient statistical rigour. The fishing sector has also participated in other collaborative work, for example the UK *Finding Sanctuary* project (http://www.finding-sanctuary.org ) in which stakeholders have provided knowledge and information to help in development of marine conservation zones (MCZs). The UK National Federation of Fishermen's Organisations (NFFO) has recently developed an Annual Fisheries Report, with an initial trial in the south west of England by the Cornish Fish Producers Organisation (one of the partners in the present project). The AFR provides detailed information on fleet structure and activities together with fishermen's observations on stocks. These various stakeholder collaborations have the potential, if appropriately structured, to provide very valuable information to "add value" to existing data collections, identify gaps in knowledge, or to provide independent evidence in support of fisheries management.

*To what extent is there a need, from the stock perspective, to merge/compare these national data sets into regional/international data sets and analysis?*

Some forms of stakeholder collaboration provide information useful for development of local management initiatives in coastal waters subject to national jurisdiction (for example supporting marine coastal zone management). At the international level, for example supporting the work of the NWWRAC, ICES and STECF, there is a strong requirement to generate consistent data sets and ancillary information across all Member States fishing in a region.

*Are there drivers for designing or keeping alive such projects, for instance national interest in managing local fisheries, or interest of the sector in obtaining a sustainability label?*

The reform of the CFP, including regional devolution of fishery management and concepts such as "reversal of the burden of proof" is likely to be a major driver for designing and sustaining collaborative studies involving the fishing sector and fishery scientists. The development of long term management plans and associated technical and other measures for individual regions, with major input from stakeholder-led bodies such as the RACs, pre-supposes the availability of sufficient and credible information on stocks and national fisheries at appropriate levels of resolution. The buy-in of the fishing sector to new management initiatives is expected to be strongest where the sector has been actively involved in developing the evidence base and where scientific data has been open to scrutiny.

*Is "added value" provided to the recurrent data collection under the EU Data Collection Framework?*

The DCF has been in existence only since the early 2000s, whilst most scientific assessments utilise much longer time-series of data. Some national contributions to the present project have included interviews and questionnaires to collect longer-term information on changes in the fleets and fishing technology that is needed to interpret fishing effort and LPUE time series. The other "fishery information" approaches adopted in the project relate more to collaboration with the fishing sector to interpret data currently collected from EU logbooks, sales slips and vessel monitoring systems. This includes facilitating the development of the fleet (metier) –based approach to data collection and interpretation.

#### 3.1.3 Project tasks

Given the needs for fishery information to support the work of both scientific groups and the NWWRAC, the Lot 1 Celtic Sea pilot project was established as a collaborative process to compile information on the fishing fleets in the Celtic Sea and western English Channel in a way that would (a) facilitate interpretation of fishery data used in stock assessments, (b) provide readily accessible and visually intuitive material on fishery descriptions that could be used by the NWWRAC or other stakeholder bodies, and (c) help in the process of defining fleet metiers for which data are required under the EU Data Collection Framework.

The implementation phase of the Lot 1 pilot project involved fishery scientists and fishermen's organisations in Ireland, England, Belgium and France in addressing three topics, with each country adopting a different balance between the three tasks:

*Task 1: Description of the demersal fisheries*
Describe the activities of national fishing fleets targeting demersal fish in the Celtic Sea and Western Channel - annual fishing patterns, gears used and the key areas of operation. A more detailed picture of the fleet activity would help in targeting any necessary management measures at fleet sectors, times and areas where the measures will be most effective whilst avoiding unnecessary impacts on other vessels and areas.

*Task 2: Technological changes affecting fishing efficiency*
Identify the main technological developments and operational changes that have occurred in the fisheries over time and assess the extent to which these are likely to have influenced catching efficiency or some other aspect e.g. improved safety. The intention was also to quantify changes at the fleet level that could explain changes in fishery LPUE series used in stock assessments, taking into account the more detailed knowledge of seasonal and spatial fishing patterns developed in Tasks 1 & 3.

*Task3: Responses to management measures*
Document how fishermen respond to management measures such as closed areas, quota restrictions etc. and how fleet activity may have altered in response to the introduction of key measures.

The example chosen for Task 3 was the Trevose cod closure introduced in the Celtic Sea in 2005 following a joint Irish – French – UK industry proposal for a measure to reduce fishing mortality on cod by 15% by closing the main spawning grounds in spring. A number of reviews of the effectiveness of the Trevose cod closure have been produced, most recently by STECF (2007) based on an evaluation made by the 2007 ICES Working Group on the Assessment of Southern Shelf Demersal Stocks (WGSSDS). STECF (2007) concluded that "*the existing evaluations of the closure have been unable to disentangle the effects of the closure from other factors influencing fishermen's tactical decisions. A more comprehensive evaluation of how fleet activities have been affected by the closure and other regulations and factors is required, based on accurate fleet definitions and fishing activity data collected at an appropriate spatial and temporal resolution*." The fishery distribution and catch composition data collated during the Lot 1 project, together with fishermen's views of the effect of the closure based on questionnaires and interviews, are evaluated to provide further insights into the effectiveness of the closure and its impact on fleets.

An additional important form of collaboration between industry and scientists has been through industry-science partnerships such as the UK Fisheries Science Partnership[2]. Examples of such projects in the Celtic Sea and western Channel are given in the report sections for each country, particularly where they add to the implementation of the three tasks.

The concept of a fishery information report has been put into practice by one industry partner in the Lot 1 project. In 2009, the UK National Federation of Fishermen's Organisations produced a pilot version of an Annual Fisheries Report (AFR), developed by the Cornish Fish Producers Organisation (CFPO) and Seafood Cornwall Training Ltd. with funding from the UK Department of Environment, Food and Rural Affairs (Defra) Fisheries Challenge Fund. The AFR provides a profile for each CFPO fleet sector in terms of number of vessels, in-year fleet changes, average length, age, engine power, tonnage, no. crew, days at sea and annual turnover. The report then covers technological developments in vessels and gears; perceptions of seasonal and spatial trends in availability, distribution and composition of stocks; changes in market prices; impact of management measures on fishing patterns and areas fished; economic features and trends, and skippers' comments, views and issues arising. The first draft of the CFPO AFR was provided to the ICES Roundfish Benchmark Working Group in early 2009 and the ICES Working Group on the Celtic Seas Ecoregion in May 2009 and received positive feedback. The Lot 1 project provides an opportunity to facilitate further development of industry-led AFRs and enhance their usefulness for industry, scientists, government and the RACs.

The Celtic Sea pilot project addressed Task 1 (fishery information) and Task 3 (involvement of stakeholders in quality assurance end interpretation) specified in the tender. The objectives and structure of this pilot project were discussed at a meeting between fishery scientists and industry participants at the BIM offices in Madrid on 2 July 2008. The meeting was timed to immediately precede the NWWRAC meeting on 3-4 July, where the outcomes of the 2 July meeting were presented.

There are a number of parallel initiatives on joint data collection to which the Lot 1 pilot project can "add value" as well as providing valuable information in its own right. These include:

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[2] http://www.cefas.co.uk/data/fisheries-science-partnership-(fsp).aspx

- EC project (Lot 7, FISH/2006/15: Joint data collection between the fishing sector and the scientific community in the North Sea – completed in 2008);
- ICES benchmark assessment data workshops that are open to the industry to evaluate existing data (e.g. landings data) and provide a forum for the industry to present additional information.

The methods and results of the application of the Celtic Sea pilot project in Ireland, Belgium, England and France are described in sections 3.2 – 3.5 below.

## 3.2 Celtic Sea pilot project: Ireland

### 3.2.1 Methods

The implementation of the pilot project in Ireland focused on Tasks 1 and 2 (fishery description and technical changes affecting the fishing industry). In addition, the project acted as a catalyst to develop and execute a Quarter-1 cod-targeted demersal survey including the development of a new survey trawl and input from the commercial sector in the survey design.

#### 3.2.1.1 Task 1 Fishery description

The description of the fisheries and demographic description of fishing types by port were obtained by interviewing Marine Institute port based sampling staff who as routine regularly monitor the activity of the various metiers and report annually on changes in the fleet structure.

Spatial patterns in the Irish demersal fisheries are shown using a combined analysis of VMS data and EU log book data. These provide high-resolution plots of the spatial distribution of landings of cod, haddock, whiting, hake, megrim, sole and Nephrops by Irish vessels, and the VMS data provide maps of fishing effort for otter trawls, Scottish seine nets, beam trawls and fixed nets. Species compositions of reported landings by ICES rectangle are shown for four periods in 2008, for a range of different gear types and mesh size bands used by otter trawlers, beam trawlers and fixed-netters targeting demersal species in the Celtic Sea area. The pie diagram centred on each ICES rectangle is scaled so that the radius of the circle is proportional to the landed weight of all species. Note that the scaling is the same for all periods and mesh bands in each national gear type, but varies between gear types. The pie diagrams are centred over each ICES rectangle and therefore do not reflect the distribution of landings within a rectangle. The species composition plots by gear and rectangle in ICES Divisions VIIf,g,h,&j are compiled in Appendix 3 (Figs A-3.1 – A-3.5) along with the equivalent plots for other countries.

#### 3.2.1.2 Task 2 Technical changes affecting fishing efficiency

During 2009 the Marine Institute began an information collection process with the fishing industry by carrying out face to face interviews with skippers. The information from these interviews is used to describe the historical development of fisheries in order to identify the main drivers of change and also to investigate the current relationship between effort metrics for fishing gear and vessels.

The interview firstly covered the personal details of the skipper, his involvement with the fishing industry and the vessels and gears used during his career. Vessel details included the length, weight, engine power, winch power and construction type (i.e. wood or steel). The presence or absence of a shelter deck, refrigerated fish-hold and variable pitch propeller was also recorded as was the technology on board the vessel such as radio, navigation and fishing finding equipment. Next, information was requested regarding the fisheries themselves, such as which species were targeted at different times of year, did this pattern change over time and if so what were the reasons for switching the target species from one year to the next. The interview then covered details of each fishing trip such as the duration, the time spent steaming to the fishing grounds and the economic and technological reasons for longer or shorter trips. Finally, information was requested regarding the details of the gear used during the fishing operation. For mobile fishing gear (i.e. trawls) questions were asked regarding length and type ('clean' or 'hopper') of the ground gear and the circumference of the fishing circle. For fixed fishing gear (i.e. pots and nets) the number of pots per string, the length of bottom set nets and the quantity of such gear used were recorded.

In cooperation with the Irish Sea Fisheries Board, the Marine Institute also collected information on trawl size, vessel power and length. The data has been used to explore the relationship between vessel size and the size of the trawl used for a given vessel capacity. This work is presented here.

### 3.2.2 Results

#### 3.2.2.1 Task 1: fishery description

*Location of main ports and activity in SW Ireland*

The main ports on the South West coast of Ireland bordering on ICES Division VIIj are Schull, Baltimore, Union Hall with a few other small piers located around the Beara Peninsula. Vessels in the minor ports range from small punts up to 80ft (24.4m) twin rig trawlers. The demersal fleet operates from ICES Division VIb in the North West down to VIIg off the South East of Ireland. Pelagic vessels function anywhere from VIIa (south) up to VIa. The remaining inshore fleet is made up of otter trawl (OTB) vessels and potting boats working 1-2 day trips in VIIj. A number of pelagic vessels pair-trawl for tuna during August – September. They commence fishing off northern Spain and finish off the west of Kerry at the end of September. The pelagic fleet operates around the coast of Ireland, commencing in the Celtic Sea during the herring summer fishery and then moving onto mackerel until early March. These vessels land into Dunmore, Ringaskiddy, Cobh, Baltimore and Dingle, and into the west coast ports Ros a Mhil (VIIb coast) & Killybegs (VIa coast). Some vessels landed into Scotland and Norway throughout 2008.

The composition of the fleet in the south west is currently as follows:

| FLEET | NO. VESSELS |
|---|---|
| Otter trawl single rig | 20 |
| Otter trawl twin rig | 45 |
| Seine | 1 |
| Gillnet | 6 |
| Pelagic | 10 |
| Inshore vessels | 35 (>7m) 15(<7m) |
| Long line | 2 |

A brief description of the main ports in SW Ireland is given below:

**Union Hall**: This has the impression of a quiet harbour but is a busy port with consistent landings. The port has a fleet of over twenty vessels ranging in size from inshore craft to 80ft trawlers. The port is restricted by water depth, only providing berth space for vessels of 80ft or under. The Union Hall Fisherman's Co-Op in Skibberen handles sales of fish, auctions being held on a daily basis. The fleet is predominantly modern twin-rig (TWR) trawlers from France. New vessels have been added to the fleet over the past several years, most notably the *Ocean Pioneer II*.

**Baltimore:** This port has a fleet of more than 10 vessels. The capacity of the pier is restricted by depth and berth space for vessels. .

**Schull:** This small port is used by a fleet of over five vessels, which anchor out at moorings, especially in sustained poor weather. This is done due to danger of vessel damage against the main pier. The port caters for a handful of inshore boats and four whitefish trawlers. The majority of the landings are handled by Normandy Fish Ltd located at the pier.

**Castletownbere:** The inshore fleet from this port works around Dunmanus, Kenmare & Bantry Bays, bordering on VIIj. The larger demersal fleet operates anywhere from Rockall in VIb down to the Smalls (VIIg) in the South East. Other grounds include West of Achill (VIIb), Porcupine Bank (VIIc; April – July), West of Thiariacht, Skellig Grounds (VIIj), South of Fastnet (VIIj) and Labadie Bank (VIIg). The fleet moves depending on the available catches and quota restrictions in these fishing grounds.

*Location of main ports and activity in SE Ireland*

The main ports in the South East of Ireland, along the coastline adjacent to VIIg and VIIa (south) are Kilmore Quay, Duncannon, Helvic, Youghal, Ballycotten, Kinsale, Crosshaven, and Cobh. Dunnybrattin, Boatstrand, Knockadun and Ardmore are four small ports west of Dunmore East in County Waterford that have recently become very important in terms of landings. The boats that generally land into here are small, the majority being single rig trawlers, gill-netters, tangle netters and pot boats. The composition of the fleet is currently as follows:

| FLEET | NO. VESSELS |
|---|---|
| Otter trawl single rig | 3 |
| Otter trawl twin rig | 6 |
| Gillnet | 5 |
| Beam trawl | 10 (all at Kilmore Quay) |
| Pelagic | 0 (5 boats switched to herring fishing in November - January |
| Inshore vessels | 6 (>7m) 6(<7m) (Fleet increases to 15 boats in summer, mainly fishing for mackerel, crab and shrimp) |

The main fishing grounds for the SE vessels are mainly in ICES Division VIIg and into the southern part of VIIa. Important grounds are the Smalls, Helvick, Labadie bank and the Gas Rigs. There is also a considerable amont of fishing in the lower tidal stretches of the river Suir above Dunmore East (VIIaS)for Codling and Herring. The best times of the year for fishing the Smalls is from March to late September. However the ground is fished all year round if the tides and weather are right. The Helvick ground is a spring fishery, from January to March. The Gas Rigs are good grounds for trawlers from September to October. Gill-netters fish these grounds all year on good tides.

*Main fishing areas*

Figures 3.2.1 to 3.2.7 show the quarterly distribution of catches for the main demersal species based on an analysis of logbook and VMS data. These show in most cases that the catches are highly seasonal for some species such as cod, but more homogenous across quarters for others e.g. megrim. Figure 3.2.8 show the main distribution of fishing activity by gear type on an annual basis.

The highest concentrations of otter trawl effort (Fig. 3.2.8) are associated with the *Nephrops* fisheries (Fig. 3.2.5). The *Nephrops* fishery in the Celtic Sea (Div. VIIg) is on the Smalls Ground. The activities of the otter trawl fleet are more widespread than the beam trawl and gillnet fleets, extending to along the shelf-edge off SW Ireland and to Rockall where haddock are targeted.

*Species compositions of landings*

The species compositions of the landings, by ICES rectangle, gear, mesh-band and period of the year, are shown in Appendix 3 Figs. A-3.1 – A-3.5.

The main target of otter trawlers using 70-99mm mesh in 2008 was *Nephrops* (crustacea), with highest catches on the Smalls grounds in the eastern part of VIIg, especially in April-June (Fig. A-3.1a-b). The remaining landings were a mixture of haddock, whiting, cod, anglerfish, megrim. The proportion of the landings comprising cod was very low for most of the year, with a small increase in February-March in VIIg in areas beyond the Trevose closure. The species composition of otter trawlers using 100mm+ mesh was dominated by haddock, whiting, anglerfish, megrim, with a smaller proportion of *Nephrops* than in the 70-99mm gears (Figs. A-3.2a-b). Cod landings were again a very low proportion of the total for most of the year with a small increase in spring.

The landings of Irish beam trawlers in 2008 were dominated by anglerfish, megrim, elasmobranches, small species of flatfish such as sole, and haddock/whiting (Figs A-3.3a-b). A small increase in the proportion of the catches comprising cod was evident in spring, towards the spawning grounds off SE Ireland. Most activity using beam trawls was in VIIg (Fig. 3.2.8).

Landings using fixed nets with mesh sizes in the 100-219mm range were mainly from VIIg&j, and were dominated by pollack, ling and hake, with seasonal catches of cod in spring towards the spawning grounds off the SE coast of Ireland (Fig. A-3.4a-b). The proportion comprising pollack & ling was highest over the autumn-winter period. Larger mesh tangle nets (220mm+) were less frequently deployed, mainly in summer, when anglerfish, turbot and brill were the main targets in VIIg&j (Fig. A-3.5a-b).

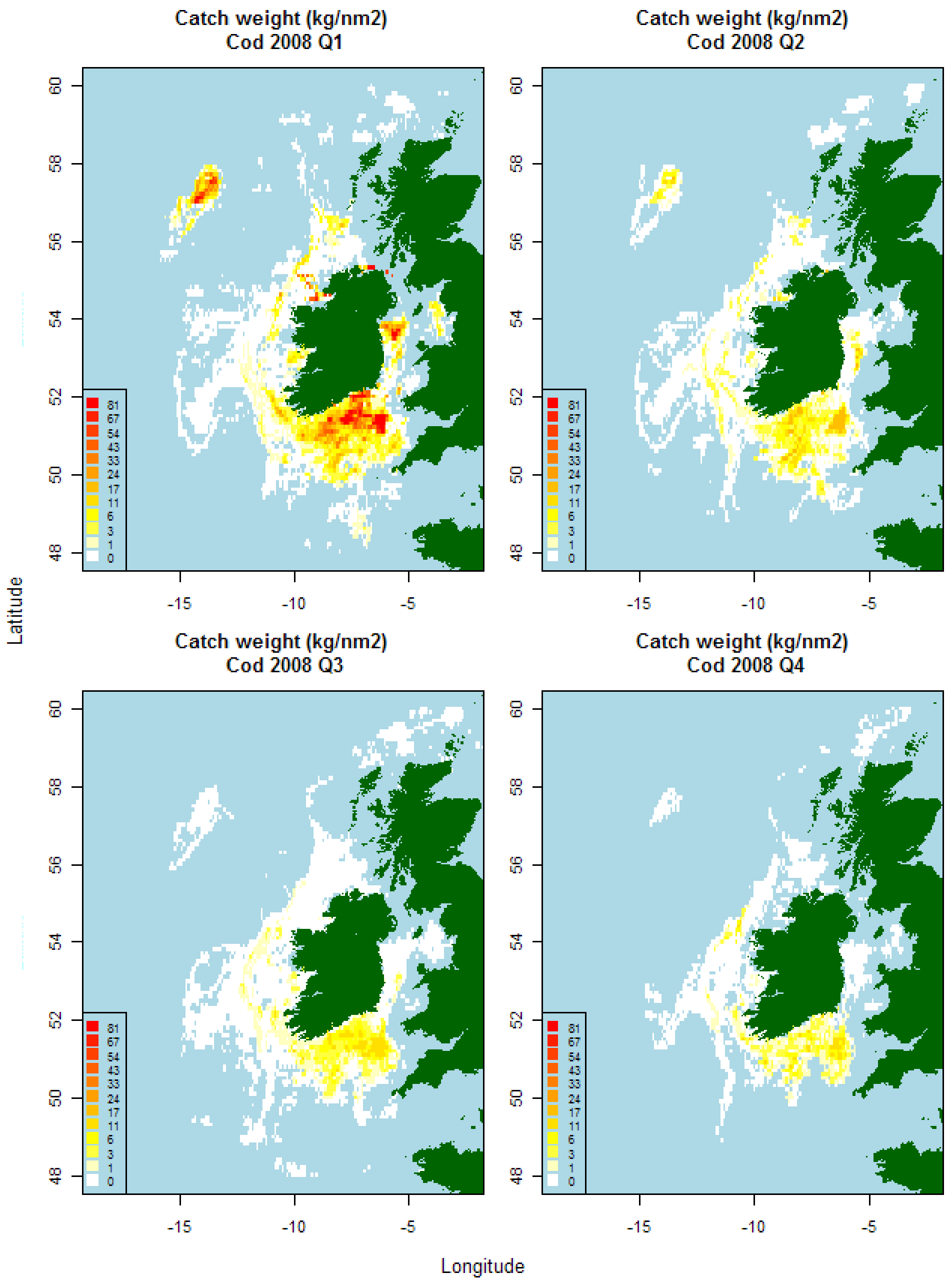


Figure 3.2.1 Cod catches by quarter associated with all fishing types.

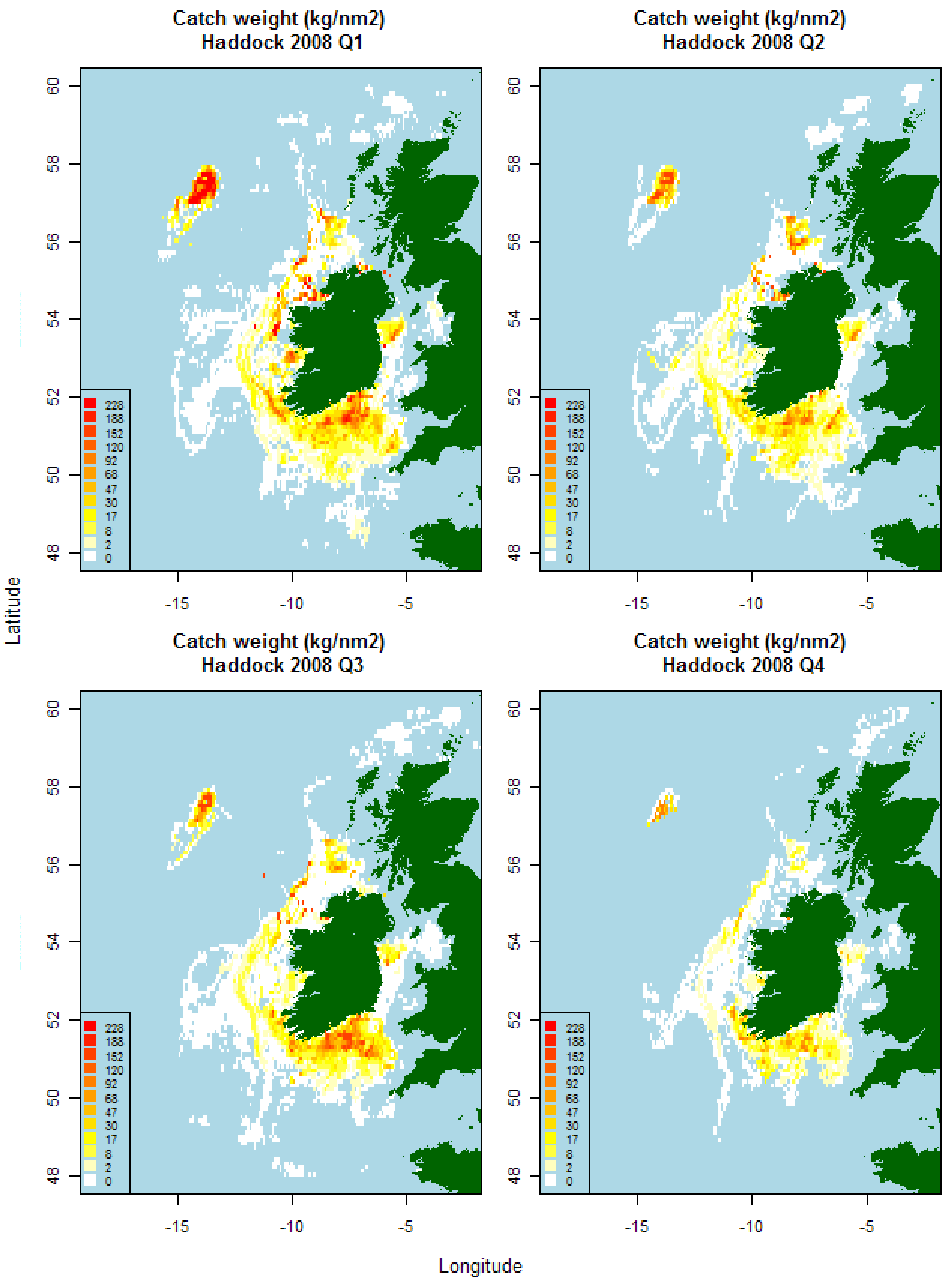


Figure 3.2.2. Haddock catches by quarter associated with all fishing types.

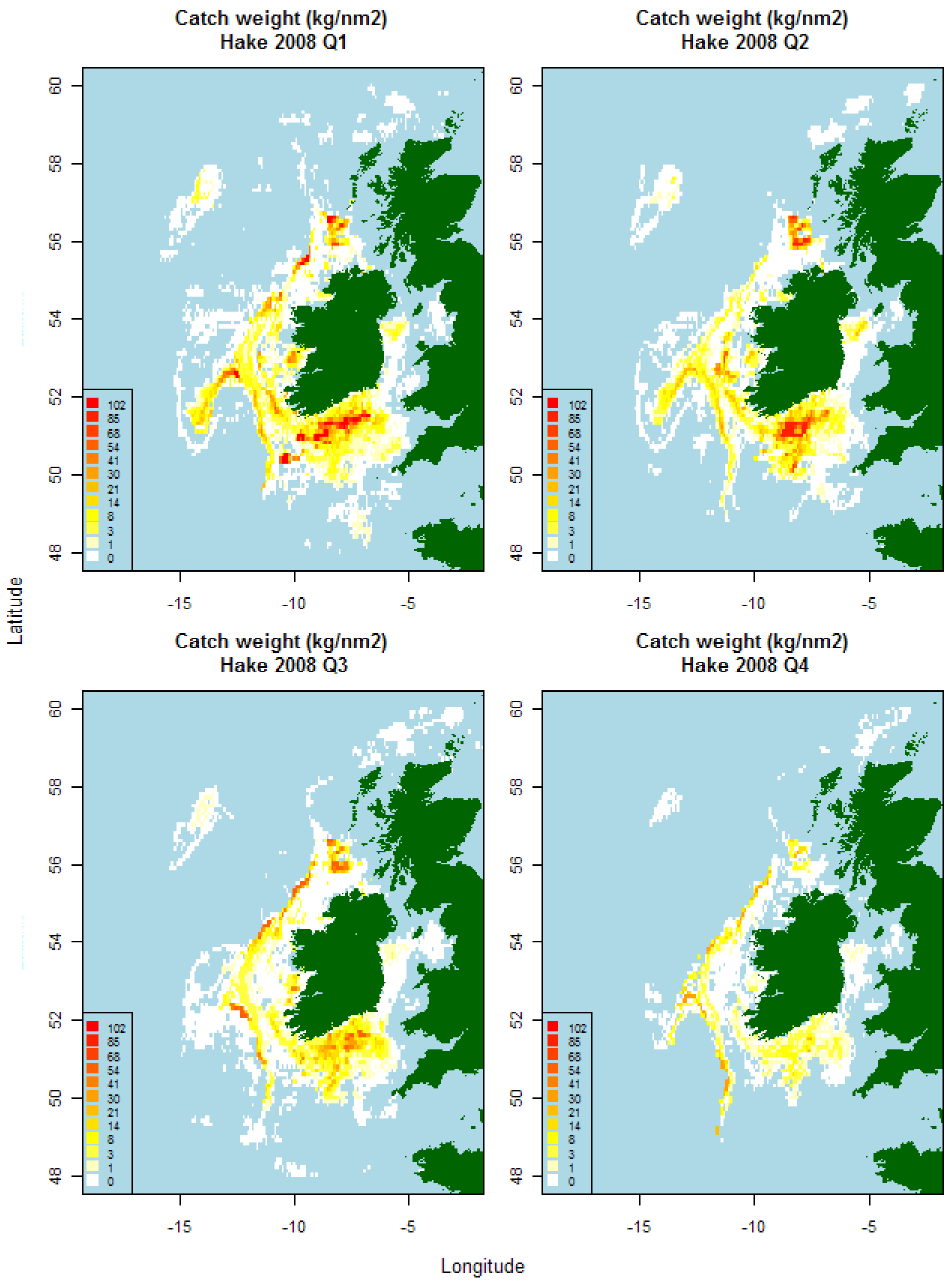


Figure 3.2.3. Hake catches by quarter associated with all fishing types.

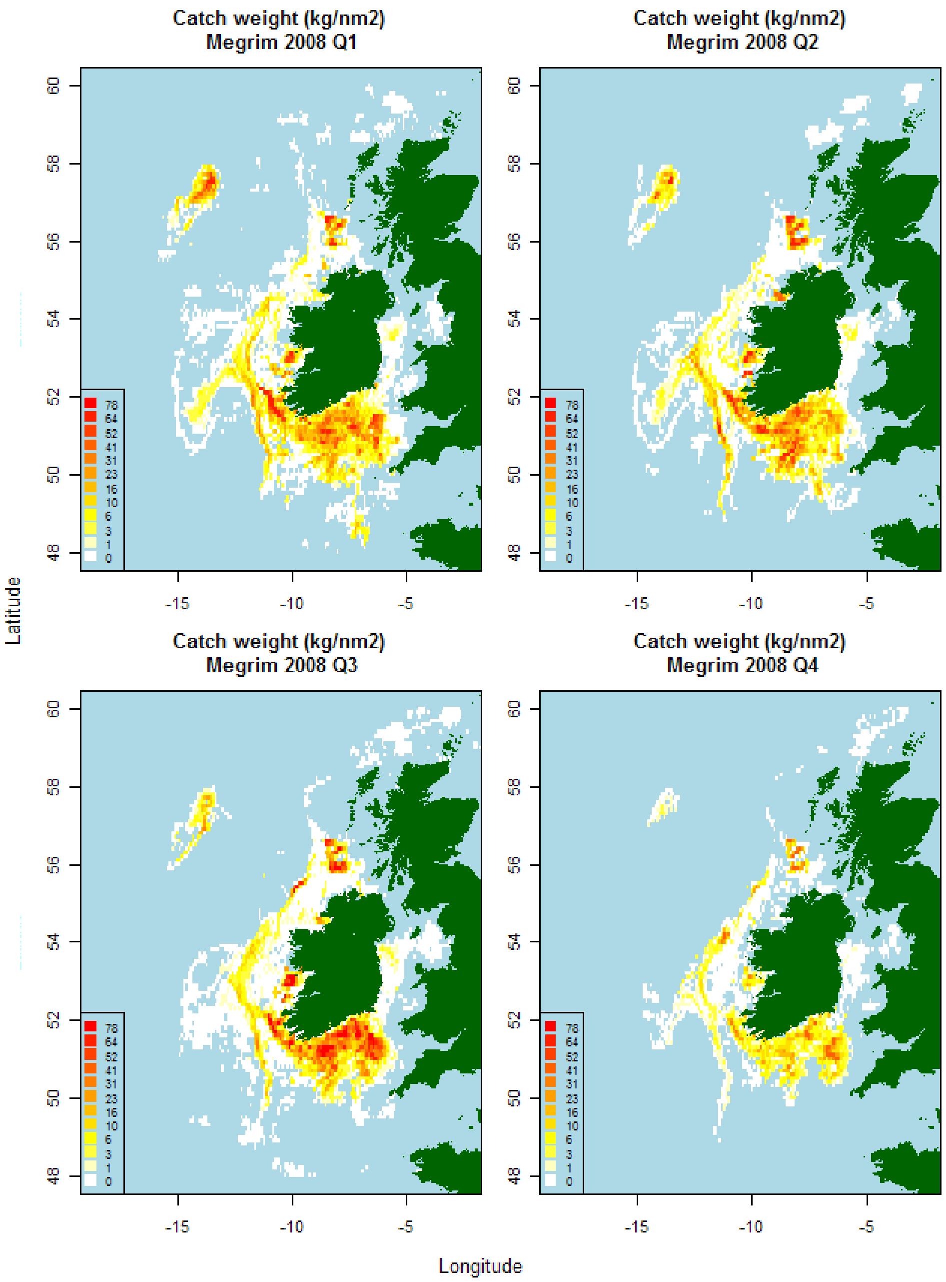


Figure 3.2.4. Megrim catches by quarter associated with all fishing types.

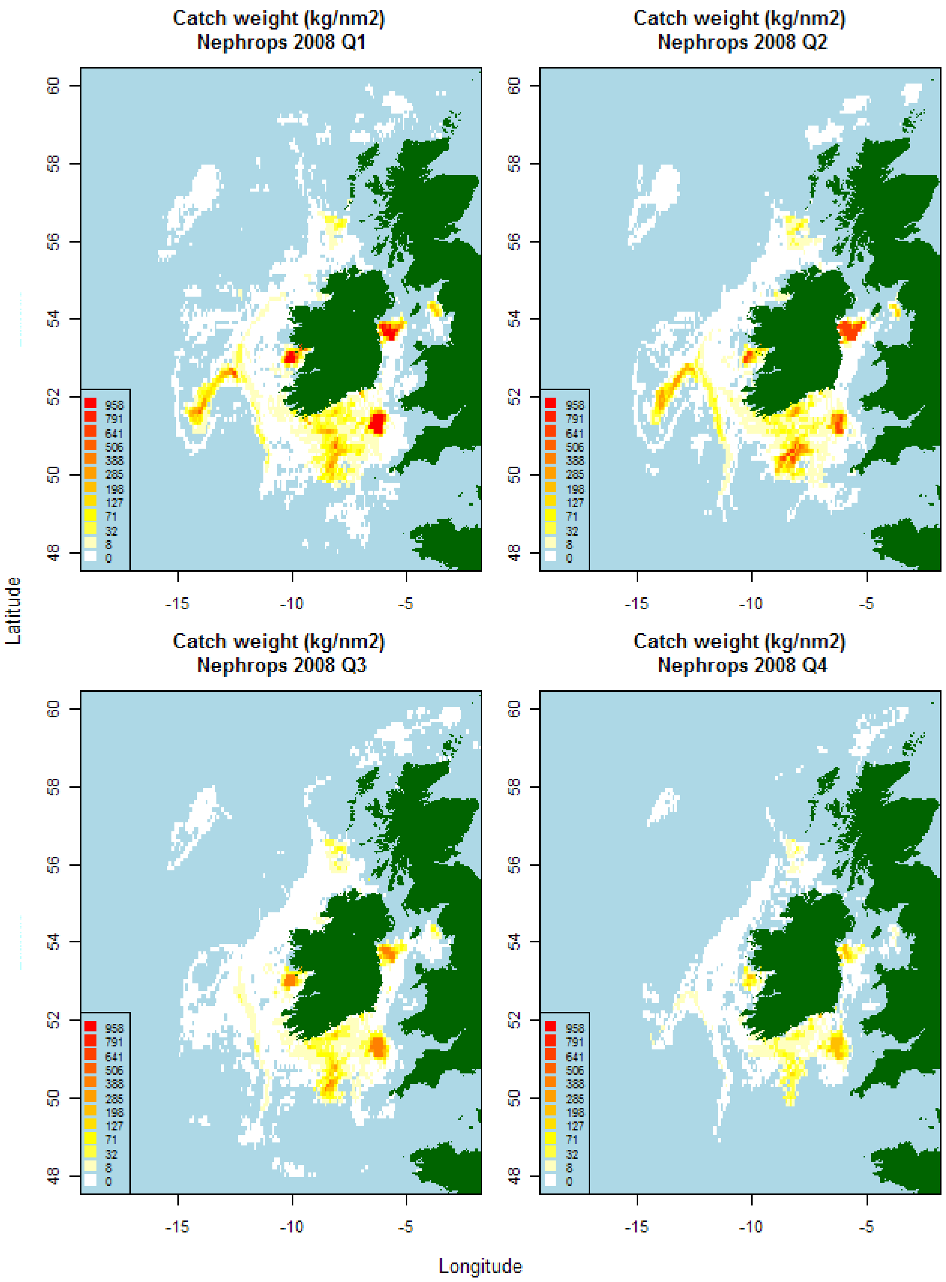


Figure 3.2.5. Nephrops catches by quarter associated with all fishing types.

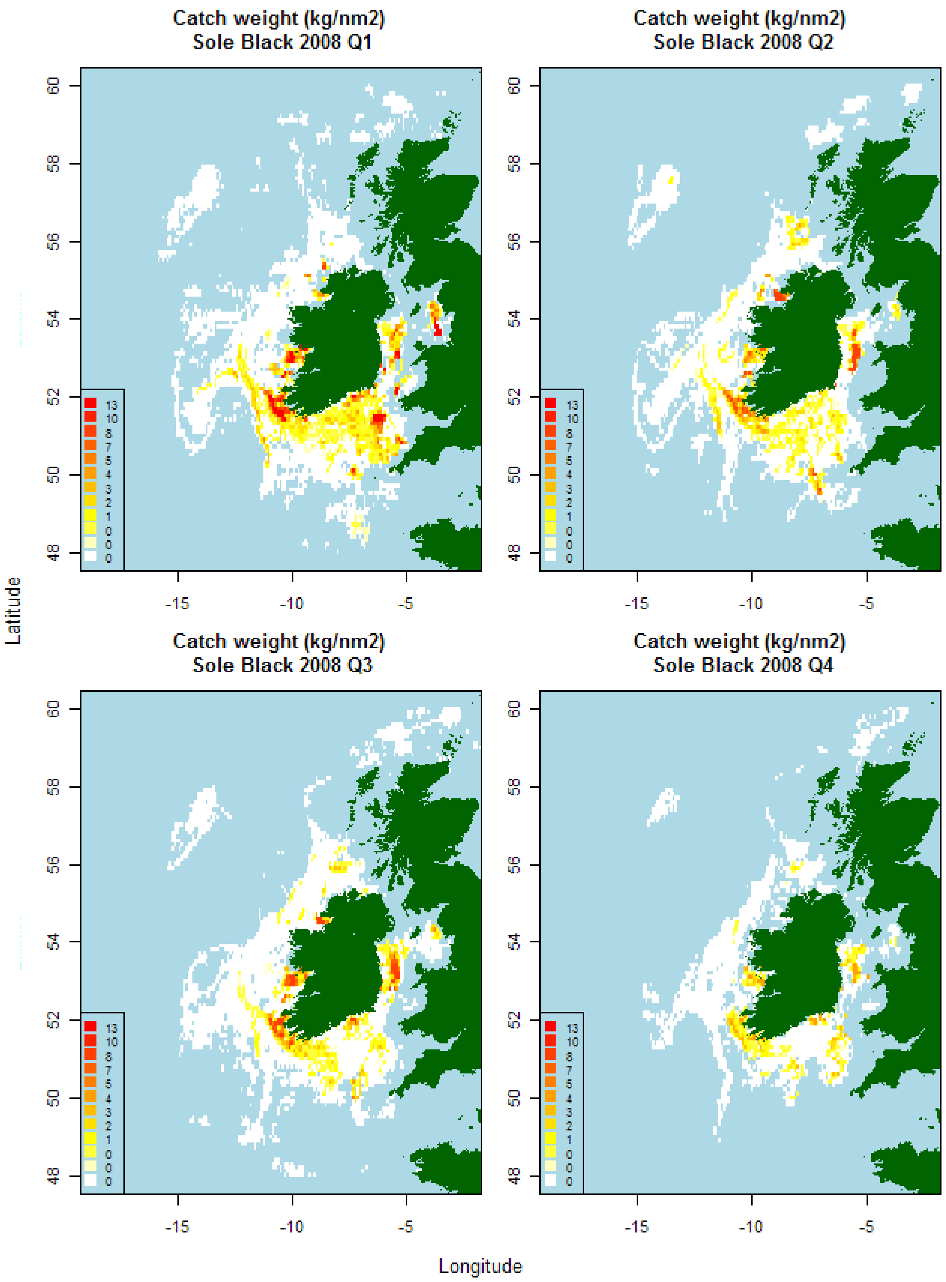


Figure 3.2.6. Black sole (*Solea solea*) catches by quarter associated with all fishing types.

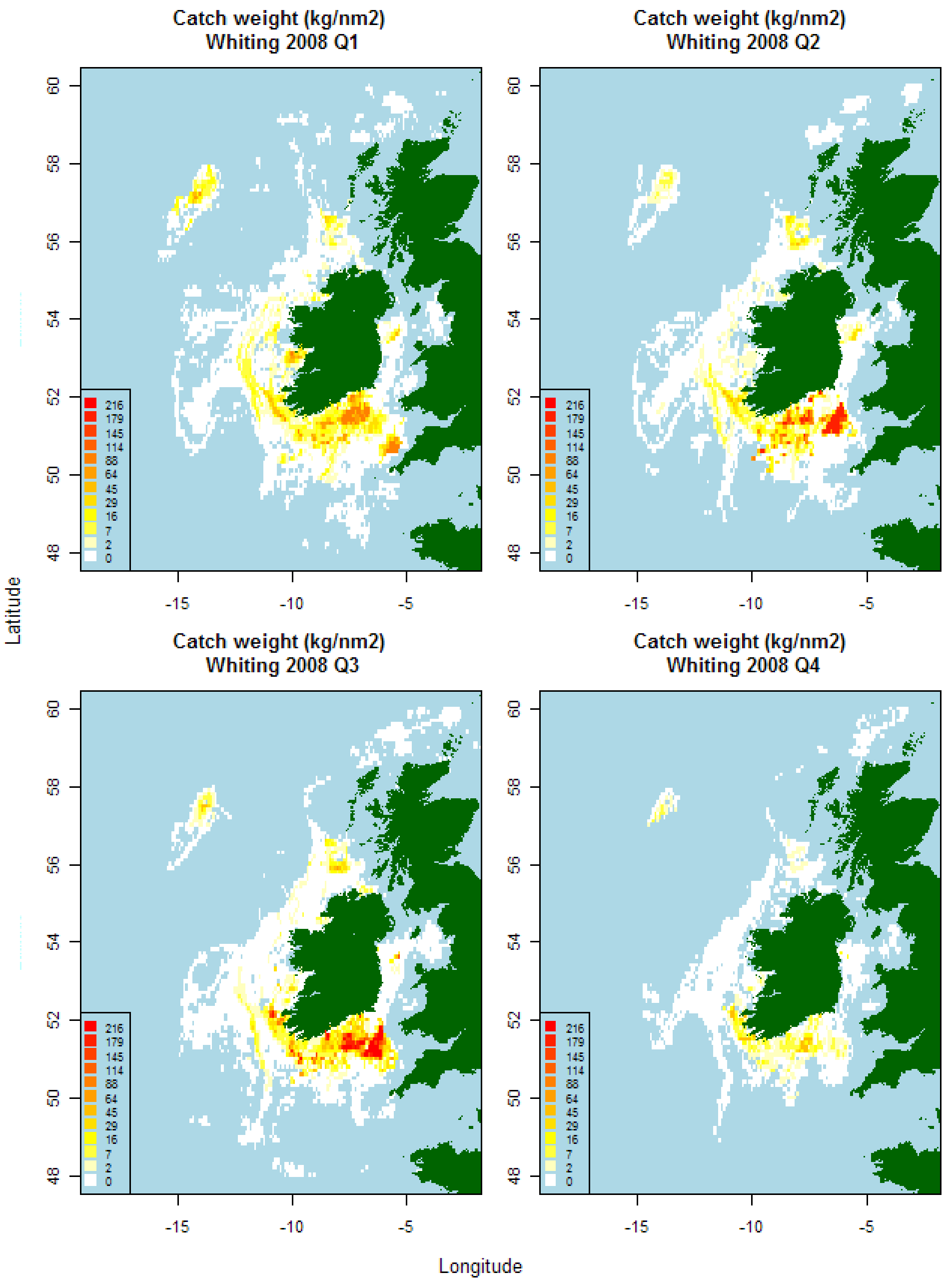


Figure 3.2.7. Whiting catches by quarter associated with all fishing types.

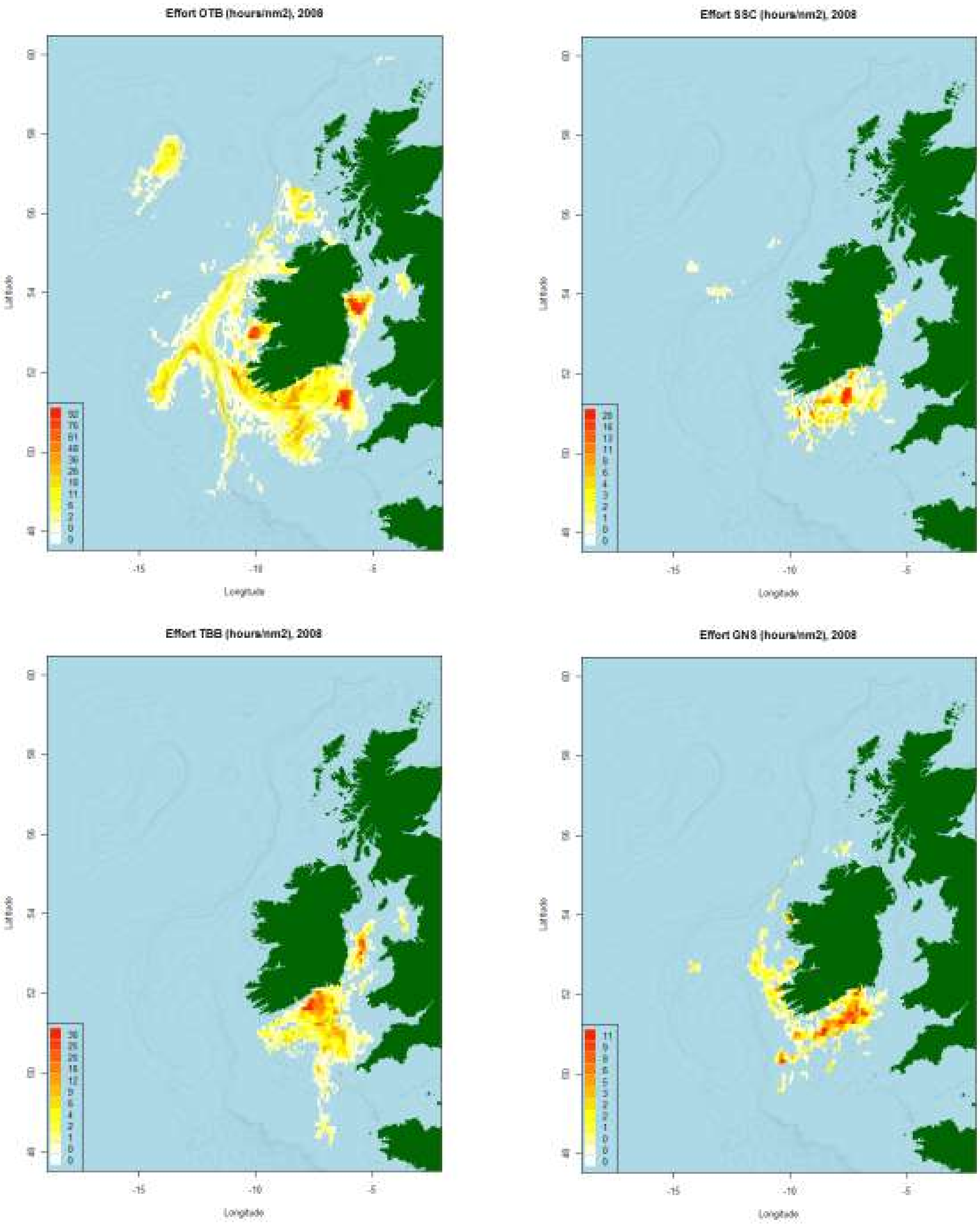


Figure 3.2.8. Effort plots for Irish vessels by main demersal gear type Otter trawl (TL), Scottish Seine (TR); Beam trawl (BL) and gill net (BR)

#### 3.2.2.2 Task 2. Technical and targeting changes in the Irish fleet since the 1960’s

The following information is based on interviews with four commercial fishermen and one trawl maker (also a retired skipper). It summarised the findings from all four and provides an insight into the technological changes in vessel construction, gear design and other important developments to have happened in the Irish demersal and pelagic (herring) fisheries off the South Coast on Ireland since the early 1960’s. While the Lot 1 project is aimed specifically at demersal fisheries, it is important to review and report on the pelagic activity as up until very recently, vessels were generally engaged in both demersal and pelagic fisheries and much of the technical development (from a vessel perspective) were driven by the desire to increase hold capacity and to tow larger pelagic trawls. This had a secondary impact on the demersal fleet.

The Irish fishing fleet was underdeveloped in this region during the 1960s with second hand, 70ft Scottish vessels using 230hp Gardner engines making up the majority of the fleet. These vessels used light fishing gear such as the multipurpose 20 fathom ‘Boris No.2’ nets (20fm footrope, 20-25fm doubles, 40fm singles with 2” rubbers). This gear was restricted for use on clean ground only and fishing trips were generally limited to a single day.

To improve the state of the fishing fleet a fleet renewal programme was initiated in the late 1960s by Bord Iascaigh Mhara (BIM) and 65-70ft vessels with 360hp CAT engines were constructed. The engine in these vessels was placed up front which provided space for a large fish holding area in the rear, thereby making longer fishing trips possible. The deck was originally of open construction, however the covered/whaleback design appeared in the 1970s which allowed fishing to continue in bad weather. The primary target for these new vessels was the winter spawning Celtic Sea herring from October to February although some demersal trawling also occurred outside this period. Single-vessel semi-pelagic trawls (Engel Nets) were used which initially had a net opening (height x width) of 10x12fm, with 12” mesh in the wings, and this gradually increased to 12x14fm. Single vessel trawling was gradually replaced by pair trawling from the late 1960s onwards as it increased the towing speed and storage capacity of the fishing operation. Consequently the gear used by the pair trawlers remained approximately the same size as that used by the single vessels. As the herring were typically taken near the seabed, the spread of the trawl was an important feature hence the nets became increasingly asymmetrical. IC Trawls became a key player with the introduction of the 12x20fm net, with 64” wing mesh, and this gear remained popular during the 1970s. During the mid 1980s a 14x22fm net, with 128” wing mesh, was introduced by Swan Nets and these remained popular up to the early 1990s.

Engine size also increased at this time up to 1000hp and Gundry’s accommodated this development by designing a larger net to target mackerel and sprat. As the newer vessels became more powerful it became more difficult for the older BIM 65ft vessels to compete and another fleet renewal programme was launched by BIM in the late 1980s to construct 600hp 80ft vessels. Some of these were subsequently re-engined up to 1000hp in the early 1990s. A major advancement in fishing technology was made with the arrival of Refrigerated Sea Water (RSW) vessels during the mid-1980s.

This development increased the length of time the catch could be stored and therefore extended the length of the fishing trip. These vessels became more popular as time progressed and at present the vast majority of pelagic trawlers have RSW capability.

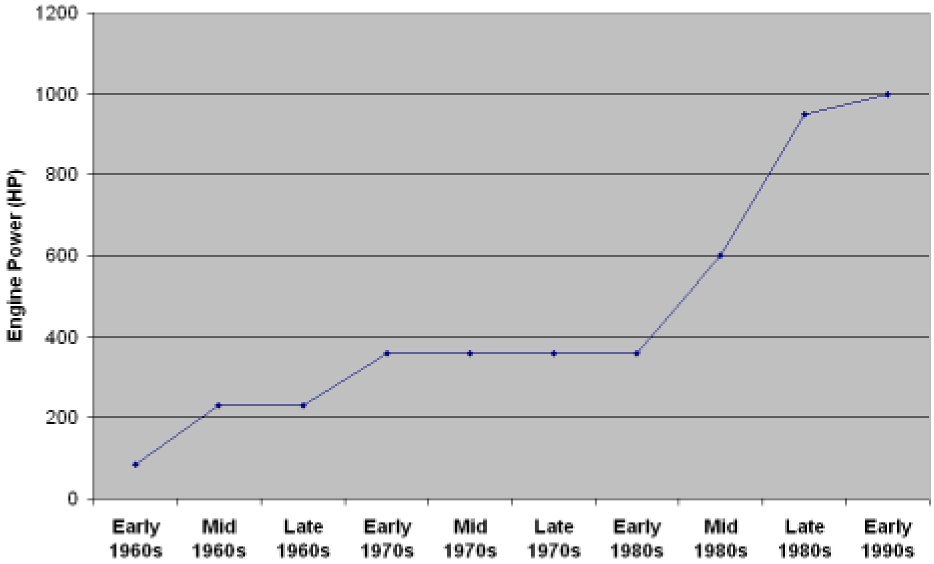


Figure 3.2.9 Change in typical engine power with trawlers operating from the South Coast of Ireland since early 1960.

The development of the demersal fishing gear was similar to the pelagic gear in that the trawls increased in size as the vessels became more powerful. However the demersal trawls also became heavier, with the addition of 'rock hopper' foot ropes and four-panel nets, so that they could work in rougher areas (Boris Nets and IC Trawls). In the late 1980s and early 1990s a new market for monkfish and megrim developed in Spain and to supply this demand the 'scraper' trawl was produced by IC Trawls. This was similar to the older *Nephrops* trawl in that it had a low headline height and a wide spread, however it also had extended wings and was constructed of a heavier twine. These nets typically had a fishing circle of 450 x 4.5" meshes and a 40fm foot rope. During the 1990s some vessels targeting monkfish switched to twin rigging to increase the spread of the foot rope. However this technique was heavy on fuel and involved a more complicated fishing operation. Consequently many twin riggers reverted back to single-rig fishing.

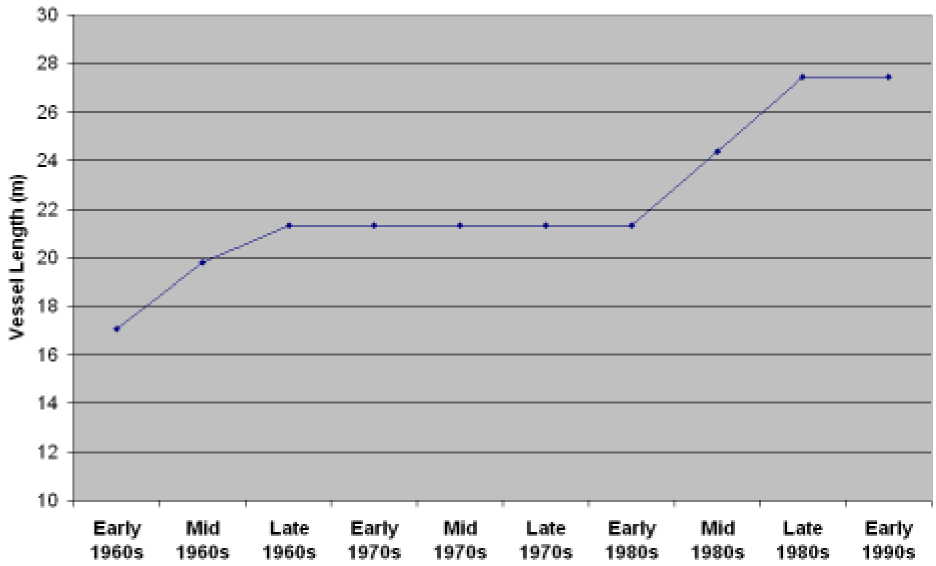


Figure 3.2.10. Change in typical engine power with trawlers operating from the South Coast of Ireland since early 1960.

Technological advancements over this time period are not limited to the fishing gear itself. The use of sounders, sonar and radar to locate fish, check water depth and ground type and 'see' other vessels have become ubiquitous in the fishing fleet and increased fishing efficiency. At the start of the 1960's vessels were not equipped with radar and much of the fishing activity had to be confined to coastal areas using land fixes for locating known fishing grounds, during this period, weather and in particular fog, limited activity considerably. The opening up of new grounds was a cautious affair and resulted in considerable net damage. The advent of bobbins and subsequent introduction of rockhoppers offered a lot more protection to the trawl and the opening up of new grounds was accelerated due to this development. The availability of shore based facilities also impacted on the behaviour of the fleet. Ice making facilities were limited to a few ports and those vessels operating elsewhere limited their activity to only one day trips to avoid spoilage, although this was a problem during the summer months. Increased availability of ice making facilities in the early 1970's, coupled with introduction of more sophisticated navigational tools, allowed vessels to operate further from home and for extended periods of time. Finally, the development of personal computers and Global Positioning Systems have improved navigation and allowed skippers to pinpoint and record their trawling positions.

While the above focuses on technical developments, the interviewees were also asked to discuss other external drivers that have influenced the technological changes in the fleet. Over time, and largely due to licence and quota restrictions, the South Coast fleet has become more and more specialised. Historically, vessels tended to target pelagic species in preference to demersal, with a typical pattern being the winter and early herring a sprat fishery with demersal species only being targeted in the summer and autumn months. One of the key changes to this pattern was the accession of Spain to the EC in 1986, which opened up significant markets for demersal species that had no demand from the domestic markets. These tended to be for benthic species such as megrim, *Nephrops* and other 'prime' species. The opening of these markets also led to a change in otter trawl design, away from high headline, short-winged nets for targeting cod, haddock and whiting towards the use of ‘scraper’ nets which are designed specifically for targeting *Nephrops* etc. This change was dramatic and will have resulted in a considerable change in catching efficiency for all species.

The information gathered from the interviews in terms of changes in catching efficiency, show that while there has been a general increase in efficiency over time, the opening of foreign markets is likely to have been the key driver in terms of gear and vessel design which has seen an increased shift towards specialisation over time.

*Relationship between vessel capacity and trawl size for Irish demersal otter trawlers*

Following on from the general description of the historic developments of the Irish demersal fleet described above, national data on the physical characteristics of the vessel (e.g. weight, length or power) and the size of the gear deployed by that vessel capacity (length and power) was explored further. Data were obtained from personal contacts within the industry and the Irish Sea Fisheries Board (BIM) from historic engineering trials and the results discussed with commercial net makers. The periodic changes seen in vessel constriction and power (Fig. 3.2.11) are also evident from the sample of vessels from which technical gear specifications were available (n=36) and corroborates the observations made by the interviewees, with lower powered vessels in the early 1970’s and gradually increasing during the 1980’s. The lack of data from the 1990’s is reflective of the lack of capital investment in the Irish industry during that period and amid concerns of the problems of an ageing fleet, a fleet modernization programme was introduced in 1999/2000. While the numbers of actual vessels replaced was a relatively small fraction of the total fleet, the capacity in terms of both length and power were considerably greater than the rest of the fleet.

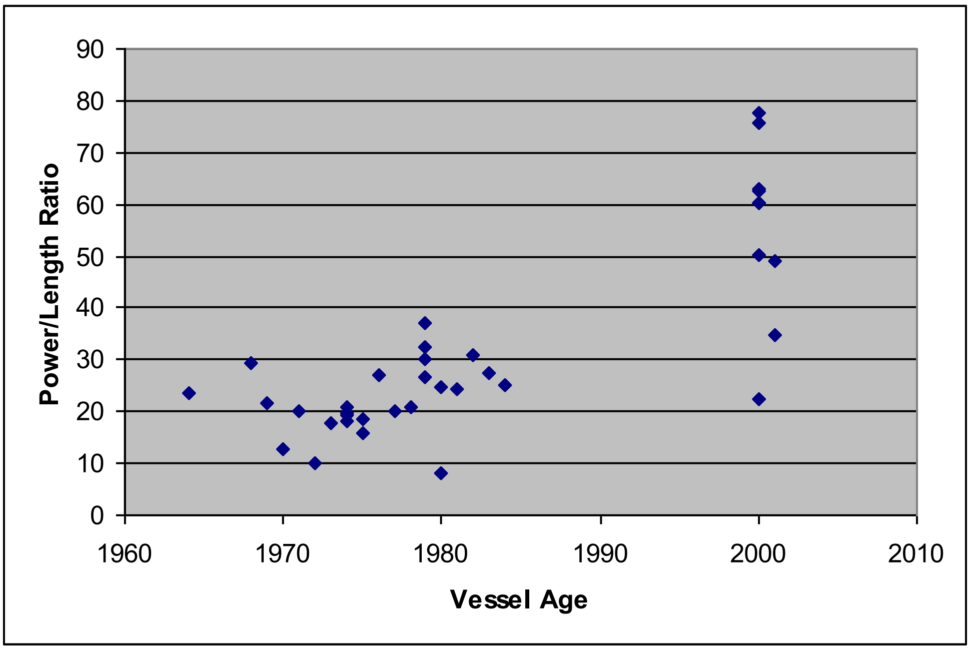


Figure 3.2.11. Relationship between vessel age and ratio of power/length

While vessel size/power (or some function thereof) nominally represents fishing capacity, it is the combination of fishing vessels characteristics such as the fishing platform and the size of the gear deployed that constitute the physical overall capacity (individual skill representing human capacity). In order to explore the hypothesis that larger vessels have greater capacity due to the deployment of bigger nets, the data were explored to assess the relationship between vessel size and the size of trawl used. The choice of appropriate gear metrics is not clear, and there are many ways of measuring the size of a net. However, based on the commonalities with other studies (SGEM, 2009), we focused our examination of the relationship between gear and vessel on length of ground gear and on fishing circle.

For the ground gear, the total length of the ground gear including the foot rope and any extensions is used. The ground gear length can be used to give an indication of the net swept area for a given trawl. Net swept area in this case would be a function of the distance between the wings and the distance towed. Clearly, the distance between the wings is not the same as the ground gear length, due to the curve in the ground gear during towing. However, it can be assumed that the longer the ground gear, the greater the wing spread, and hence swept area for any given length of tow. For the fishing circle, information on the mesh size at the front of the net and the number of meshes round the opening, quantifies the fishing circle in metres. This can be used with the tow distance to estimate the net swept volume for a given trawl. These two metrics; fishing circle and ground gear length were considered as representing the "fishing power" of the vessel. The greater the fishing circle and/or ground gear length, the greater the fishing power. As a working hypothesis, it is postulated that swept volume would be most important for fishing power for whitefish vessels, and so fishing circle would be the main metric. These nets tend to have a large vertical opening. Conversely, swept area would be most important for *Nephrops* boats and for other groundfish species such as monkfish and megrim, for which the gears have a small vertical opening relative to groundgear length (scraper nets), hence gear length the main metric. Theses two trawl derivatives were noted by the interviewees with the latter scraper type net introduced as a consequence of the opening of markets due to the accession of Spain to the EC in 1986.

Data were available for two well defined sectors or métiers in relation to the vessel characteristics, and gear size is considered as an indication of fishing power. So, for the vessels sampled in a given sector, the combined fishing power would be the sum of the ground gear length or the cross sectional area of the net. There was evidence that some of the vessels were using nets smaller than they were capable of towing. In such cases we examined what the effect would be on the combined fishing power if the larger vessels were to have used the largest gear possible. For example, if vessel A of 500Hp towed a gear with a 50m ground gear, then all vessels of higher power should also be able to tow the same net. This was taken as representing the difference between actual, current fishing power, and the potential fishing power of the vessels if they were to tow the largest possible gear. It should be noted, that there are many possible reasons why a larger vessel may not tow a gear as big as a smaller one. There could simply be physical constraints on the deck. The boat may be considered more efficient with a smaller net, or the skipper may choose a smaller net for operational reasons. Anecdotal information suggests that vessels with a high power to gear size ratio, are better able to fish in poor weather.

*Irish Celtic Sea (VIIj,g) demersal otter trawling for mixed whitefish*

There are sub divisions of this fleet using 'clean' nets, where the ground-gear (footrope) is made from small rubber discs (typically less than 4" in diameter) and those operating on rougher ground using 'rockhopper' ground-gear with discs greater than 12". For vessels using 'clean' trawls there was a good positive relationship between vessel power and the fishing circle and ground gear length of the net towed (Figure 3.2.12). There were indications that the larger vessels could potentially increase the swept volume by at least 63% by towing larger nets (based on the difference between the largest and smallest net).

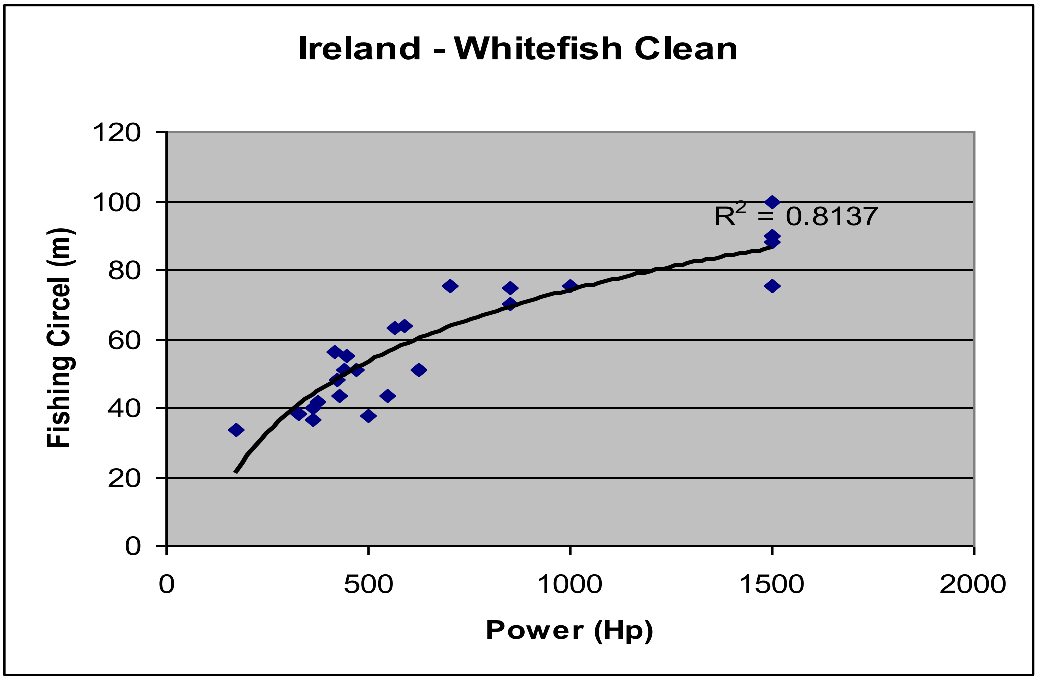


Figure 3.2.12. Relationship between fishing circle (stretched length) and vessel power for whitefish nets with 'clean' ground-gear.

There are indications of a positive relationship between vessel power and ground-gear length for Irish whitefish vessels using 'clean' ground-gear, although the relationship is not as marked as see with the relationship between fishing circle and power (Fig. 3.2.13). This suggest that while the size of the main body of the trawl increases with power, this does not necessarily result in matched increases in ground-gear.

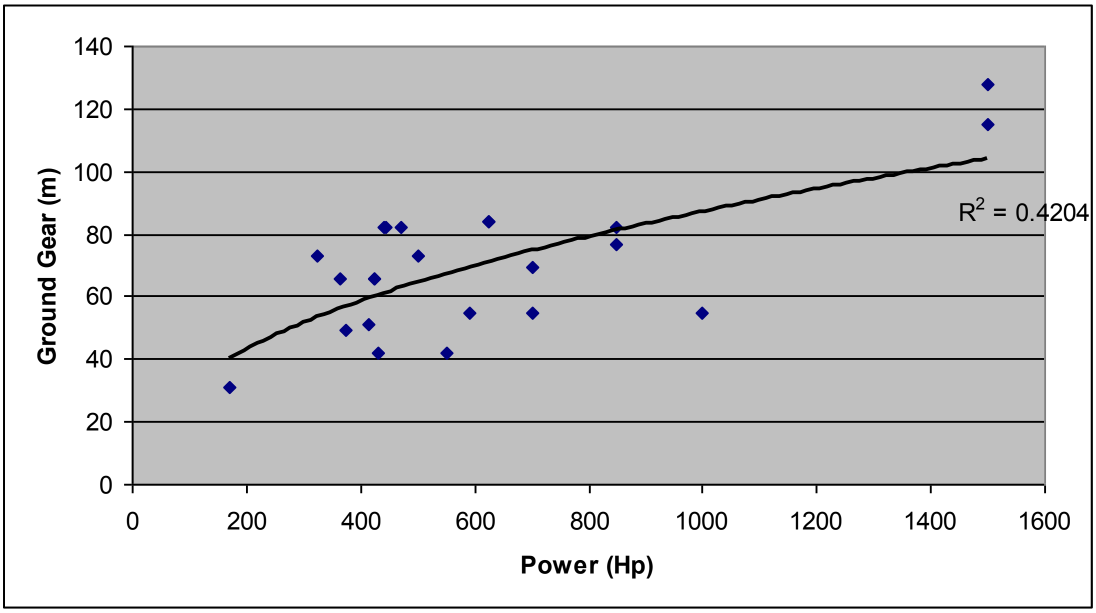


Figure 3.2.13. relationship between vessel power and length of ground gear for the Irish whitefish single trawls with 'clean' ground-gear.

Vessels of less than 1000Hp towing trawls with rockhopper ground-gear showed a good positive relationship between vessel power and the fishing circle of the net towed (Figure 3.2.14). For vessels greater than 1000Hp, there was no relationship between vessel power and the fishing circle of the net towed. There was no relationship between vessel power and the ground-gear length of the net towed.

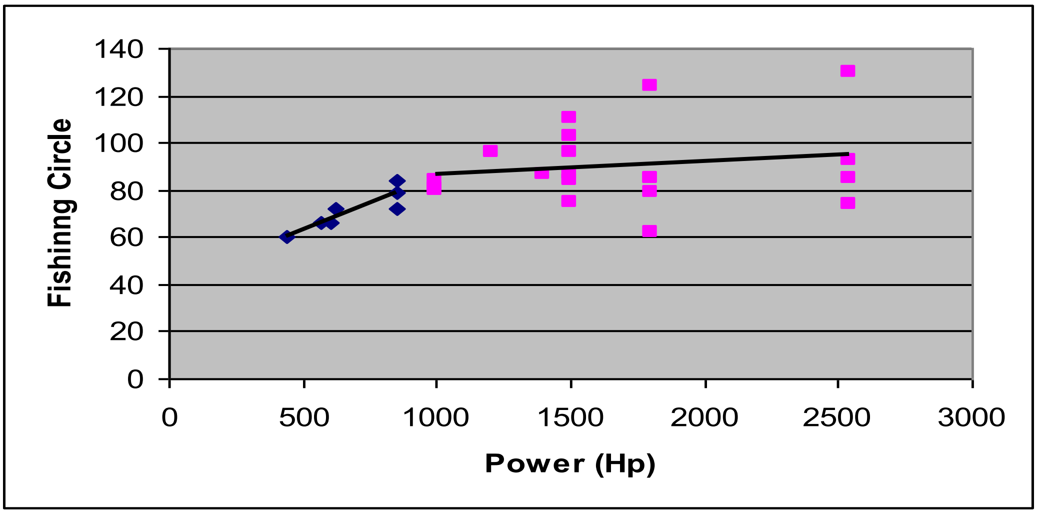


Figure 3.2.14. Relationship between vessel power and fishing circle for Irish whitefish rockhopper (disc size >8") single trawls. The trend lines are logarithmic fits in Excel. For vessels below 1000Hp the $R^2$ was 0.78, for the larger vessels it was close to zero (0.03)

As with the Irish 'clean' whitefish trawls, the relationship between ground-gear length and power is less well defined, although there is indication of a weak positive relationship (Fig. 3.2.14).

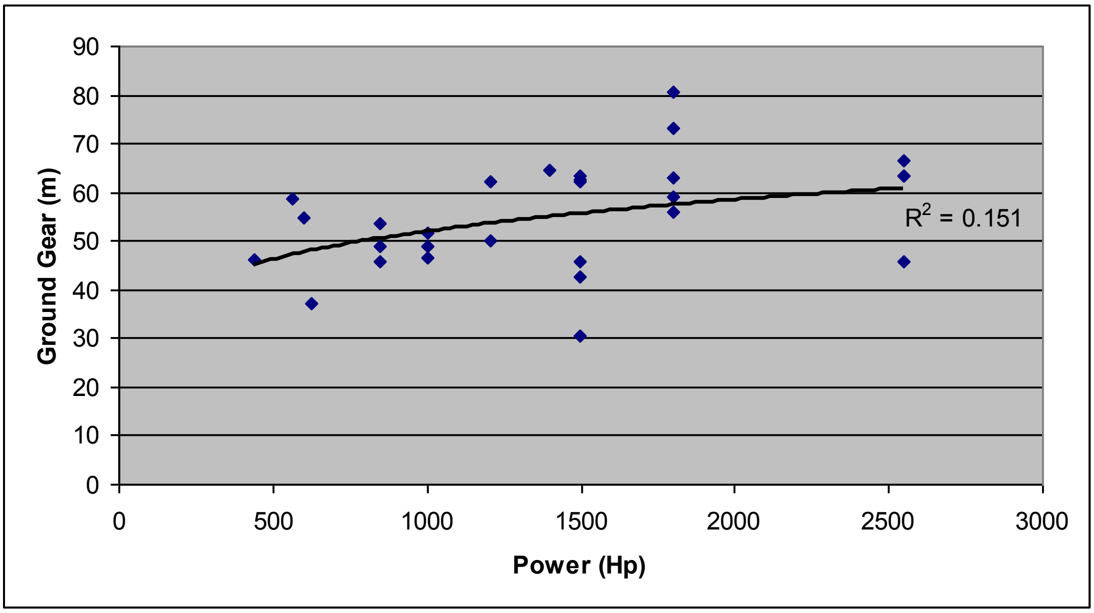


Figure 3.2.15. Relationship between vessel power and ground-gear length for Irish 'clean' whitefish otter trawls.

*Twin trawl Nephrops vessels*

For twin-trawl *Nephrops* vessels, there is a clear relationship between vessel power and fishing circumference (Fig. 3.2.16). The trend is more pronounced than that observed for Scottish vessels (SGEM, 2009) albeit with fewer data points. There is some evidence of closer correlation between the two parameters for vessels <400hp, with greater variability above, a pattern similar to the whitefish trawls.

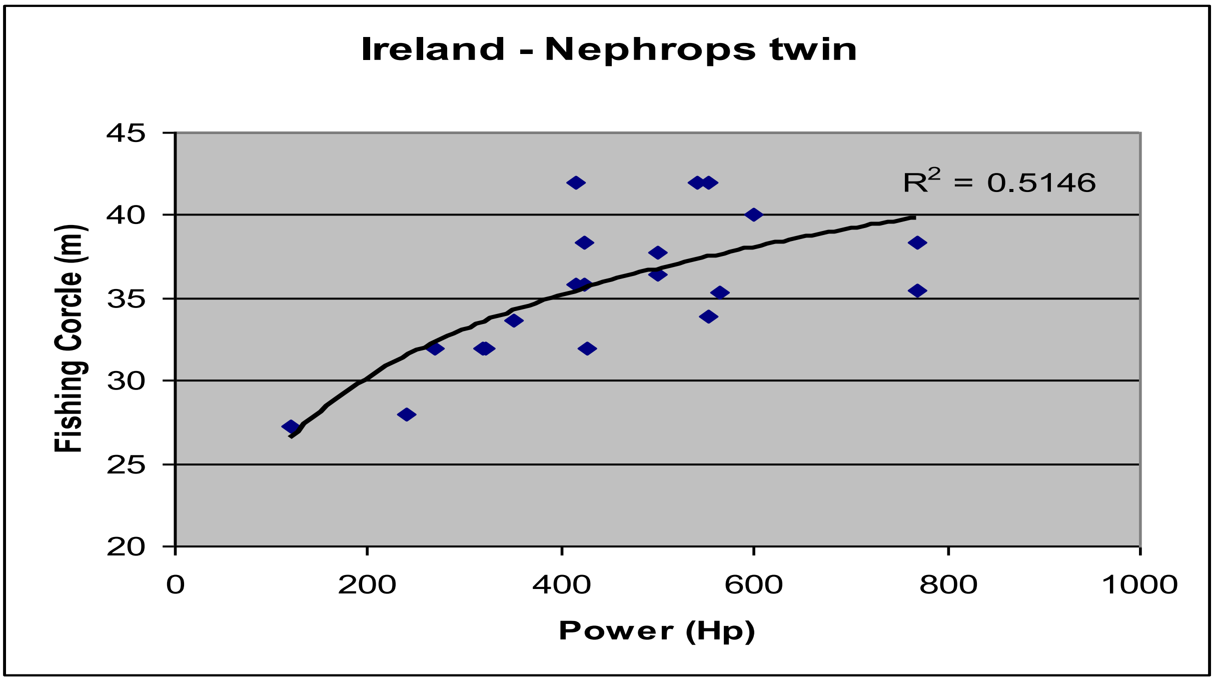


Figure 3.2.16. Relationship between vessel power and fishing circle for Irish *Nephrops* twin trawls. The trend line is a logarithmic fit in Excel.

There is a strong positive correlation between ground-gear length and power for Irish *Nephrops* twin trawls (Fig. 3.2.17) with little variation throughout the data range indicating that the vessel power is a reasonable proxy for effective swept area in this fleet segment.

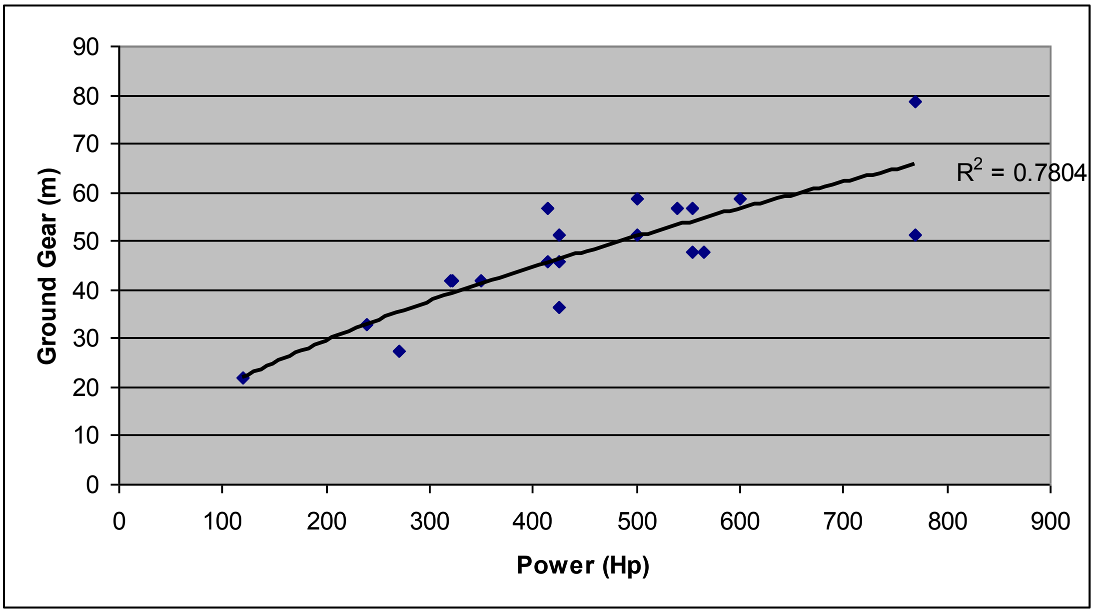


Fig. 3.2.17 Relationship between vessel power and ground-gear length for Irish *Nephrops* twin trawls. The trend line is a logarithmic fit in Excel.

From the data presented, it is clear that the relationship between vessel power and the size of the gear deployed is not straight forward. For whitefish vessels using rockhopper nets, the relationship has a 'hockey stick' shape, where below a certain vessel power, there is reasonable linear relationship between vessel power and gear size. This suggests that up until a certain point, vessel power is a reasonable proxy for the size of gear towed. This has also been observed for the Scottish demersal rockhopper trawlers (SGEM, 2009). So far this describes a rather mechanical relationship; a bigger boat tows a bigger net. However, how this relationship translates into fishing mortality requires further work, evaluating the CPUE associated with the vessels and a more detailed analysis of their individual catch profile. It is highly likely that the relationship between firstly the vessel, and secondly, gear size, with catches will be highly variable, as the success of an individual vessel at catching fish is not simply a technical relationship between the vessel and the size of gear, but a significant degree of success is related to the skill of the individual fisherman at deploying the fishing unit. Beyond the point of inflection on the 'hockey stick', the relationship between vessel power and gear size generally breaks down. All the case studies presented show that beyond a certain engine size, vessel power as a proxy for gear size is not reliable due to the lack of relationship between the two parameters. This would suggest that the 'surplus' power is used for other purposes or their may be other limiting factors that constrain the size of gear deployed. There is some evidence in one data set which suggests that this power surplus is used to tow a trawl faster, thereby increasing the overall swept area. Increasing towing speed to increase swept area has been observed in the Faroese pair trawl fishery to partially compensate for effort limitations (Thomsen, 2005). What is of particular note is that from a theoretical perspective at least, many of the larger powered vessels are able to tow larger nets of a size towed by other vessels within their power band, although they apparently choose not to do so. This would suggest that there is some potential latency in fleet as vessels could adopt to use larger nets if stimulated to do so For example this could present a compensatory reaction to limits on activity, such as day and/or effort restrictions. However, it is important to ascertain why individual skippers chose not to tow larger net before assumptions can be made as to how transferable the theoretical latency is in practice. For example, it is possible that the choice to use a smaller net is due to practical restrictions such as deck space or machinery or that the design and size of the gear is optimal for a specific fishery.

#### 3.2.2.3 Fisheries Science partnership Projects

*Using fishery dependant data to design a fishery independent survey*

For the past several years there as been general industry disagreement with the scientific assessment of Celtic Sea cod, in particular stock biomass. This has led to a number of national initiatives to explore the reasons behind this differences in perception and mechanisms of how thus may be rectified. Under the auspices of this and other projects the Marine Institute has worked with fishermen from the South coast of Ireland with the objective of designing a new Celtic Sea survey as well as gathering information on the technical and fleet behavioural changes that have occurred (see section 3.2.2.2).

The assessment of Celtic Sea cod failed during a benchmark assessment in 2008 due to uncertainties in the commercial catch at age matrix. Until these issues can be resolved, ICES (2009) note that a dedicated cod survey providing fishery independent information would provide the best option. However, the current quarter-4 IBTS survey does not track cod particularly well as the population is widely dispersed at this time and catch numbers are correspondingly low. This option to develop an Industry-Science partnership survey has been discussed between the Marine Institute and the Irish fishing industry for the past several years and has culminated in the successful completion of a quarter 1 survey in 2010. The background work to this was catalysed by the Lot 1 project as part of consultations with the industry in 2008.

*Survey Trawl Design*

Industry partners included three commercial net makers, the Irish South and West Producers Organisation (ISWPO) and the Irish South and East Producer Organisation (ISEPO). The main role of the net makers was to propose initial survey trawl designs, modify these based on consultation with fishermen, build prototypes, test them at sea on commercial vessels; modify them accordingly and to produce trawls and rigs in preparation for the survey to be conducted annually.

The role of the producer organisations was to encourage fishermen to participate in a consultation meeting, discuss ideas on appropriate trawl designs and to suggest suitable survey locations. Through discussion with the project partners, 20 individual skippers with known experience of cod trawling along the south and south west coast were invited to participate in a working group meeting. 15 skippers participated in a half day working group meeting. The group comprised of a good balance of south east and south west skippers representing the inshore and offshore sectors as well as the net makers and the other partners. It is noted that their participation, time and travel was provided without cost and indicates the importance they placed on the project objectives.

From these consultations, it was concluded that there was a need to develop and conduct two parallel surveys, with an inshore and offshore survey component. The fishermen noted that there are also offshore areas where juvenile cod are prominent and that these should also be surveyed. This necessitated the design two separate survey trawls due to the differences in size of the vessels size needed to survey the inshore and offshore sites.

An initial, generic, trawl design was presented by the commercial net makers and was considered as a sound starting point but would require a number of adaptations. Following further consultation between the net makers and a number of fishermen, two prototype trawls were agreed and subsequently built. The final designs agreed by the consultation group were as follows.

*The inshore net*

460x70mm (15/20 braided twin) hopper net with 17m of hoppers 10" (centre) and 8" (wing) with 6" spacers and 3.6m rubbered (3" discs) chain extensions. Headline length is 17.9m and fishing line length of 17.1m. The group opted for 5"6' Dunbar 'V' doors to provide optimum stability together with 30m, 22mm combination single sweeps and 30m bridles, 22mm lower and 18mm upper legs.

*The Offshore net*

800x70mm (2.5mm compact twine) hopper net with 27.5m of hoppers 14" (centre 10m) and 12" (wings 8.75m) with 6" spacers and 5.8m rubbered (70mm discs) chain extensions. The Headline length is 29m and a fishing line length of 27.4m. While the Dunbar type 'V' doors are typical of those used on inshore vessels, there is a greater variety of door designs used by larger offshore vessels. These have particular hydrodynamic and stability attributes and their performance can vary depending on net and rig design. The objective was to select a door that would provide optimal stability and was least sensitive to subtleties in door rigging or towing performance of the vessel. A range of trawl doors were tested during the engineering performance trials and 850kg Thyboron type 4 were considered to be optimal for this design of net. The trawl is rigged with 70m, 34mm combination single sweeps with 45m bridles, the lower legs constructed from 18mm wire with 60mm rubbers and 18mm combination for the upper legs.

The hoppers on both nets are fitted with a stainless steel bar mounted between the two centre disks to accommodate a hanging, bottom contact sensor. This was not tested during the engineering trials, but would be used on subsequent surveys as this provides an accurate record of the 'touchdown' and 'liftoff' on and off the seabed, providing precise information on actual bottom time, which is then used to standardise the catch information between tows.

*Survey Design Process*

Conventionally, the location of individual hauls conducted in a scientific survey are randomly generated or have a fixed grid pattern within a set of physical limits such as a maximum and minimum depth and the geographic range of the survey area. These do not generally include detailed prior information on areas where a particular species is most abundant but are designed to monitor the entire stock area as it is important to see if the range and numbers in the stock is changing (increasing, decreasing or shifting). This will not normally be picked up with information on commercial catches alone, as fishermen will tend to fish in areas with the potentially highest catch rates. For individual species and age groups, these locations and how the individual species behaves to environmental factors can be very specific and including prior knowledge can greatly enhance a survey by ensuring that the key areas are covered and at an appropriate time. Fish are known to react in particular ways to environmental factors such as tidal strength, speed and direction, water colour and weather. These habits are often well known to commercial fishermen, as understanding these is central to the economic success of an individual skipper and crew. Incorporating fishermen's knowledge into the design of a survey that takes these factors into account not only benefits the design of the survey area and its timing, but can also help explain variability in survey catches.

The working group were asked to provide local information on individual locations where juvenile cod are found and what environmental conditions may influence the catch levels. It is important to note that this information was given freely by individual skippers, which should be acknowledged given the importance of local knowledge to the success of individual skipper. Figure 3.2.18 shows the proposed locations for the primary tows for the inshore survey.

For the offshore survey, the survey design of the Q1 cod survey is based on an analysis of logbook and VMS data (Figure 3.2.19) to provide spatial estimates of LPUE from 2009 data. The resolution of the data was subsequently made coarser to identify specific areas of high, medium and low CPUE. The impact of the cod closure can clearly be seen due to the lack of activity in statistical rectangle 32E3 (encircled). Note that there is a low amount of activity recorded in this rectangle due to the inclusion of data from January 2009, the month preceding the closure.

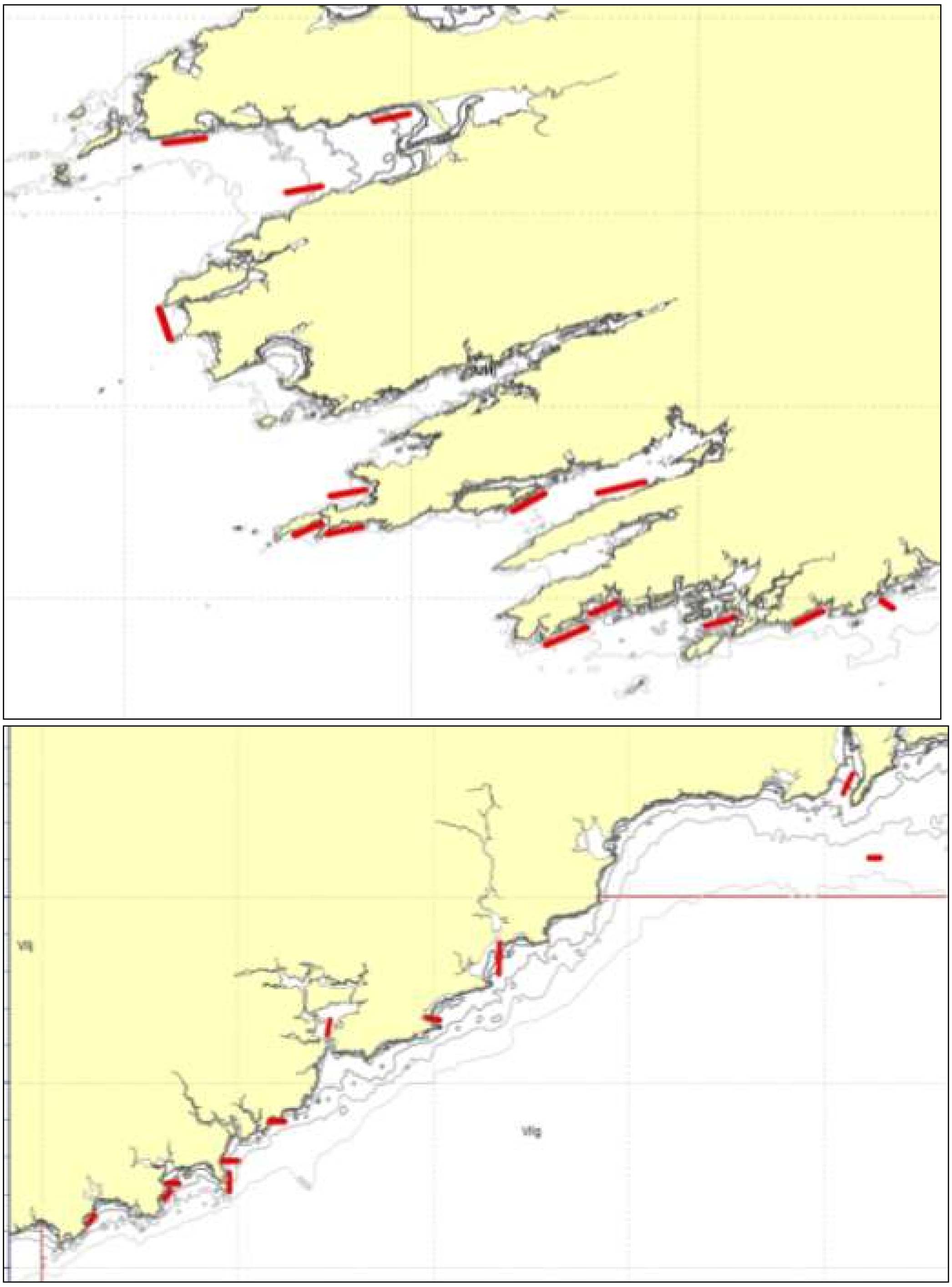

Figure 3.2.18. Locations of south west (top) and south/south east (bottom) inshore survey locations as proposed by the industry working group.

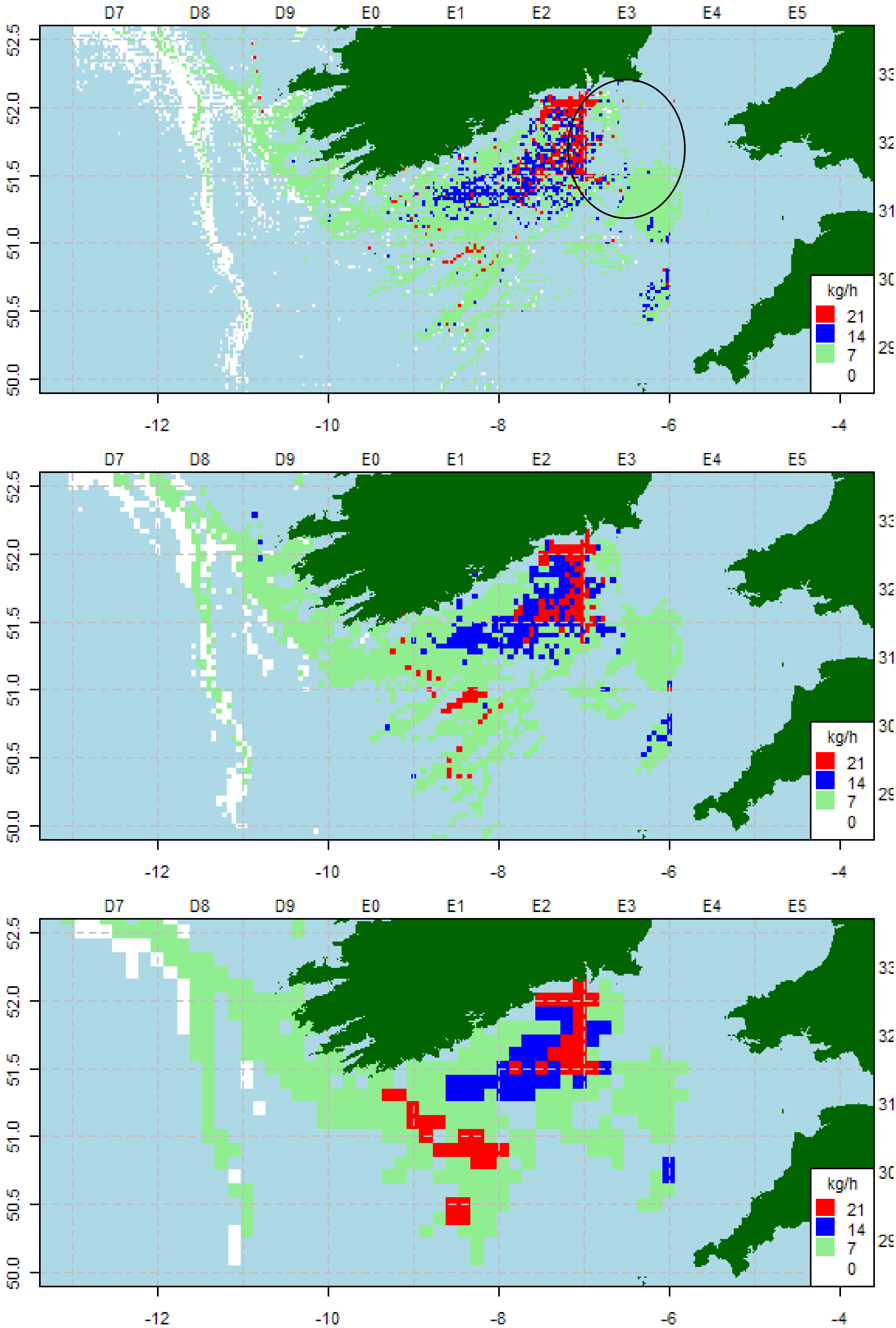


Figure 3.2.19 OTB LPUE from analysis of 2009 logbook and VMS data at varying degrees of coarseness.

The data were then used to stratify the survey into areas of high, medium and low intensity. Seventy stations were randomly selected with an intensity of 50, 30 and 20% for the high, medium and low areas respectively. In addition to the stations shown in Figure 3.2.20, the industry also selected 15 stations, which will be fixed annually.

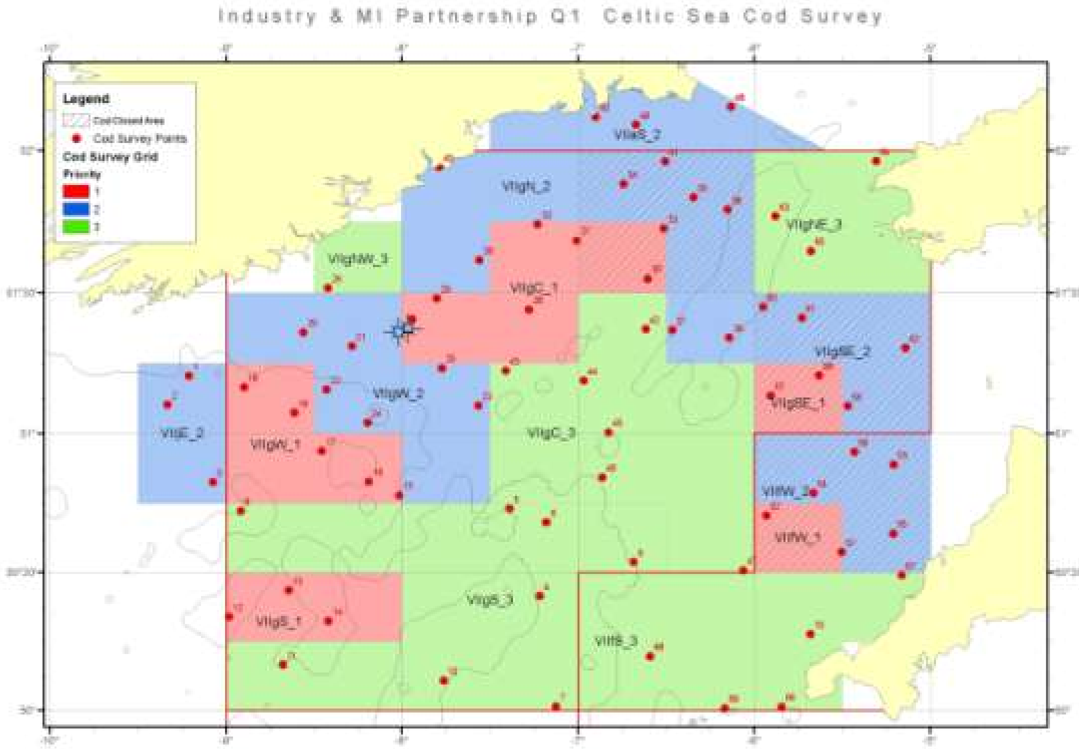


Figure 3.2.20 Locations of individual survey stations for the Irish ISP Celtic Sea cod demersal survey.

*Survey results*

Unfortunately, only funding for the Q1 ‘offshore’ survey was available so despite the inshore net being developed and build, this has not been used yet. It is too soon to present the data from the offshore survey as this was only completed on 25 March 2010. Funding has been made available for a minimum of 5 years and will be reported to the ICES WGCSE.

## 3.3 Celtic Sea Pilot Project: Belgium

### 3.3.1 Methods

#### 3.3.1.1 Fishery description

In order to provide a picture of the Belgian fisheries in the Celtic Sea (VIIf, g), fishery data from 1929-1999 were plotted into several graphs. These data are part of an initiative to reconstruct historical time-series on landings in Belgium (Lescrauwaet *et al.* 2010, in press), based on dispersed and previously neglected governmental data reported at the spatial level. It should be noted that between 1940 and 1945 no data were reported because of the Second World War. The data were provided by the Flanders Marine Institute (VLIZ) integrated database “A Century Sea Fisheries in Belgium”[3] . In terms of landings, this dataset reports gutted weights (kg). After ranking the landed species according to the yearly average weight, a top ten list of species was assembled. Thereafter, the selected species were divided into 4 groups: Dover sole, lemon sole, megrim and plaice as flatfish species; hake, whiting and cod as round fish species; dogfish and ray as elasmobranch species; herring as a pelagic species. The spatial descriptions are based on standardized and geographical delineated historical fishing grounds (Figure 3.3.1).

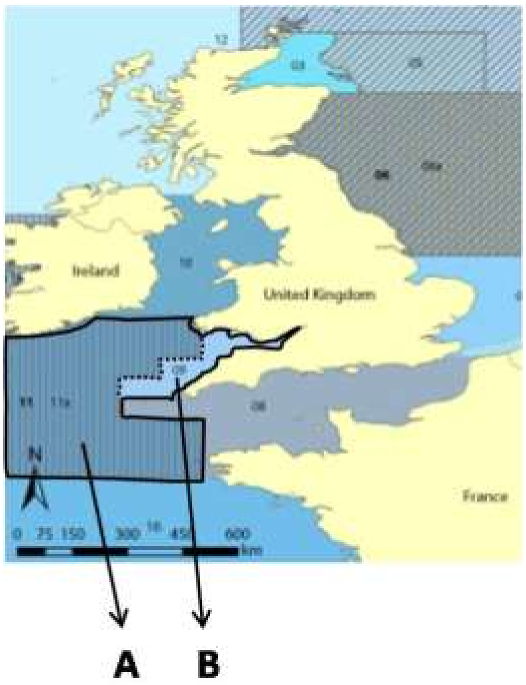


**Figure 3.3.1**: Map with standardized and geographical delineation of historical fishing grounds for Belgian vessels. Map adapted by ILVO from ‘Boundaries and names of fishing areas in historical data sources, after standardization. *Source: 'HiFiDatabase: A century of Sea Fisheries in Belgium (VLIZ, 2009)'. http://www.vliz.be/cijfers_beleid/zeevisserij/map.php*

[3] **Source: ‘A century of Sea Fisheries in Belgium’ (VLIZ 2009).** http://www.vliz.be/EN/Figures_Policy/Figures_Policy_Belgian_Sea_Fisheries

Spatial distribution of fishing effort of Belgian vessels in 2008 was examined using seasonal plots of fishing effort (days fished) by ICES rectangle as the VMS data were not available. Species compositions of landings in 2008 are presented as spatial maps showing species compositions of landings by ICES rectangle. These are given as pie charts scaled so that the diameter of the pie is proportional to the square root of the total landings per rectangle. Species were grouped in a logical way taking account of the species associations in the fisheries, to reduce the number of slices in the pies – e.g. anglerfish and megrim have very similar spatial distributions and are grouped. Small flatfish species are also grouped (plaice, sole, lemon sole, dab). These plots need to be viewed in colour, and are grouped with similar plots for Ireland, France and the UK in Appendix 3 (Figs A-3.6 & 7).

#### 3.3.1.2 Technological changes affecting efficiency

For this part of the project, we used the 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'. This questionnaire was designed to obtain a clearer picture on longer term trends in fishing activities in the Celtic Sea. The questionnaire covers the time period from 1960 until 2009, divided in 5-year periods. The first part of the questionnaire has questions on the vessel details whereas the second part focuses more on the gears and fishing activities. Initially, fishermen were contacted and asked if they were willing to cooperate. Finally nine fishermen (10% of the Belgian fleet) accepted the invitation and answered the questions to the best of their ability. They were involved in the Celtic sea fisheries during different time periods.

The numeric responses are presented in graphs (mean ± standard error of the mean) whereas for the non-numerical answers, trends were deduced. Questions for which the number of answers was too small, were not mentioned in the results. For 2008 we subtracted fresh weight (kg) data from our national database to further address the seasonal species patterns.

#### 3.3.1.3 Responses to management measures

In order to provide a picture of the responses of the Belgian Industry to the Trevose cod closure, effort data were subtracted from our national database and were plotted into several graphs. The first dataset (2008) reports fishing days whereas the second dataset (2002-2008) reports fishing hours. Furthermore, the last part of the questionnaire contains questions about the Trevose cod closure. Although in essence, sometimes anecdotal information was provided, attempts have been made to describe similar findings in a more coherent way.

### 3.3.2 Results

#### 3.3.2.1 Fishery description

In area A, from the early 50's onwards, the landings of Dover sole and plaice gradually increased, whereas megrim and lemon sole remained more or less constant over time (Figure 3.3.2). Figure 3.3.3 shows the decrease of cod and whiting landings since the beginning of the 60's. From 1950 onwards, only small amounts of hake were landed. Figure 3.3.4 shows that before 1965, landings of rays fluctuated highly between about 200 and 1200 tonnes. Since 1965, ray landings remained more or less constant around 200 tonnes. For sharks, most of the landings, for the whole time series (1929-1999) are below 200 tonnes apart from seven annual landings which are just above 200 tonnes. Landings of herring (Figure 3.3.5) were zero for many years, with significant landings of herring recorded only between 1950 and 1960.

In area B (Figures 3.3.6, 3.3.7 and 3.3.8), similar patterns for the landings of Dover sole, plaice, lemon sole, megrim, hake, whiting, rays and sharks as in area A were observed. Cod landings in area B followed a similar pattern as in area A until 1983, since then landings have fluctuated with an increasing trend from around 100 tonnes to around 300 tonnes. From 1932 until 1938, the herring landings reached a maximum but were negligible in subsequent years (Figure 3.3.9).

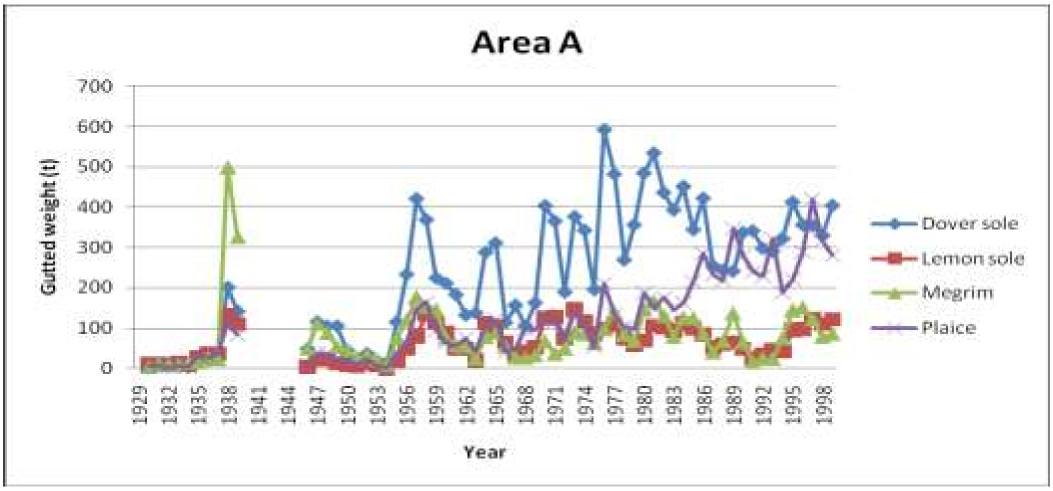


**Figure 3.3.2**: Landings (gutted weight in tonnes) of dover sole, lemon sole, megrim and plaice in area A from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

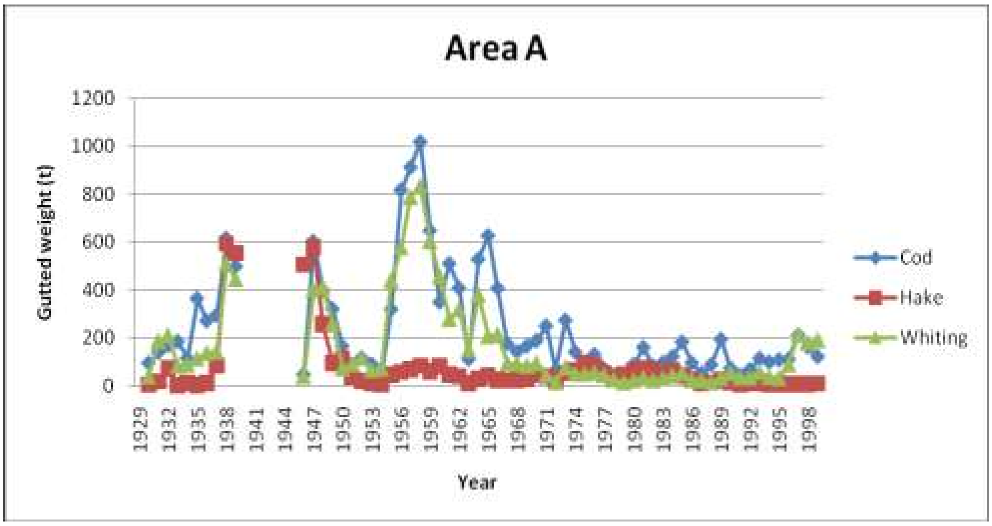


**Figure 3.3.3**: Landings (gutted weight in tonnes) of cod, hake and whiting in area A from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

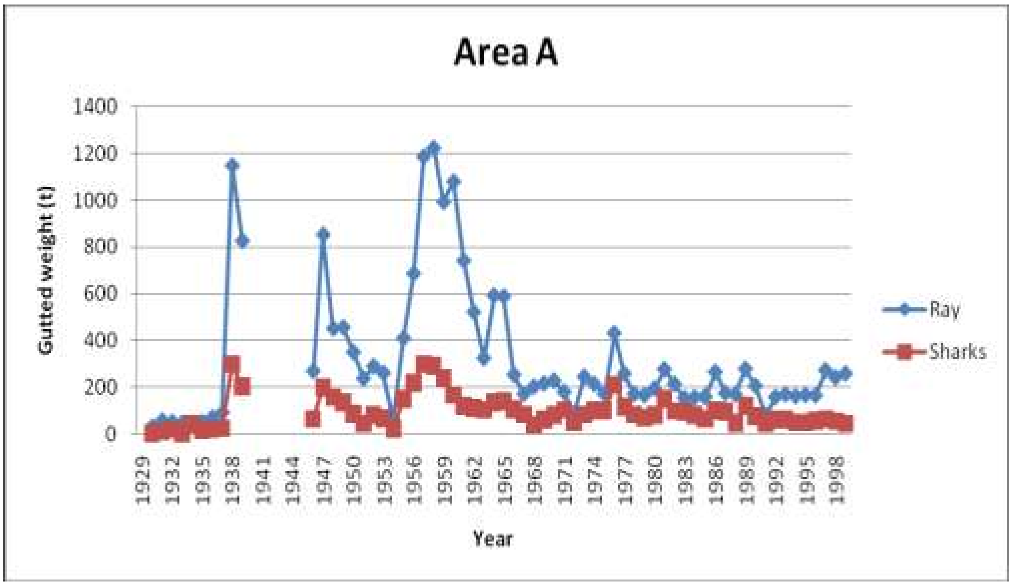


**Figure 3.3.4:** Landings (gutted weight in tonnes) of ray and sharks in area A from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

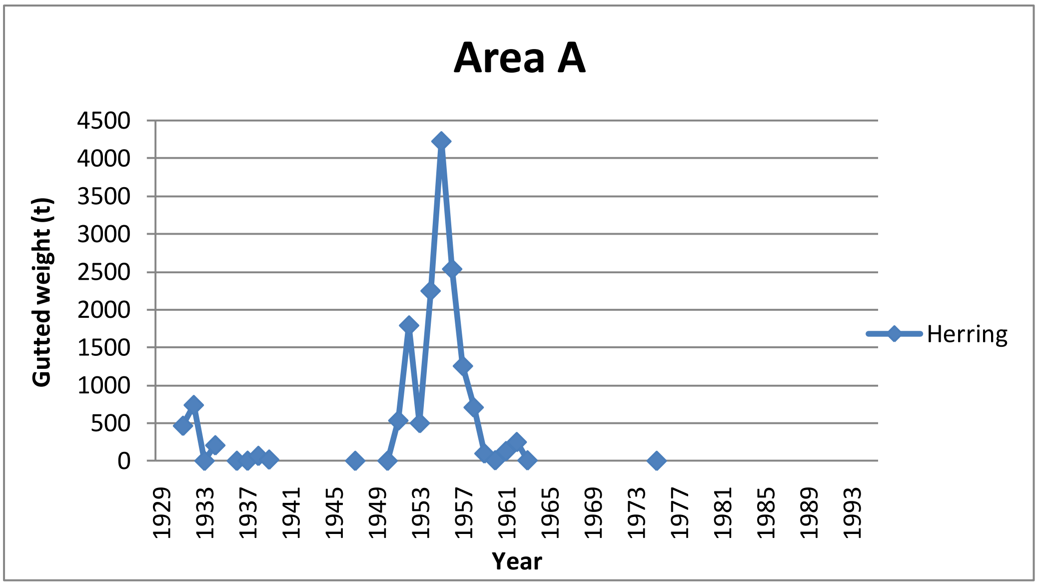


**Figure 3.3.5**: Landings (gutted weight in tonnes) of herring in area A from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

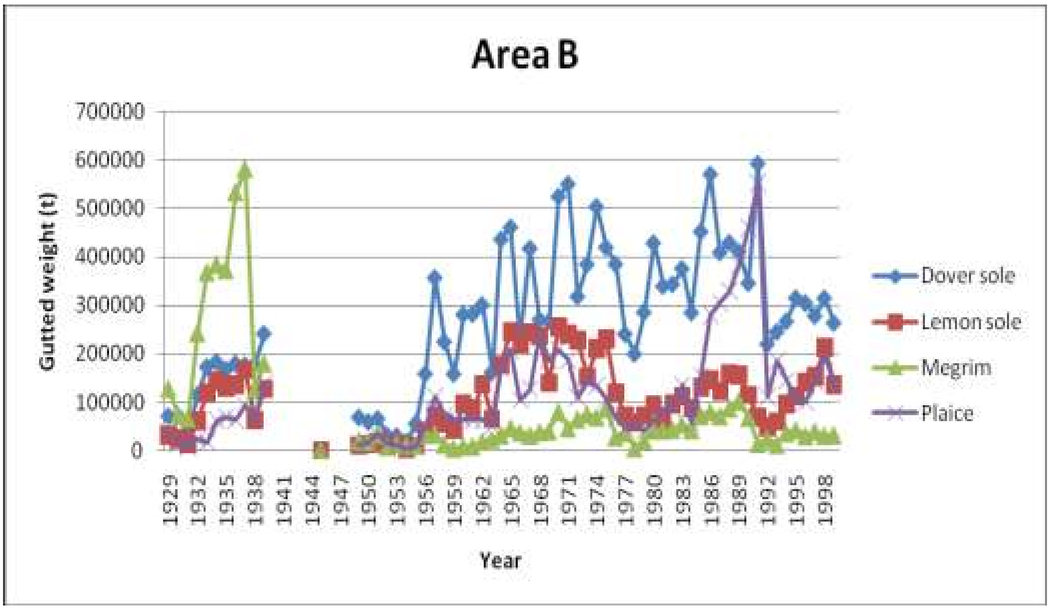


**Figure 3.3.6**: Landings (gutted weight in tonnes) of dover sole, lemon sole, megrim and plaice in area B from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

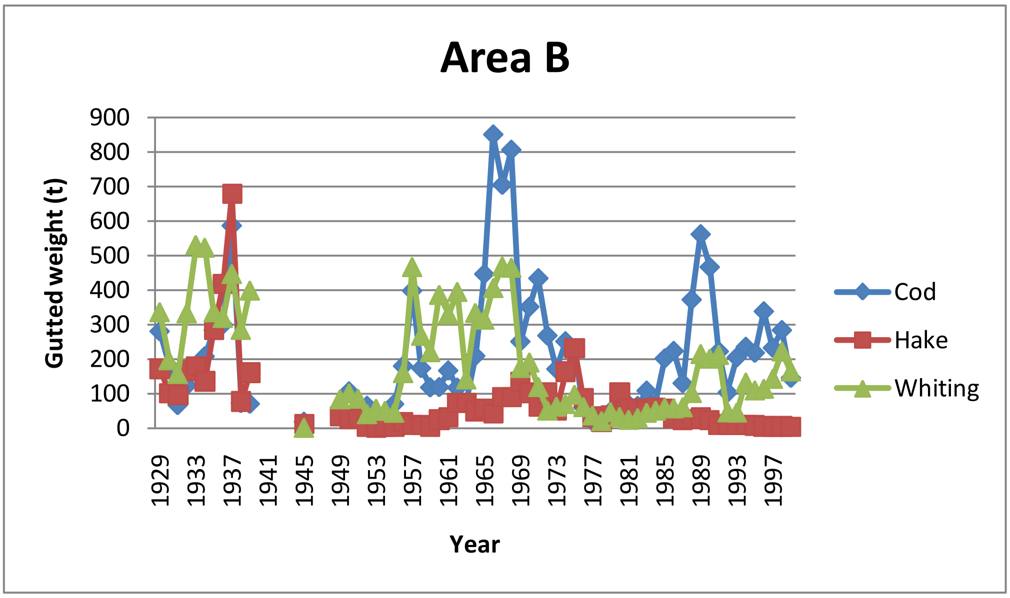


**Figure 3.3.7**: Landings (gutted weight in tonnes) of cod, hake and whiting in area B from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

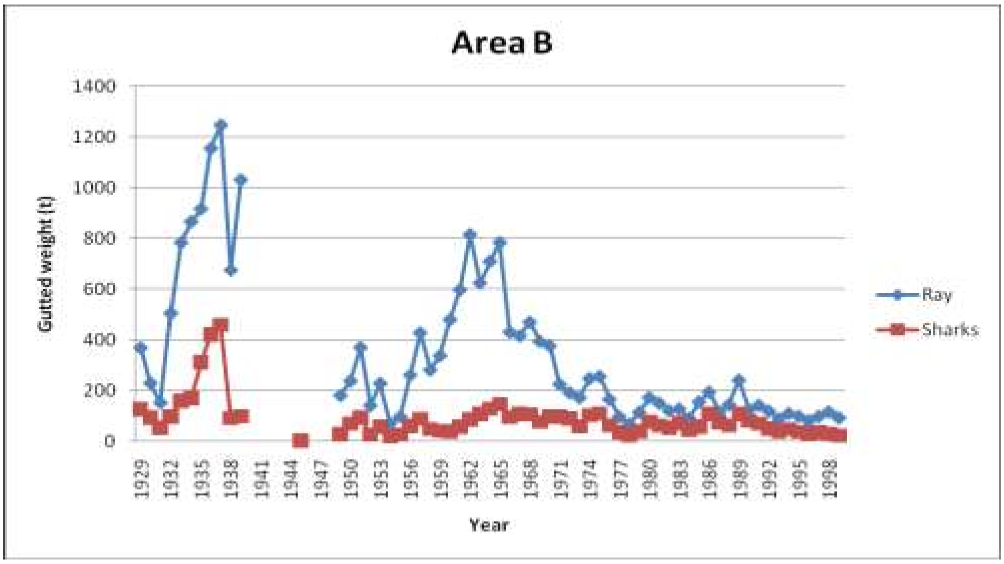


**Figure 3.3.8**: Landings (gutted weight in tonnes) of ray and sharks in area B from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

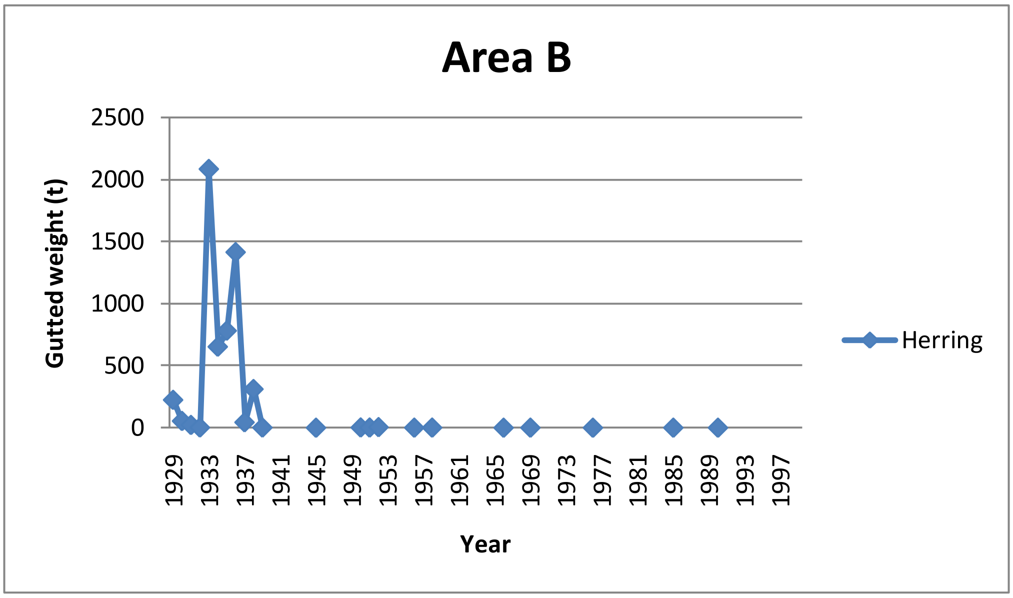


**Figure 3.3.9**: Landings (gutted weight in tonnes) of herring in area A from 1929 up to and including 1999. Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009)

### 3.3.2.2 Technological changes affecting efficiency

*General evolution of the Belgian fleet*

After World War II, the Belgian fishing fleet was dominated by diesel powered side trawlers that targeted demersal species in the winter and pelagic species in the summer months. In the early 60's, the modern beam trawl was successfully introduced in the Belgian fleet. Whereas in most European countries the fishing fleet evolved from side to stern trawlers, the Belgian fleet evolved into a beam trawler fleet. By the end of the 80's, over 80% of the fleet consisted of beam trawlers. Today, the Belgian fishing fleet is still dominated by beam trawlers.

*Vessel details*

Through time (from 1960 until present), the overall length of the vessels almost doubled (from 23.7 m to 41.5 m (Figure 3.3.10)). Also the tonnage and horse power of the vessels gradually increased from respectively 81.7 GRT to 286.6 GRT (Figure 3.3.11) and 192 kW to 1205 kW (Figure 3.3.12). From the 1970's onwards, all the vessels were made of steel and an upper deck with overhead protection for the weather became more and more in use. Ten years later, all the vessels were provided with a shelter deck and a nozzle was introduced. Overall, a fixed propeller type was put into place. In the 1960's, you could by exception find a ship with a reduction box, whereas afterwards it was a general tool on all vessels. In the beginning of the time series (1960's), the winch was driven by a belt, whereas in 1980's the electric motor came into operation. However, it has taken ten years until the electric drive system was commonly used. In the mean time, the hydraulic winch power was also introduced, but the electric power system remained the most popular.

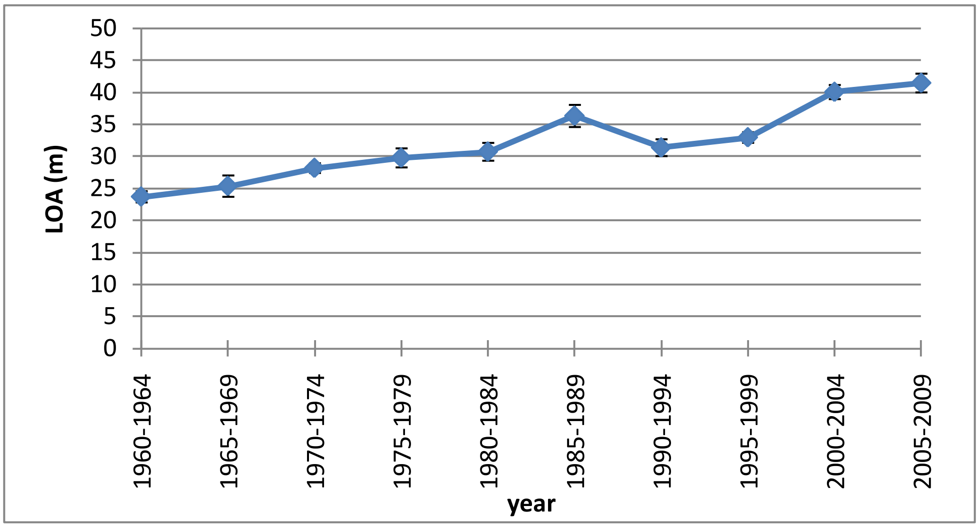


**Figure 3.3.10**: The vessel length overall (metres) for Belgian vessels from 1960 up to and including 2009 in 5-year periods. Source: 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'- filled out by Belgian fishermen.

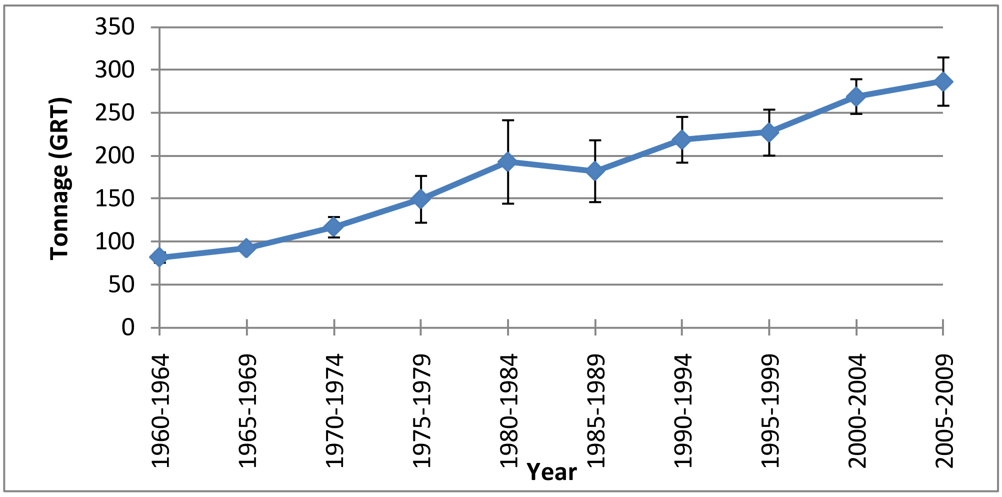


**Figure 3.3.11**: The vessel tonnage (GRT) from 1960 up to and including 2009 in 5-year periods. Source: 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'- filled out by Belgian fishermen.

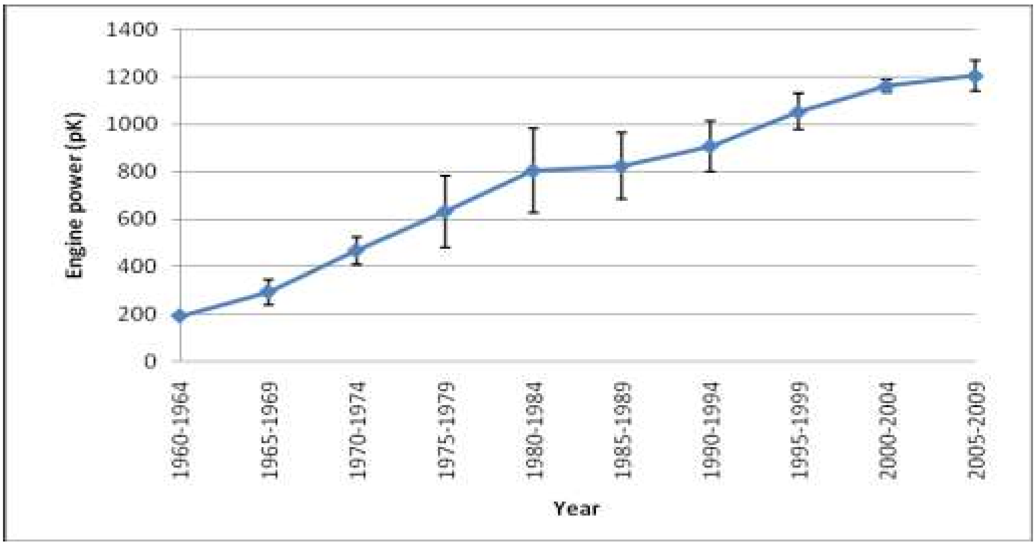


**Figure 3.3.12**: The vessel engine power (horse power) from 1960 up to and including 2009 in 5-year periods. Source: 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'- filled out by Belgian fishermen.

Initially, the catch was collected on deck, whereas from 1985, the catch handling system was improved with the introduction of a catch collection box and conveyer belt. The landings were stored in the fish room (dry hold type).

With the early navigator system, Decca radio navigation signals were received and the vessel's track was registered on paper. From 1980 registration was also recorded by video. Five years later, the global positioning system (GPS) won ground and from 2000 onwards, the navigation of every ship relied on GPS. An echosounder was always present on board. Until 1990 no net monitoring system was used whereas afterwards only a few vessels were equipped with such a system.

*Gears and fishing activities*

Beam trawls
Through time (from 1970 until present), the nets were made by the fishermen themselves. The trawls were equipped with 2 beams, one on each side of the vessel. The beam width gradually increased over time (from 6.63 m to 10.53 m (Figure 3.3.13)). Overall the gears were provided with a chain mat. An open system (tickler chains) is an exception. In 1985 a flip-up rope was introduced. From 2000 onwards all beam trawls had a flip-up rope and wheels were introduced. From 1970 until the mid 1980's the codend mesh size increased by 6 mm (Figure 3.3.14). From that time onwards only a small increase of the mesh size is noticed. At present the average mesh size used, varies between 80 and 85 mm. In the period 2000-2004, the fishermen started using escape panels (120 mm). Afterwards, many others followed their example. The length of a fishing trip decreased from around 16 days (in the 1970's) to around 10 days at present (Figure 3.3.15).

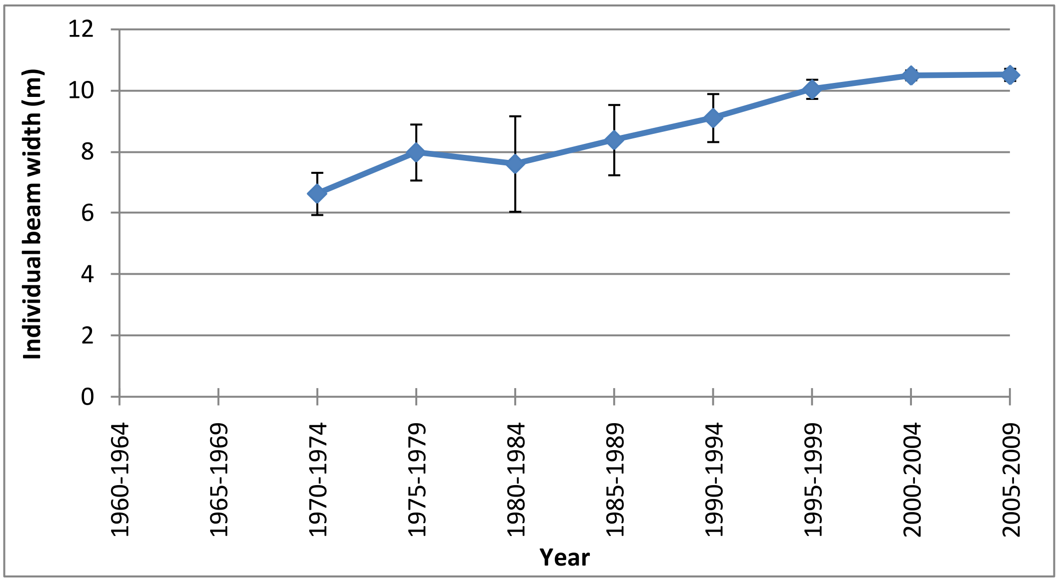


**Figure 3.3.13**: The individual beam width (metres) of beam trawl vessels from 1960 up to and including 2009 in 5-year periods. Source: 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'- filled out by Belgian fishermen.

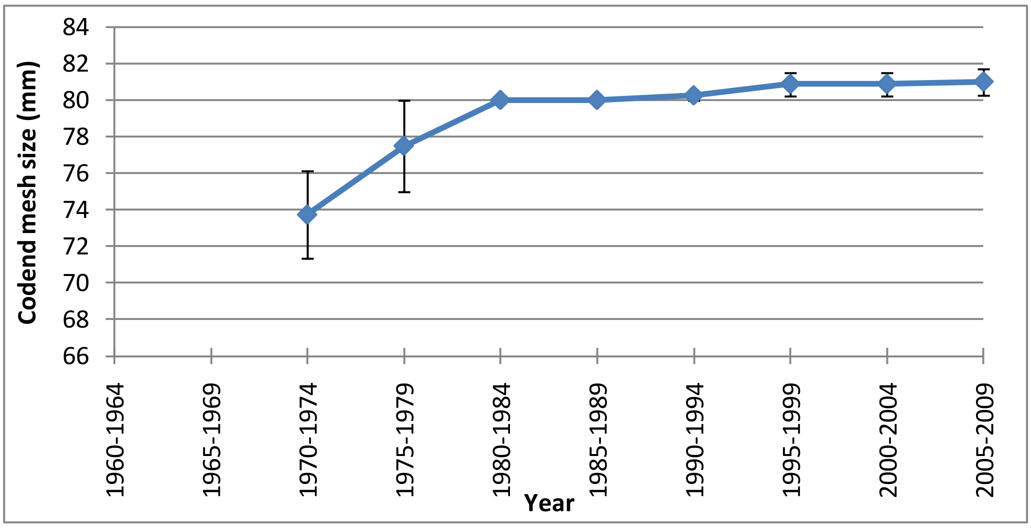


**Figure 3.3.14**: The codend mesh size (millimetres) of beam trawl vessels from 1960 up to and including 2009 in 5-year periods. Source: 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'- filled out by Belgian fishermen.

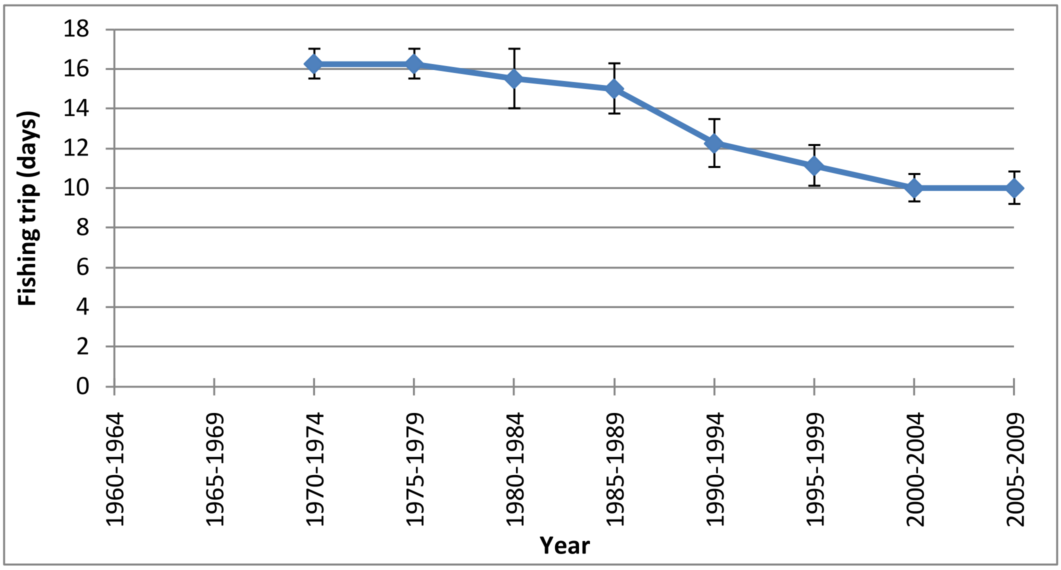


**Figure 3.3.15**: The length of the beam trawl fishing trip (days) from 1960 up to and including 2009 in 5-year periods. Source: 'CEFAS questionnaire 'CFPO collaborative pilot project on Celtic Sea demersal fisheries'- filled out by Belgian fishermen.

Over the entire time period and over the 4 quarters, sole is by far the key target species for beam trawlers, followed by lemon sole. Until 1980 rays were one of the important landed species, whereas afterwards less of these species were caught. From the 1980's, brill on the other hand, became also one of the target species. Together with turbot, brill became more important through time. Looking over the whole time period, cod and whiting were mainly caught in the first quarter of the year, with the contribution of cod landings being the more significant. Plaice is a target species in the first and last quarter except for the 2005-2009 period. Anglerfish is also an important key species, although its contribution is quite variable throughout the years and seasons.

Appendix 3 Figures A-3.6a,b show a high variety of species caught by the beam trawlers in 2008: sole, plaice, lemon sole and dab represent the biggest part of the catch. Furthermore, the elasmobranch species, anglerfish and megrim are also of importance. Smaller quantities of cod, whiting and haddock are landed. In the second half of 2008 the catch proportion comprising elasmobranchs increased, whereas that of cod, whiting and haddock decreased.

<u>Otter trawls</u>
Information for the otter trawls is only available for of a small part of the time frame: from 1960 until 1980 and from 2005 until 2009. Moreover, some of the questions on the questionnaires were rather poorly answered.

Over the two periods, mainly single-rig otter trawls were active. To our knowledge, in recent years only one Belgian stern trawler practised twin-rig trawling in the Celtic Sea. Next to this, some beam trawlers practise outrigger fishing for fuel economy reasons. All of the nets were made by the fishermen themselves. Furthermore, it was not possible to recognize a pattern in the type of groundrope (clean-rockhopper-bobbins) used. In the period from 1960 until 1980, the length of the fishing trip gradually declined from around 17 to around 15.5 days. Later on (2005-2009), the fishing trips were even shorter (around 9 days). Between 1960 and 1980, sole was the main target species in all 4 quarters. In the first, second and last two quarters, cod, lemon sole and rays were the second most caught species, respectively. In the first and last quarter of the most recent period, sole was the key target. In the second and third quarter, rays were as important as sole.

Appendix 3, Figures A-3.7a&b (Source: 'national database') show that sole, plaice, lemon sole, dab, elasmobranchs, anglerfish, megrim, haddock and whiting represent the overall landings of the otter trawls. The proportion of haddock, whiting and elasmobranchs increased substantially in the second and third quarter of 2008.

*Fishing grounds*

Milford, the Smalls, Pendeen, Trevose head, the Trevose box and Lundy Island (fishing grounds in VIIf and the eastern part of VIIg) were mentioned as fishing grounds of importance for the Belgian fishermen. Lundy Island (rectangle 31E5) was visited throughout the whole year for the entire time frame (1960-2009). Until the 90's, the Milford fishing ground was mentioned in the 3rd and 4th quarter of the year, whereas afterwards the fishermen were active in this area throughout the whole year except in May and June. The Smalls was mostly visited in the second half of the year, whereas after 1980, there was a shift more towards the beginning of the year. For the entire time period, the Trevose head area was reported as an important fishing ground in the first 4 months of the years. Until the 1980's, the fishermen only fished in the Pendeen area from January up to and including April, whereas afterwards also from October up to and including December. The Trevose box (30E4, 31E4 and 32E3) and the nearest surrounding rectangles are successful fishing grounds in the beginning of the year (January-April). From the 70's onwards, there was a modest shift more towards the end of the year.

#### 3.3.2.3 Responses to management measures

According to the Belgian fishermen who were interviewed, the area comprising the Trevose cod closure is a very popular area in spring. Before the closure, it was the favourite fishing grounds for the beamers, especially in the first quarter. The main species targeted were in order of importance, sole, lemon sole, anglerfish, cod and plaice. Since the closure was introduced, they moved to the North Sea and the eastern English Channel in February and March. In those alternative areas, sole, plaice, anglerfish, lemon sole and cod (in order of importance) were the key species targeted by beam trawls.

The opinions on the effectiveness of the closure were divided. However the majority of the interviewed fishermen stated that the closure is not effective because of the low concentration of cod in the Trevose box. Moreover, the closure in February and March caused a major shift in effort in these rectangles to the beginning of April, creating a temporal concentration of fishing.

The importance of the Trevose box for Belgian beam trawl fishery is shown in Figure 3.3.16. Note that some effort is apparent in the closed boxes in February and March because the data were provided with auction dates rather than actual catch dates, resulting in some catches in January being plotted as taken in February. In the first half of 2008, rectangle 30E4 had the highest effort of the three Trevose rectangles, whereas in the second half, rectangle 31E4 seemed to be the most important. In contrast to February and March where the lowest effort is reported, the fishing activity in April, May and June is most pronounced. The Belgian otter trawls (Figure 3.3.17) were also active in the Trevose box in months outside the closure period in 2008 although to a lesser extent than the beam trawls. For the former the highest effort was noticed in the summertime.

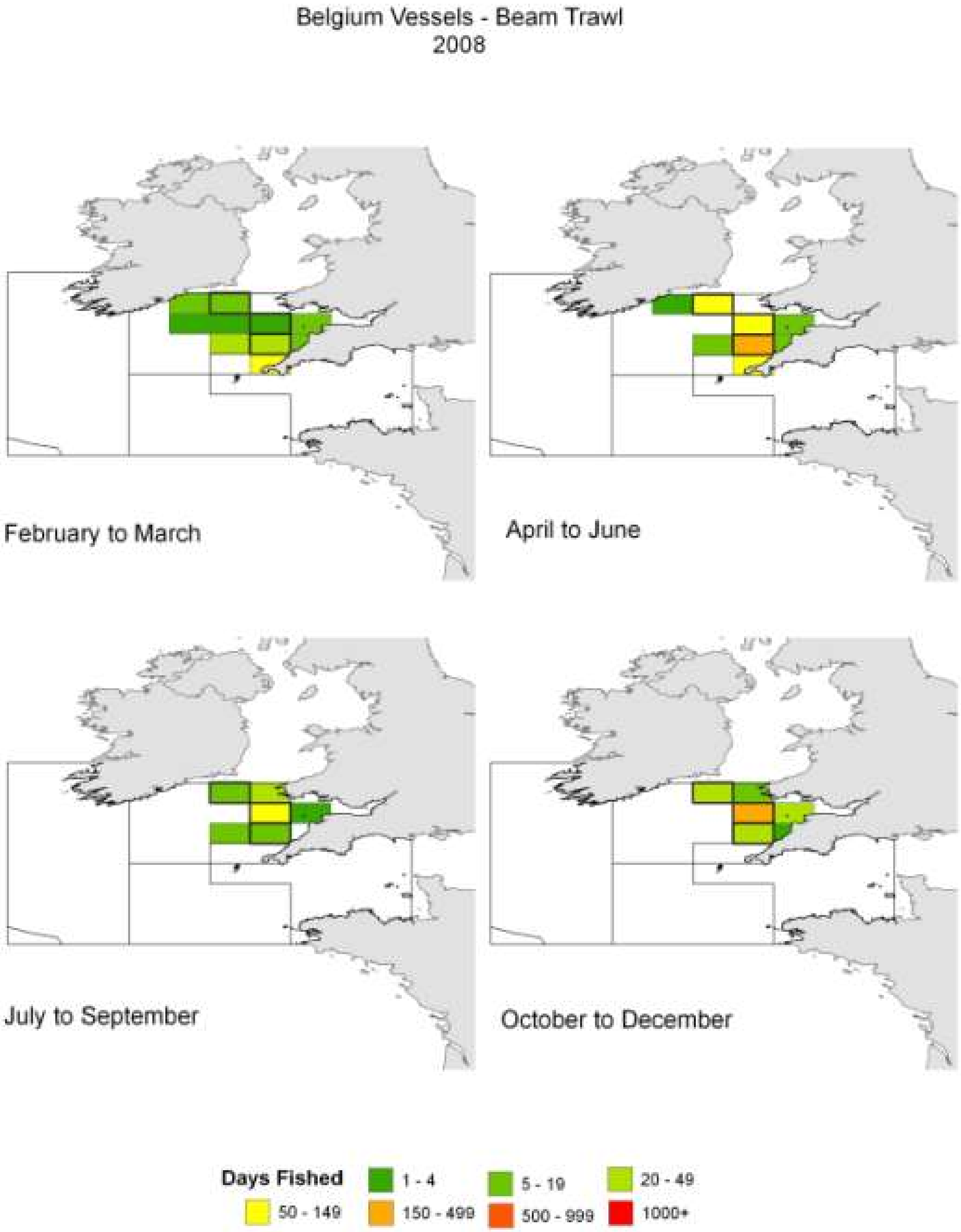


**Figure 3.3.16**: Fishing effort (days fished) by rectangle of the Belgian beam trawlers in 2008. The hatched area represents the Trevose box. *Please take into account that the data are based on the auction date instead of the fishing date, which results in a minor temporal shift.* Source: 'national database'

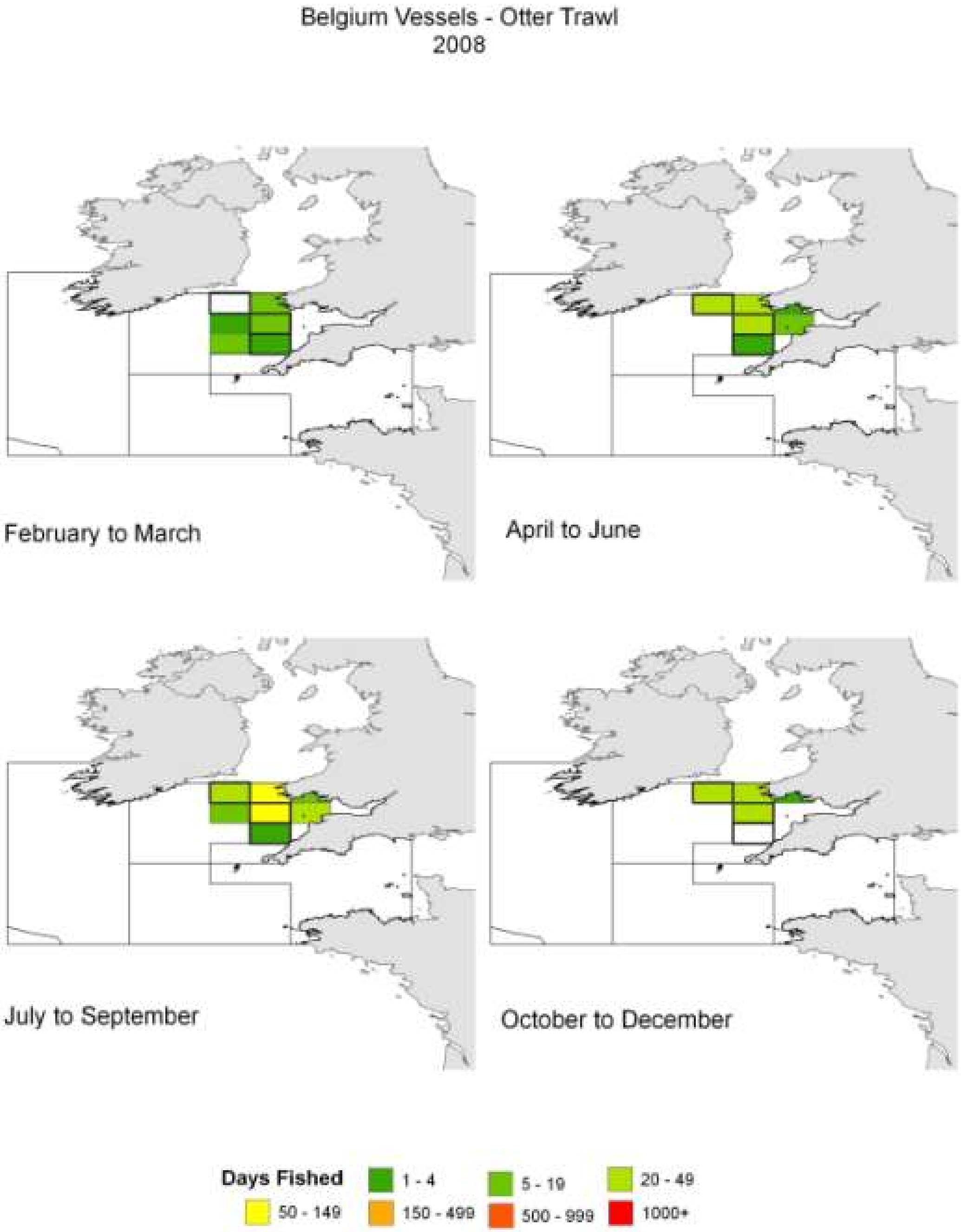


**Figure 3.3.17**: Fishing effort (days fished) by rectangle of the Belgian otter trawlers in 2008. The hatched area represents the Trevose box. *Please take into account that the data are based on the auction date instead of the fishing date, which results in a minor temporal shift.* Source: 'national database'

The monthly fishing hours of beam trawls are shown for the most important Belgian fishing areas in 2002-2004 before the Trevose closure (Fig. 3.3.18), in the first year of the closure (2005) when beam trawlers were allowed access during March (Fig. 3.3.19), and in 2006-2008 when no trawling was allowed in the closure in February and March (Fig. 3.3.20). For area IV and VIIa, no obvious change in effort was seen during the months of February and March when the closure was introduced, whereas in those months the areas VIId and VIIe both show a striking augmentation of Belgian beam trawl effort after the closure. In 2005 this augmentation could only be reported for February, as the Trevose closure was open to beam trawls in March. For the different time periods, the areas VIIIa and VIIIb are mainly visited during summer time.

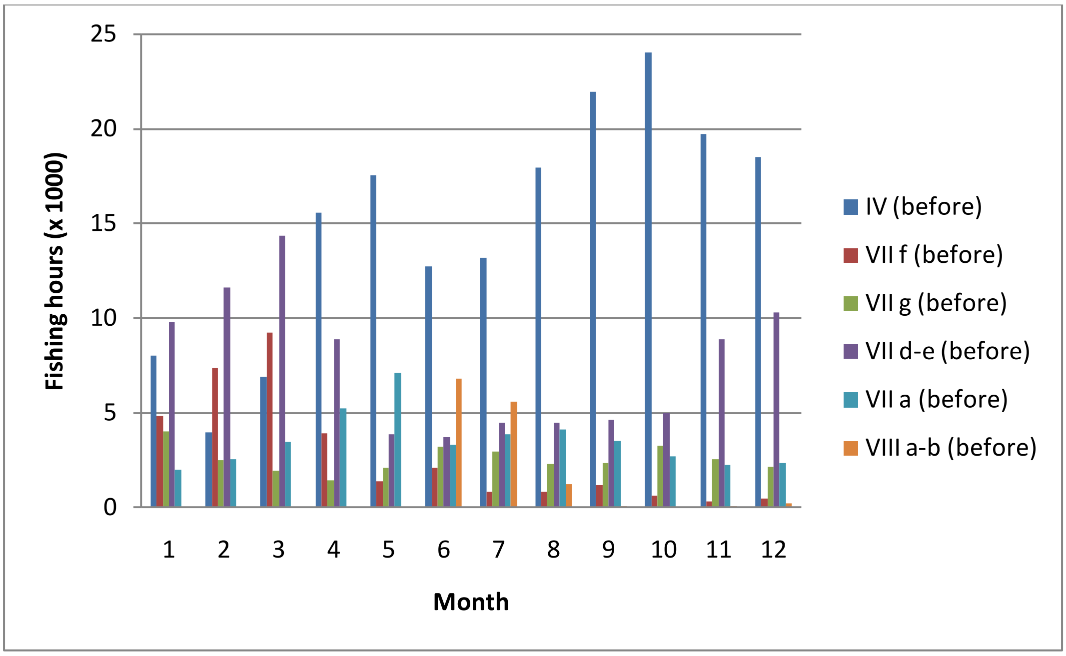


**Figure 3.3.18**: The monthly fishing hours of the beam trawls for the most important Belgian fishing areas, averaged over the time period 2002-2004. Source: national database

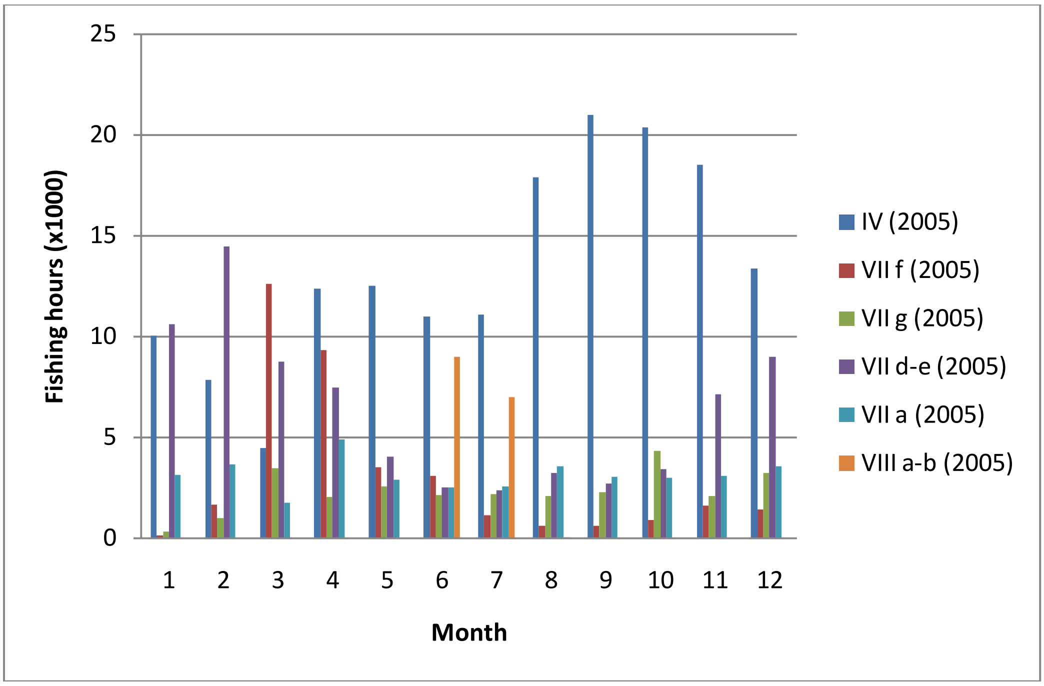


**Figure 3.3.19**: The monthly fishing hours of the beam trawls for the most important Belgian fishing areas in 2005. Source: national database

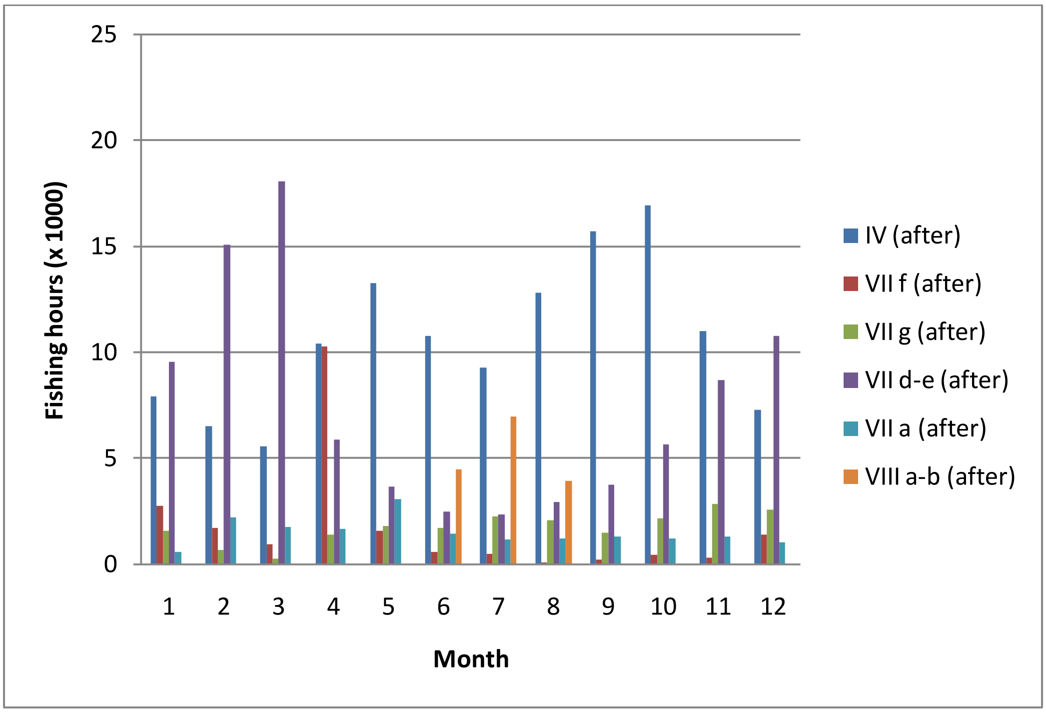


**Figure 3.3.20**: The monthly fishing hours of the beam trawls for the most important Belgian fishing areas, averaged over the time period 2006-2008. Source: national database

### 3.3.3 Discussion

Fishing has been an important industry for Belgium since the beginning of the previous century. The fishing fleet consisted of sailing vessels and steam vessels. Since the beginning of the available time series (early 1930's), the vessels mainly used passive fishing gears but later on also otter trawl nets. The first vessels equipped with a diesel engine were introduced around 1900. They had an increasing success and were, after the 50's the only type of vessels active in the fishery. As the choice of the fishing grounds depended very much on the vessels' engine power, the otter trawls were able to explore rough grounds. The expansion of this technology explains the success of the otter trawls over time (De Groot *et al*. 1998).

In the early 60's, the modern beam trawl was introduced in the Belgian fishery. It was a heavy steel gear equipped with tickler chains and later with chain matrices. As this increased the catchability, many vessels switched to the beam trawl fishery. By the end of the 80's, over 80 % of the Belgian fishing vessels merely fished with beam trawls (De Groot *et al*. 1998). The success of the beam trawl is also reflected in changes in the overall species composition of the landings of Belgian vessels, particularly a decrease in cod, whiting and ray landings (target species of the otter trawl fishery) and an increase of sole and plaice landings (target species of the beam trawl fishery). However, a wide diversity of species is caught by the beam trawlers, which reflects the mixed character of the beam trawl fishery. Up until now, demersal fish are still the most important target group. Pelagic fish used to be important for Belgium (Vanneste and Hovart 1959), but is almost absent in the landings since the 1980's (De Groot *et al*. 1998). Herring was landed in large quantities in the period before the 1960's, but landings have since been negligible.

The Belgian beam trawl fishery in the Celtic Sea is rather distributed along the migration path of sole, which is the main target species for beam trawlers. The fishermen visited the Pendeen area in January, followed by the Trevose box, Trevose Head and Lundy Island in February, March and April. In May and June, they left the Celtic Sea whereas in the summertime, they came back to fish in the Smalls. In the autumn and wintertime they were mainly active in the Milford area. Shifts in this pattern were noticed due to the Trevose closure among other things.

The importance of the Trevose box rectangles 30E4, 31E4 and 32E3 within the areas VIIf and VIIg, is clearly illustrated by the effort distribution plots (Figures 3.3.16&17). The closure of Trevose box in February 2005 resulted in a shift in effort to the English Channel (VIId and VIIe). From 2006, this shift is also noticed in March due to the extension of the closure to all types of trawlers and netters in March each year.

Over time, there has been a continuing trend of increasing length, tonnage and horse power of beam-trawl vessels, and increasing use of state of the art technology e.g. electric winch power and GPS as these have developed. Consequently, the fishing efficiency has gradually increased. A consequence of this has been a reduction in trip duration from around 16 days in the 1970s to 10 days in the 2000s. The LPUE of the sole in the Belgian beam trawl fleet since the 1970s has previously been used by ICES for tuning the VIIf&g sole assessment, but the information from the present Lot1 project suggests that the assumption of constant catchability over time should be reviewed in any benchmark assessment of the stock carried out by ICES.

As legally defined, the minimum mesh size for beam trawls increased from 70 mm in 1960, to over 75 mm in 1970 and to 80 mm in 1980. This regulation was confirmed by our interviews. In the spirit of the more sustainable fishing nowadays, the Belgian beam trawl fishermen have started using escape panels which enhanced the selectivity of the nets.

Detailed historical data on fishing vessels, and particularly on fishing gears used, are very scarce and often not available in the statistics which makes it difficult to clearly assess the historical evolution of Belgian fisheries in the Celtic Sea (de Groot *et al.*, 1998).

### 3.3.4 References

[2] **Source: 'A century of Sea Fisheries in Belgium' (VLIZ 2009).**
http://www.vliz.be/EN/Figures_Policy/Figures_Policy_Belgian_Sea_Fisheries

De Groot, SJ; Lindeboom, HJ; Rumohr, H; Arntz, W; Polet, H; Zevenboom, W; Lambeck, RHD; Hall, S; Spencer, B; Hughes, R; Damm, U; Keegan, BF. 1998. Impact 2: The effects of different types of fisheries on the North Sea and Irish Sea ecosystem. Third european marine science and technology conference (MAST conference), Lisbon, 23-27 May 1998: Project synopses Vol. 5: Fisheries and Aquaculture (AIR: 1990-94) -- Selected projects from the research programme for Agriculture and Agro-Industry including Fisheries. pp. 207-212. 1998

Lescrauwaet AK, Debergh H, Vincx M, Mees J. 2010 (In press). Historical Sea Fisheries Data for Belgium. A discussion paper on data sources, data management and data integration to reconstruct historical time-series on the composition and value of landings of sea fisheries in Belgium. Fisheries Centre Research Reports. In press 2010.

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## 3.4 Celtic Sea Pilot project: England

### 3.4.1 Methods

#### 3.4.1.1 Fisheries Science Partnership projects.

An important collaboration since 2003 in England has been the Fisheries Science Partnership[4] involving fishermen and Cefas scientists. Several of these projects, including time-series surveys for anglerfish, plaice and sole, and other shorter-duration projects, have taken place in the Celtic Sea and western English Channel. The success of these surveys and projects as a means of joint data collection between scientists and industry is briefly reviewed in the Lot 1 report.

#### 3.4.1.2 Task 1: fishery description

The implementation of the pilot project in England focused on Tasks 1 and 3 (Fishery description, and impact of management measures). The UK fisheries in the Celtic Sea (ICES Divisions VIIf,g,h,j) and western Channel (VIIe) include most of the vessels affiliated to the project industry partner (CFPO) as well as other vessels from England, Northern Ireland, Scotland and Wales, and Anglo-Spanish vessels operating out of ports such as Milford Haven in Wales. The following fleet segments participating in the demersal fisheries are included in the fishery descriptions:

- Beam trawlers: >10m fleet
- Otter trawlers: >10m fleet
- Gill & tangle netters: >10m fleet
- 10m and under fleet (trawlers, netters)

Shellfish fisheries using pots and dredges, and pelagic fisheries, are not included. Line fishing for mackerel, bass and some demersal species is also not covered by this report, as the demersal component is relatively small compared to towed gears and fixed nets.

The following methods were adopted to provide easily-interpretable visual images of fishing activities by the different fleet sectors, taking 2008 as an example year. In each case, the plots are provided for the following periods: February-March (months of the Trevose cod closure), April-June, July-September and October-December.

- Production of filtered VMS plots to provide fishing positions for 15m+ beam trawlers, otter trawlers and netters in ICES Divisions VIIe,f,g,h&j.
- Production of fishing effort plots (days fished) per ICES rectangle for vessels under 15m in overall length (i.e. vessels with no VMS).
- Production of spatial maps showing species compositions of landings by ICES rectangle. These are given as pie charts scaled so that the diameter of the pie is proportional to the square root of the total landings per rectangle. Species were grouped in a logical way taking account of the species associations in the fisheries, to reduce the number of slices in the pies – e.g. anglerfish and megrim have very similar spatial distributions and are

[4] http://www.cefas.co.uk/data/fisheries-science-partnership-(fsp).aspx

grouped. Small flatfish species are also grouped (plaice, sole, lemon sole, dab). These plots need to be viewed in colour.
- Verification of the fishing patterns through interviews with CFPO fishermen.

The VMS data are grouped over fleets of vessels and are therefore fully anonymised and cannot be used to identify individual vessel activities. The data were filtered using vessel speed over the ground, so that the positions reflect fishing activities as far as is possible. The methods are fully described in the final report of Lot 7, FISH/2006/15, which included a workshop on the processing of VMS data.

##### 3.4.1.3 Task 2: Technological changes affecting fishing efficiency

This task was addressed using a questionnaire approach, based on the questionnaire drawn up by the Marine Institute for the Lot 1 project, and also used in the Belgian project. The questionnaire was distributed to all CFPO members, and was discussed and completed with a number of the fishermen who were interviewed. However, the overall return rate was very low, and given the very limited funds available for Cefas staff in the project, it was decided not to allocate the funds to the significant time that would be required to follow up with individual fishermen. The main results of the returned questionnaires are tabulated.

##### 3.4.1.4 Task 3: Impacts of management measures

This task focused on the impacts of the Trevose cod closure on the English fishing fleet. Fleet activity data for UK otter trawlers, beam trawlers and fixed netters were collated by month and ICES rectangle for the years 2003-2009. Vessels that reported the top 95% of the cod landings during February-March in 2003 and 2004 in the three closure rectangles (30E4, 31E4 and 32E3) were selected to evaluate their activities from 2005 onwards when the closure came into force. Three evaluations were conducted:

1. An evaluation of spatial shifts in effort from 2005 onwards, within the Celtic Sea and western Channel and beyond;
2. An evaluation of changes in species composition of catches (i.e. have the vessels targeted a different species assemblage, or the same assemblage but with a much lower cod component).
3. Fishermen's perceptions of the impacts of the closure on local fleet activities.

#### 3.4.2 Results

##### 3.4.2.1 Fisheries Science Partnership projects

A strength of the FSP has been the fishing surveys conducted using commercial vessels and fishing gears on the fishing grounds where UK vessels typically operate. In an area where commercial fishery landings per unit effort (LPUE) data continue to be used in a number of ICES assessments, the FSP surveys provide controlled annual snapshots of catch-rates and catch compositions at precisely known locations within the fishing grounds from which log-book based LPUE data are also derived for the ICES assessments. The possibility therefore exists to use the FSP data as abundance indices in their own right, and/or as a means for improving the interpretation of logbook based LPUE data through comparison of the two sources of data at the same time of year. The FSP projects include or have included:

- The western Channel sole and plaice survey in VIIe using beam trawlers in autumn (on-going since 2003);
- The western anglerfish survey in VIIe,f&g using beam trawlers in autumn (on-going since 2003)
- The western cod survey in VIIf,g&h using an otter trawler during March inside the Trevose cod closure and in surrounding areas (2003 – 2005);
- The Celtic Sea sole and plaice survey in VIIf&g using beam trawler in March (2005 only);
- Gear selectivity projects (e.g. hake gillnet selectivity project using a gillnetter on the hake fishing grounds in 2005; evaluation of selectivity of otter trawls for bass using square mesh panels in 2009; evaluation of benthos-release panels and square-mesh cod-ends in beam trawlers in 2008).

*Western Channel sole and plaice survey*
This survey is conducted in autumn in ICES Division VIIe using two fishing vessels deploying commercial beam trawls of 80mm mesh. The survey provides very high resolution data on catch rates and species compositions on the Western Channel fishing grounds where UK beam trawlers fish for mixed flatfish, anglerfish and cuttlefish at different times of year (Fig. 3.4.1).

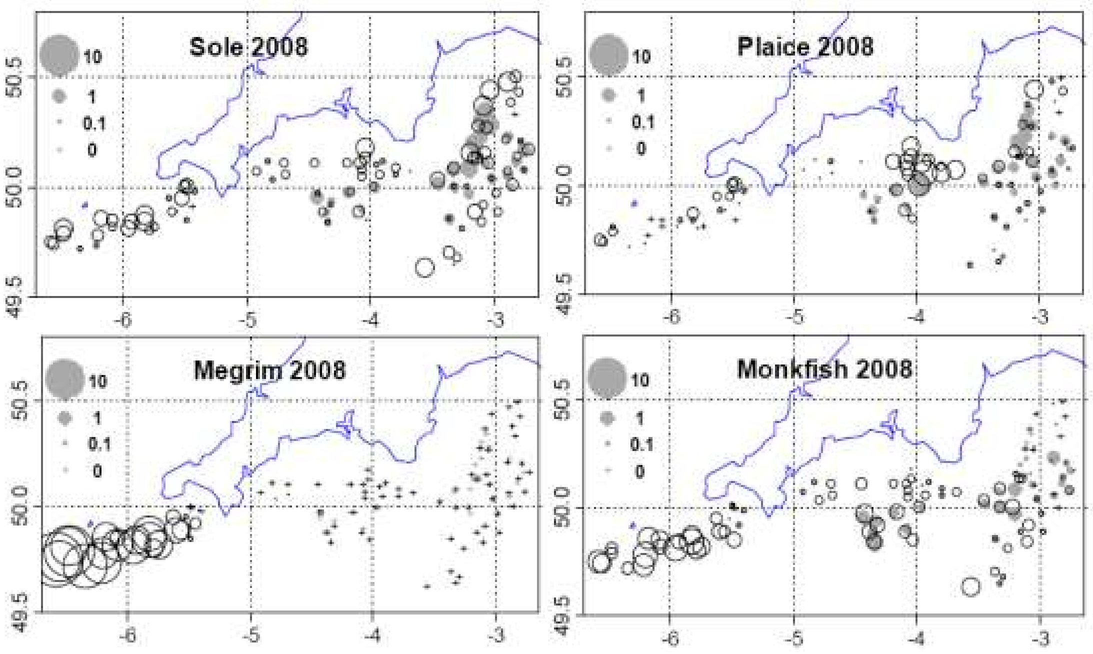


**Fig. 3.4.1**. Distribution of sole, plaice, megrim and anglerfish in 2008 from the FSP western Channel sole and plaice survey (Engelhard *et al.* 2008). Solid and open circles are for the two different vessels. (Numbers per metre beam length per hour.)

Indices of spawning stock biomass (SSB) of sole and plaice from the western and eastern components have different trends, but the combined index followed the estimates of SSB from the ICES stock assessments up to 2007 before diverging, possibly as a result of a change in vessel and timing in the eastern part of the survey (Fig. 3.4.2).

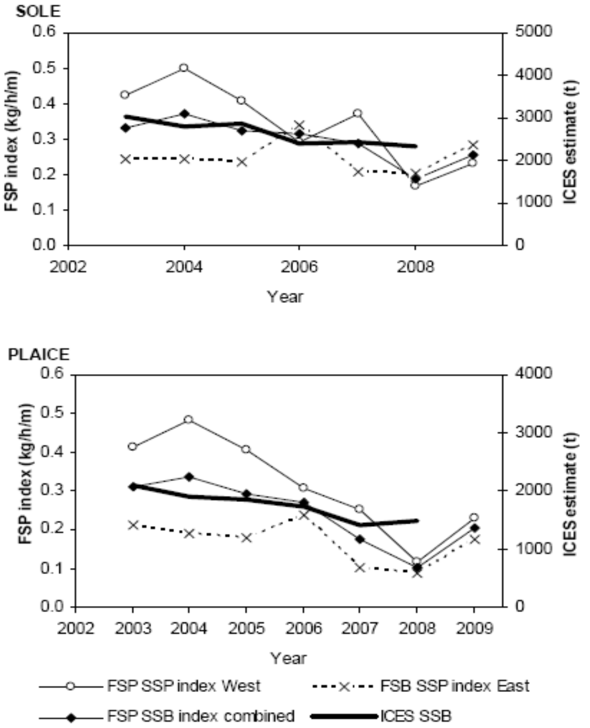


**Fig. 3.4.2**. FSP Western Channel sole and plaice survey: Comparison of the trends in spawning stock biomass (SSB) found by the FSP surveys and the most recent ICES assessments for the VIIe stocks of sole and plaice (ICES, 2008, 2009). FSP trends are given separately for the eastern and western surveys and for the combined survey.

*FSP Western Anglerfish survey*

This survey is also conducted in Autumn using two beam trawlers deploying commercial beam trawls with 80mm mesh on the fishing grounds where the larger UK beam trawlers target anglerfish, megrim and mixed demersal species. The survey shows coherent spatial patterns of abundance and size composition, and clearly demonstrates areas where small (recruiting) anglerfish are found (Fig. 3.4.3). Smooth trends in relative abundance are obtained from the surveys, which show a stable biomass of *Lophius piscatorius* and an increasing biomass of *Lophius budegassa* since 2003 (Fig. 3.4.4).

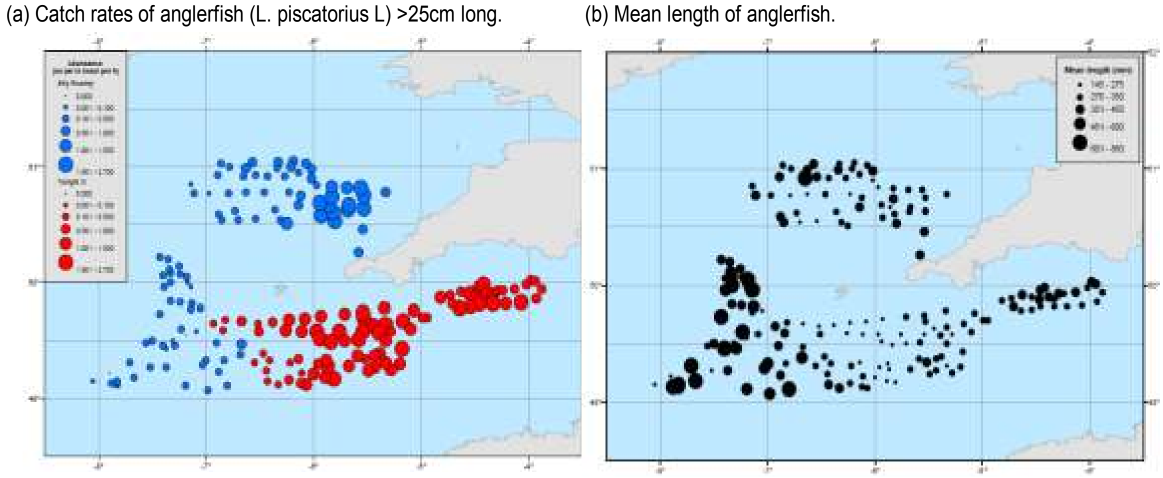


**Fig. 3.4.3**. FSP western anglerfish survey in 2009: (a) Catch rates of anglerfish of 25cm and longer, and (b) spatial patterns in mean length of anglerfish.

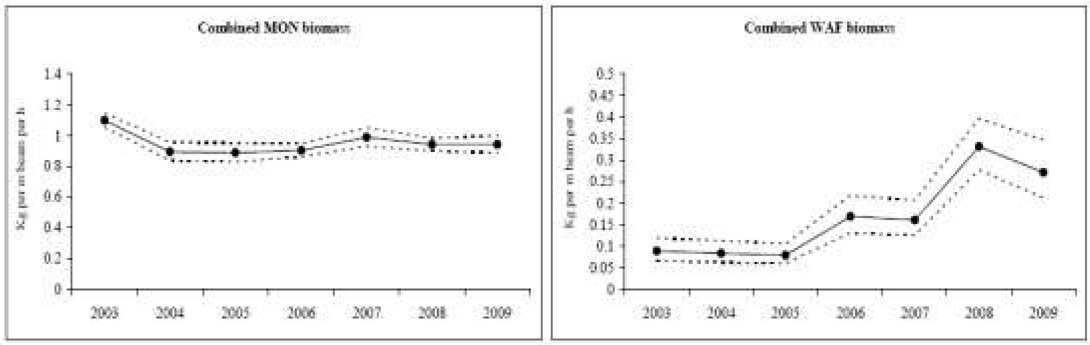


**Fig. 3.4.4**. FSP western anglerfish survey: Indices of anglerfish *L.piscatorius* (MON) and *L. budegassa* (WAF) biomass between 2003 and 2009 (Walmsley *et al*. 2009)

The anglerfish stocks in ICES Area VII cover a much larger area than the FSP surveys, but the surveys show clearly the trends on the fishing grounds used by the UK fleet, and are of considerable use for interpreting commercial fishery LPUE data. Additional data on anglerfish are obtained from the FSP Western Channel sole and plaice survey (see Fig. 3.4.1).

*FSP Celtic Sea sole and plaice survey*

A single survey of the sole and plaice stock in ICES area VIIf&g was conducted in March 2005 using a commercial beam trawler using commercial gear (Armstrong *et al.* 2005). The survey covered stocks that are the subject of individual ICES scientific assessments, and provided high-resolution spatial data across the fishing grounds used by UK beam trawlers targeting these stocks in spring, particularly in relation to the Trevose cod closure which excluded beam trawlers in March 2005 and in February and March from 2006 onwards.

The survey demonstrated that sole and plaice were abundant along the coast of north Cornwall and Devon in ICES Division VIIf, in the SE corner of the southernmost rectangle (30E4) of the Trevose closure and to the south of the closure (Fig. 3.4.5).

This figure is important for interpreting the changes in the pattern of the UK and Belgian beam trawl fisheries in 2005 discussed elsewhere in the Lot 1 report. The age compositions of sole in the survey followed the forecasted age compositions for the fishery in 2005 from the most recent ICES assessment available at the time (Fig. 3.4.5).

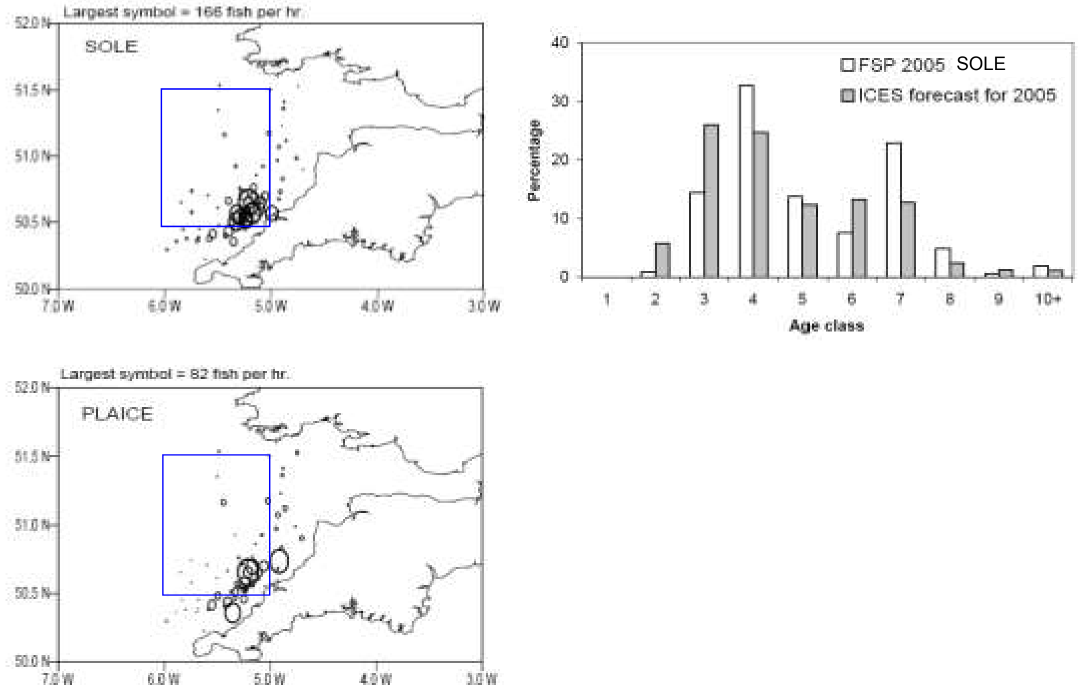


**Fig. 3.4.5**. FSP Celtic Sea sole and plaice survey in 2005. Distribution of sole and plaice in relation to rectangles 30E4 and 30E4 comprising two of the three rectangles in the Trevose cod closure introduced in spring 2005 (Armstrong *et al*. 2005). The age compositions of sole from the survey are shown in comparison to the forecasts for 2005 from the most recent ICES assessment at the time.

*FSP Western cod survey*

This FSP survey was carried out in the Celtic Sea in March 2004-2006, using a commercial trawler fishing a commercial otter trawl with 80mm mesh. The project was set up for providing information on cod abundance and distribution during the cod spawning season, and in 2005 and 2006 it was designed to provide data on cod inside the Trevose closure and immediately adjacent areas. The data clearly showed the presence of spawning aggregations of cod inside the closed rectangles (Fig. 3.4.6). The distribution off North Cornwall was similar to patterns of cod egg abundance observed in plankton surveys in 1990 (Fig. 3.4.6). This project demonstrated clearly that closure of the three rectangles comprising the Trevose cod closure would prevent intensive commercial fishing on dense aggregations of cod during the spawning season. Vessels excluded from the aggregations would be expected to have a reduced catch rate of adult cod in surrounding areas if the bulk of the spawning population was present in the closed area. Cod could still be caught as they migrate in and out of the spawning grounds, but are likely to be at lower density than on the spawning grounds. The extent to which UK vessels were displaced from the closure is examined elsewhere in this Lot 1 report.

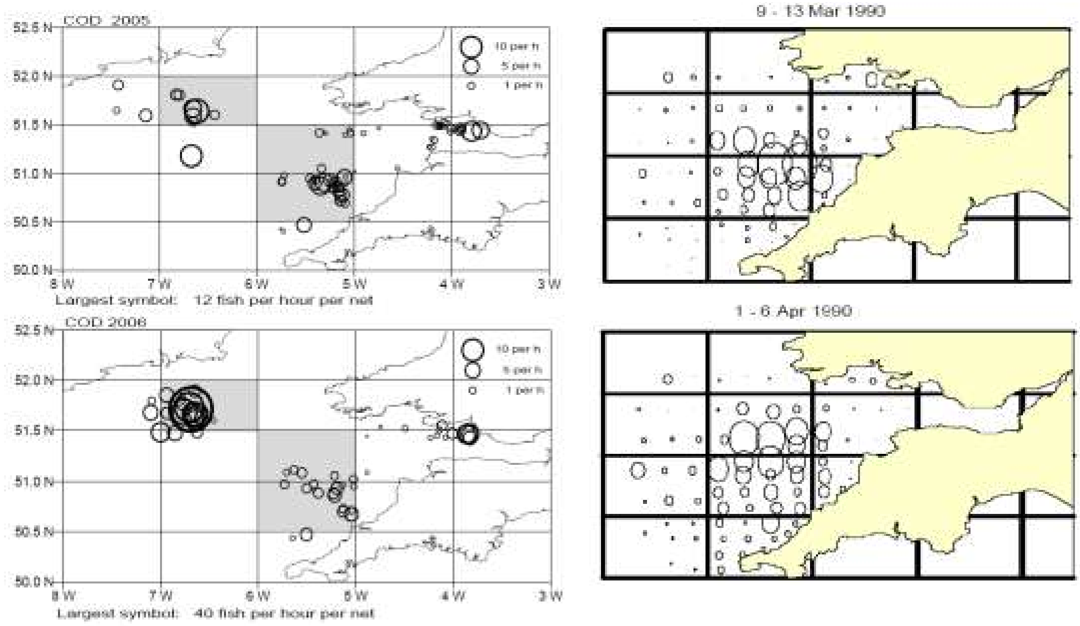


**Fig. 3.4.6**. FSP Western cod survey: Left-hand plots show catch rates of cod during the 2005 and 2006 surveys, relative to the Trevose cod closure (shaded rectangles). Right-hand plots show cod egg distributions in spring 1990. From Dann *et a*l. 2006.

#### 3.4.2.2 Task 1: description of UK demersal fisheries in the Celtic Sea and western Channel

*Ports and harbours*

The ports and harbours where the majority of UK (England & Wales) vessels in the Celtic Sea and western Channel fisheries land their catches are mainly in the south-west of England and in south Wales (Fig. 3.4.7). The main ports in terms of volume of landings are Brixham (demersal and pelagic fisheries, with a large fleet of beam trawlers), Plymouth (mainly pelagic vessels), Newlyn (mainly demersal otter trawl, beam trawl and netters), and Milford Haven (mainly Anglo-Spanish trawlers) (Table 3.4.1). However there are many smaller ports and harbours, which is reflected in the existence of a very large number of under-10m vessels involved in small-scale fisheries all round the coast (Table 3.4.2).

*Fleet composition*

The composition of the UK fleet operating in the Celtic Sea and western Channel can be quantified as the number of vessels in different vessel length classes that recorded landings in the area in a given year. In 2008, 1002 out of 1360 UK-registered vessels (registered in England, Wales, Scotland and Northern Ireland) that fished in ICES Divisions VIIe,f,g&h were under-10m vessels (Table 3.4.2a). Around half of the total landed value of the catches of the <10m fleet was from catches using pots for crabs, lobsters and molluscs, whilst the remaining half was using trawls, nets, dredges and lines. Numbers of vessels declined with increasing LOA except for 24-40m which includes the large beam-trawl fleet in the south west of England. This fleet segment had the highest landed value in VIIe,f,g&h in 2008. The majority of UK registered vessels operating in VIIb,c,j&k are Anglo-Spanish flag vessels operating mainly out of Milford Haven in Wales (Table 3.4.2b).

The UK fleet metiers making up the top 90% of landings or effort or catch value in 2007-08 in the western Channel, Celtic Sea and western Ireland are listed in Table 3.4.3, in descending order of catch value in each region. The large under-10m fleet of vessels operating in the Celtic Sea and western Channel is reflected in the high fishing effort and landed value for vessels using pots and traps for crustacean and molluscs. The demersal fisheries are mainly conducted using beam trawls, otter trawls and fixed nets (gillnets and trammel nets). The overall fleet segment and metier structure for VIIfgh and VIIe is reflected in the structure of the fleet whose owners belong to the Cornish Fish Producers Organisation (Table 3.4.4; from the NFFO/CFPO Annual Fisheries Report for 2008/09). A description of the main UK fleets operating in each area is given below, drawing on EU log-book data, VMS data and information from fishermen interviewed during the project.

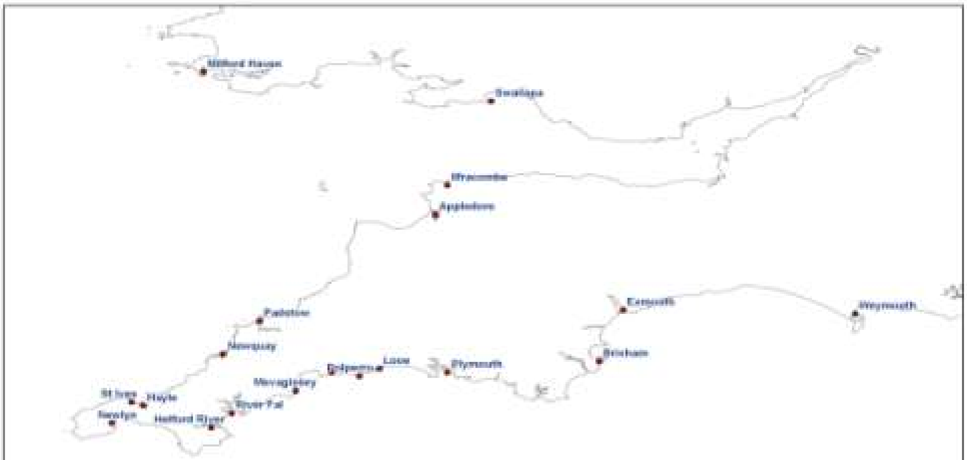


**Fig. 3.4.7** Map of SW England and Wales for the coastline bordering on ICES Divisions VIIe,f,and g.

**Table 3.4.1** Landings by port and gear group for UK (England and Wales) registered vessels in 2008. Data are for ports with 10 tonnes or more landed in 2008.

| | PortName | Dredge | pots | beam trawl | otter trawl | Fixed/drift net | lines | Midwater trawls seines | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Western Channel VIIe | Swanage | 1 | 76 | 0 | 0 | 0 | 0 | 0 | 0 | 78 |
| | Kimmeridge | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| | Lulworth Cove | 0 | 6 | 0 | 0 | 1 | 0 | 0 | 6 | 14 |
| | Weymouth | 135 | 898 | 1 | 35 | 37 | 48 | 0 | 0 | 1155 |
| | Ferrbridge | 0 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 11 |
| | Portland | 0 | 58 | 0 | 5 | 10 | 1 | 0 | 13 | 87 |
| | West Bay | 221 | 329 | 0 | 11 | 22 | 2 | 0 | 17 | 602 |
| | Lyme Regis | 68 | 89 | 0 | 28 | 33 | 1 | 0 | 0 | 219 |
| | Beer | 0 | 40 | 0 | 1 | 5 | 1 | 0 | 0 | 46 |
| | Exmouth | 107 | 1121 | 3 | 130 | 24 | 2 | 510 | 0 | 1898 |
| | Teignmouth | 64 | 55 | 0 | 6 | 10 | 7 | 1041 | 0 | 1182 |
| | Torquay | 12 | 1 | 20 | 0 | 0 | 2 | 0 | 0 | 35 |
| | Paignton | 0 | 34 | 0 | 0 | 0 | 1 | 0 | 0 | 35 |
| | Brixham | 1848 | 360 | 4917 | 1544 | 157 | 58 | 1995 | 51 | 10931 |
| | Kingswear | 1 | 234 | 0 | 0 | 2 | 2 | 0 | 0 | 238 |
| | Dartmouth | 28 | 926 | 0 | 12 | 17 | 20 | 0 | 16 | 1018 |
| | Salcombe | 1 | 1126 | 0 | 14 | 16 | 0 | 0 | 0 | 1158 |
| | Plymouth | 1539 | 134 | 682 | 527 | 208 | 21 | 5846 | 0 | 8957 |
| | Looe | 151 | 39 | 0 | 500 | 149 | 36 | 0 | 0 | 876 |
| | Polperro | 0 | 1 | 0 | 148 | 29 | 5 | 0 | 0 | 182 |
| | River Fowey | 3 | 83 | 0 | 11 | 101 | 1 | 0 | 0 | 199 |
| | Charlestown | 0 | 85 | 0 | 0 | 1 | 0 | 0 | 0 | 86 |
| | Mevagissey | 39 | 56 | 0 | 152 | 375 | 91 | 0 | 0 | 713 |
| | Portloe | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| | River Fal - Falmouth | 584 | 28 | 2 | 65 | 41 | 14 | 0 | 0 | 734 |
| | Mylor | 0 | 185 | 0 | 0 | 24 | 0 | 0 | 0 | 210 |
| | Flushing | 31 | 160 | 0 | 0 | 4 | 0 | 0 | 0 | 195 |
| | Helford River | 1 | 67 | 0 | 33 | 207 | 6 | 0 | 0 | 312 |
| | Coverack | 0 | 66 | 0 | 3 | 6 | 1 | 0 | 0 | 75 |
| | Cadgwith | 0 | 139 | 0 | 7 | 28 | 0 | 0 | 0 | 174 |
| | Porthleven | 0 | 7 | 0 | 3 | 10 | 1 | 0 | 0 | 21 |
| | Penzance | 1 | 93 | 31 | 1 | 7 | 7 | 0 | 0 | 140 |
| | Newlyn | 260 | 964 | 2523 | 903 | 3064 | 411 | 8 | 2 | 8134 |
| | Penberth | 0 | 2 | 0 | 0 | 3 | 9 | 0 | 0 | 14 |
| Celtic Sea VIIfgh | Scilly Isles | 0 | 114 | 0 | 9 | 4 | 0 | 0 | 0 | 128 |
| | Sennen | 1 | 9 | 0 | 0 | 7 | 22 | 0 | 0 | 39 |
| | St Ives | 0 | 5 | 0 | 14 | 25 | 238 | 0 | 0 | 284 |
| | Hayle | 0 | 99 | 0 | 11 | 29 | 70 | 0 | 0 | 210 |
| | Newquay | 1 | 364 | 0 | 13 | 32 | 1 | 0 | 0 | 411 |
| | Padstow | 22 | 263 | 61 | 80 | 187 | 1 | 0 | 0 | 615 |
| | Port Isaac | 0 | 138 | 0 | 0 | 1 | 0 | 0 | 0 | 139 |
| | Clovelly | 0 | 11 | 0 | 1 | 0 | 0 | 0 | 0 | 12 |
| | Appledore | 0 | 165 | 0 | 253 | 8 | 1 | 0 | 0 | 428 |
| | Ilfracombe | 0 | 469 | 0 | 427 | 0 | 0 | 0 | 0 | 896 |
| | Porthcawl | 0 | 0 | 0 | 20 | 3 | 0 | 0 | 0 | 24 |
| | Swansea | 0 | 228 | 0 | 22 | 16 | 2 | 0 | 14 | 282 |
| | Llanelli | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 279 | 282 |
| | Burryport | 0 | 1 | 0 | 0 | 8 | 2 | 0 | 0 | 11 |
| | Saundersfoot | 0 | 1514 | 0 | 3 | 4 | 5 | 0 | 0 | 1525 |
| | Milford Haven | 815 | 612 | 46 | 1516 | 30 | 3 | 0 | 0 | 3021 |

**Table 3.4.2.** Number of fishing vessels registered in the UK (England, Wales, Scotland and Northern Ireland) that recorded fishing activities in (a) ICES Divisions VIIe,f,g&h and (b) VIIb,c,j&k), by vessel LOA (length overall) class. The value of the total landings in each fleet segment and area is given by gear type, for landings into the UK and abroad.

| (a) ICES VIIe,f, g & h | | Landings value by gear type (£m) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vessel LOA | No. Vessels | Dredge | pots | beam trawl | otter trawl | Fixed/drift net | lines | Midwater trawls seines | Other | total |
| 0 - <10m | 1002 | 1.64 | 8.67 | 0.07 | 2.82 | 4.02 | 1.64 | 0.03 | 0.76 | 19.66 |
| 10 - <12m | 171 | 1.85 | 6.55 | 0.35 | 6.93 | 3.78 | 0.11 | 0.71 | 0.00 | 20.27 |
| 12 - <18m | 78 | 1.31 | 3.12 | 0.26 | 4.34 | 2.71 | 0.03 | 0.65 | 0.00 | 12.41 |
| 18 - <24m | 34 | 0.00 | 1.99 | 4.91 | 1.25 | 0.51 | 0.00 | 0.00 | 0.00 | 8.67 |
| 24 - <40m | 70 | 4.42 | 0.04 | 15.36 | 1.00 | 0.04 | 0.02 | 0.09 | 0.00 | 20.96 |
| 40m+ | 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.89 | 0.00 | 1.89 |
| total | 1360 | 9.21 | 20.36 | 20.95 | 16.34 | 11.06 | 1.80 | 3.37 | 0.76 | 83.86 |

| (b) ICES VIIb, c, j & k | | Landings value by gear type (£m) | | | | |
|---|---|---|---|---|---|---|
| Vessel LOA | No. Vessels | otter trawl | Fixed/drift net | lines | Midwater trawls seines | total |
| 0 - <10m | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 - <18m | 6 | 0.00 | 0.19 | 0.03 | 0.00 | 0.22 |
| 18 - <24m | 2 | 0.01 | 0.07 | 0.03 | 0.00 | 0.11 |
| 24 - <40m | 18 | 5.97 | 0.02 | 0.08 | 0.00 | 6.07 |
| 40m+ | 6 | 0.39 | 0.00 | 0.00 | 3.11 | 3.50 |
| total | 34 | 6.37 | 0.29 | 0.13 | 3.11 | 9.90 |

**Table 3.4.3.** Average effort, landings and value (all species) for different UK metiers providing the top 90% of landings, effort or value in 2007-2008 in VIIe, VIIfg&h, and VIIbcj&k. Most demersal vessels in VIIbcj,k are Anglo-Spanish. "Target assemblages" simply reflect the dominant component of individual trips.

| Fishing ground | Gear LVL4 | Target Assemblage LVL5 | Metier LVL6 | Effort Days | Total Landings (tonnes) | Value (million euros) |
|---|---|---|---|---|---|---|
| 27.VIIE | F BEAM TRAWL | DEMERSAL FISH | TBB_DEF_70-99_0_0 | 6227 | 5879 | 13.46 |
| 27.VIIE | N POTS AND TRAPS | CRUSTACEANS | FPO_CRU_0_0_0 | 16539 | 4782 | 8.29 |
| 27.VIIE | A BOAT DREDGE | MOLLUSCS | DRB_MOL_0_0_0 | 5784 | 5143 | 7.88 |
| 27.VIIE | C BOTTOM OTTER TRAWL | DEMERSAL FISH | OTB_DEF_70-99_0_0 | 9170 | 2439 | 5.66 |
| 27.VIIE | C BOTTOM OTTER TRAWL | MOLLUSCS | OTB_MOL_70-99_0_0 | 2752 | 1196 | 2.13 |
| 27.VIIE | N POTS AND TRAPS | MOLLUSCS | FPO_MOL_0_0_0 | 2819 | 2205 | 1.44 |
| 27.VIIE | Q SET GILLNET | DEMERSAL FISH | GNS_DEF_120-219_0_0 | 3041 | 746 | 1.42 |
| 27.VIIE | H MID-WATER PAIR TRAWL | SMALL PELAGIC FISH | PTM_SPF_32-69_0_0 | 122 | 3778 | 1.20 |
| 27.VIIE | G MID-WATER OTTER TRAWL | SMALL PELAGIC FISH | OTM_SPF_16-31_0_0 | 416 | 3369 | 1.15 |
| 27.VIIE | Q SET GILLNET | DEMERSAL FISH | GNS_DEF_>=220_0_0 | 1546 | 284 | 0.82 |
| 27.VIIE | J HAND AND POLE LINES | FINFISH | LHP_FIF_0_0_0 | 3054 | 332 | 0.77 |
| 27.VIIE | Q SET GILLNET | DEMERSAL FISH | GNS_DEF_100-119_0_0 | 1567 | 251 | 0.57 |
| 27.VIIE | Q SET GILLNET | CRUSTACEANS | GNS_CRU_>=220_0_0 | 2064 | 264 | 0.35 |
| 27.VIIE | G MID-WATER OTTER TRAWL | SMALL PELAGIC FISH | OTM_SPF_32-69_0_0 | 60 | 1020 | 0.31 |
| 27.VIIE | B MECHANISED DREDGE | MOLLUSCS | HMD_MOL_0_0_0 | 112 | 1329 | 0.14 |
| 27.VIIFGH | F BEAM TRAWL | DEMERSAL FISH | TBB_DEF_70-99_0_0 | 3411 | 2653 | 8.33 |
| 27.VIIFGH | N POTS AND TRAPS | CRUSTACEANS | FPO_CRU_0_0_0 | 12603 | 2552 | 6.88 |
| 27.VIIFGH | Q SET GILLNET | DEMERSAL FISH | GNS_DEF_120-219_0_0 | 2724 | 1199 | 2.57 |
| 27.VIIFGH | C BOTTOM OTTER TRAWL | DEMERSAL FISH | OTB_DEF_70-99_0_0 | 2162 | 991 | 1.97 |
| 27.VIIFGH | N POTS AND TRAPS | MOLLUSCS | FPO_MOL_0_0_0 | 1136 | 1637 | 1.06 |
| 27.VIIFGH | J HAND AND POLE LINES | FINFISH | LHP_FIF_0_0_0 | 3951 | 839 | 0.99 |
| 27.VIIFGH | Q SET GILLNET | DEMERSAL FISH | GNS_DEF_>=220_0_0 | 710 | 311 | 0.92 |
| 27.VIIFGH | C BOTTOM OTTER TRAWL | DEMERSAL FISH | OTB_DEF_100-119_0_0 | 294 | 358 | 0.73 |
| 27.VIIFGH | Q SET GILLNET | SMALL PELAGIC FISH | GNS_SPF_10-30_0_0 | 371 | 1250 | 0.46 |
| 27.VIIFGH | A BOAT DREDGE | MOLLUSCS | DRB_MOL_0_0_0 | 289 | 335 | 0.43 |
| 27.VIIFGH | Q SET GILLNET | CRUSTACEANS | GNS_CRU_>=220_0_0 | 802 | 110 | 0.24 |
| 27.VIIBCJK | G MID-WATER OTTER TRAWL | SMALL PELAGIC FISH | OTM_SPF_32-69_0_0 | 323 | 44739 | 13.22 |
| 27.VIIBCJK | C BOTTOM OTTER TRAWL | DEMERSAL FISH | OTB_DEF_100-119_0_0 | 3050 | 3411 | 7.34 |
| 27.VIIBCJK | Q SET GILLNET | DEMERSAL FISH | GNS_DEF_>=220_0_0 | 656 | 644 | 1.63 |
| 27.VIIBCJK | M SET LONGLINES | DEMERSAL FISH | LLS_DEF_0_0_0 | 1407 | 1163 | 1.63 |
| 27.VIIBCJK | C BOTTOM OTTER TRAWL | DEMERSAL FISH | OTB_DEF_70-99_0_0 | 490 | 569 | 1.21 |
| 27.VIIBCJK | H MID-WATER PAIR TRAWL | SMALL PELAGIC FISH | PTM_SPF_32-69_0_0 | 45 | 1656 | 1.03 |
| 27.VIIBCJK | C BOTTOM OTTER TRAWL | CRUSTACEANS | OTB_CRU_70-99_0_0 | 412 | 188 | 0.84 |
| 27.VIIBCJK | C BOTTOM OTTER TRAWL | CRUSTACEANS | OTB_CRU_100-119_0_0 | 401 | 196 | 0.84 |

**Table 3.4.4**. Composition of the fleet of vessels in the Cornish Fish Producers Organisation in 2008/09, according to predominant fishing method (NFFO/CFPO Annual Fisheries Report 2008/09.

| Fleet segment | No. vessels | Mean length (m) | Mean engine power (kw) | Mean age (yrs) |
|---|---|---|---|---|
| 24 metre and over beam trawlers | 20 | 27.95 | 545 | 44 |
| Under-24m beam trawlers | 4 | 18.48 | 221 | 22 |
| 15m and over otter trawlers | 4 | 20.81 | 287 | 28 |
| Under-15m otter trawlers | 28 | 12.43 | 181 | 20 |
| 15m and over gill/tangle netters | 10 | 16.1 | 215 | 26 |
| Under 15m gill/tangle netters | 8 | 11.3 | 122 | 29 |
| Under-10m fleet, (comprising netters, trawlers, potters, hand-liners and ring netters) | 67 | 9.25 | 141 | 11 |

*Fleet desription: Demersal otter trawls*

VMS data for 15m+ otter trawlers (Fig. 3.4.8) show the following clusters of fishing activities:

- A large area of activity of Anglo-Spanish trawlers operating off SW Ireland, mainly in VIIj (marked "A" on figure);
- A patch of activity in the eastern part of VIIg, representing mainly Northern Ireland trawlers fishing for *Nephrops* on the "Smalls" grounds (marked "B");
- Trawling activity by English vessels in the Bristol Channel (C), around the SW tip of Cornwall (D) and in the western Channel (E).

Very little trawling activity of 15m+ vessels took place in 2008 in the three closed rectangles comprising the February-March Trevose cod closure (Fig. 3.4.9). Some effort was recorded in these rectangles by under-15m vessels using otter trawls, but the main activities of these smaller vessels were in the coastal regions in the Bristol Channel, around south-west Cornwall, and along the south coasts of Devon and Cornwall in Division VIIe (Fig. 3.4.9).

Species composition maps are shown separately in Appendix 3 Figs. A-3.8a,b and A-3.9a,b for otter trawlers using 70-99mm mesh and 100mm+ mesh. Most of the activity using 70-99mm mesh is in VIIe,f&g. The fisheries in this region are diverse. Two areas stand out as having catches dominated by a single species group: firstly the *Nephrops* fishery on the Smalls (mainly Northern Ireland vessels), and secondly the fishery in the Bristol Channel which is predominantly elasmobranchs with some seasonal fishing for bass. The catches in other parts of VIIe,f&g comprise mixtures of haddock, whiting, anglerfish, flatfish, other fish species such as John Dory and red gurnard, and a seasonal fishery for cuttlefish and squid.

The otter trawl fishery using 100mm+ meshes comprises Anglo-Spanish vessels targeting mainly anglerfish in and near VIIj, and English vessels targeting haddock and whiting around the SW tip of Cornwall. The use of 100mm+ mesh was mandatory in 2008 to permit vessels to have more than a specified percentage of haddock in their landings.

Interviews with otter trawl fishermen that operate between SW Cornwall and the English coast of VIIe (areas D and E on Fig. 3.4.8) indicated that the English otter trawl fishery is very seasonal and also very tide dependent. The winter fishery (November – February) and summer-autumn fishery are interspersed with a slack period around June, which is also a period of poorer prices. One interviewed skipper used a single high-lift otter trawl with 100mm mesh for haddock, and used a twin-rig gear further offshore for mixed species, fishing further east in VIIe on spring tides and further west on neaps. The mixed nature of the fishery was emphasized by this fisherman, with 26 – 27 species being landed during the year. The importance of cuttlefish in winter is shown in Appendix 3 Fig. A-3.8b. This particular fisherman currently targets ray, sole, haddock and gurnard in quarter 1, lemon sole, haddock and John Dory in quarter 2, Dory, squid, haddock, anglerfish, megrim and cuttlefish in quarter 3, and cuttlefish, squid, anglerfish and megrim in quarter 4. Vessels targeting rays in areas such as the Bristol Channel target them year-round, with seasonal fishing activities on species such as squid in summer, bass in late summer and cod, haddock, whiting, plaice etc. from autumn to spring.

*Beam trawlers*

Most of the UK beam trawlers are large enough to have VMS, with a smaller number of under-15m vessels using this gear (Fig. 3.4.9).The vessels operate mainly in VIIe, VIIh and VIIf using 80mm mesh to target sole, plaice, lemon sole and other flatfish species as well as anglerfish in all areas and megrim in the Celtic Sea (Appendix 3, Fig A-3.10a,b). An important seasonal fishery for cuttlefish takes place in the western Channel in winter and spring. The fishery in VIIf off north Cornwall targets sole and plaice when they are spawning close inshore in spring, and operates farther off shore during summer and autumn, targeting anglerfish, megrim and associated benthic species. The distribution of beam trawl fishing closely matches the areas covered by the annual Fisheries Science Partnership surveys of Western Channel sole and plaice and western anglerfish, and the one-off FSP survey of VIIf sole and plaice (Figs. 3.4.1, 3.4.3 and 3.4.5). The FSP survey in VIIf showed aggregations of sole and plaice close inshore in March, during the spawning season, and this accurately reflects the distribution of beam trawl VMS activity in the same area in Feb - June (Fig. 3.4.9).

The smaller beam trawlers (<24m) tend to operate closer inshore than the 24m+ vessels, and their catches contain a higher proportion of sole, plaice and other flatfish. Farther offshore, the catches become dominated by anglerfish and megrim. Turbot and brill are also an important catch. An owner/skipper of one of the under-24m beam trawlers indicated that his seasonal pattern was targeting of sole in winter-spring; sole, lemon sole, anglerfish and other mixed species in summer; sole, ray, brill, turbot and plaice from late summer to autumn, and sole, plaice and cuttlefish from autumn – winter, mainly in VIIe. A single trip can cover more than one metier, for example Brixham beamers can move between inshore and offshore waters to target sole and cuttlefish in the same trip.

Considerable collaborative work has been done between Cefas and the fishing industry in SW England to improve the selectivity of beam trawls. For example, Revill *et a*l (2008) showed that an 80mm square-mesh codend together with two strategically placed 200mm square mesh panels reduced fish discards by around 60% by number and invertebrate discards by 40% in volume. A more recent initiative (Project 50%[5]) has involved a range of beam trawl fishermen testing a larger-mesh net of lighter construction, which has been successful in reducing discards by up to 60%.

*Fixed-net vessels*

The UK fixed net fishery for demersal species in the Celtic Sea and western Channel comprises a number of distinct types of fishing. These include:

- Gill netting for hake using mainly 120-140mm mesh. The gear typically comprises 180 – 200 panels 100m in length, with 30-40 panels in a tier. The nets are soaked for 12 – 24 hours, with fishing mainly conducted on neap tides. Nets are frequently set over banks (e.g. Lambadie Bank, Jones' Bank etc.). A single trip may last 6 – 8 days.
- Wreck and rough-ground netting for pollack, ling, saithe and cod. These may use larger meshes of 130 – 150mm or more. The nets are shorter than used for hake, with a fleet comprising three 100m panels to a tier, and up to 10 fleets set on ten different wrecks, with soaking times of 12 – 24h.
- Tangle-netting for large benthic fish particularly anglerfish, turbot, brill and rays, increasingly using trammel nets of mesh size 220mm and over in the finer-mesh wall. Trammels for example may use 262mm inner walls and 900mm outer walls. Soak times can be 2-3 days, with a third of the nets lifted per day. Fishing trips may last from 7-8 days. There has been increasing use of trammel nets in recent years rather than single-walled tangle nets, as the catch rates are improved allowing more frequent hauling.

[5] http://www.cefas.co.uk/media/137131/cefas-newsletter-2.pdf

- Inshore netting for smaller species such as sole, plaice, John Dory, red mullet and bass, using various mesh sizes.

The UK fixed net fishery for 15m and over vessels covers a wide area of the Celtic Sea and western Channel, clumping around banks and wrecks (Fig. 3.4.11). Over the last 2-3 years, boats have increasingly fished in Area VIII due to international quota swaps enabling vessels to target pollack on wrecks in the Biscay area (NFFO/CFPO Annual Fisheries Report 2008/09). As expected, the under-15m fleet operates closer inshore (Fig. 3.4.12). Relatively little fishing activity was recorded for 15m+ vessels at any time of year in 2008 in the three rectangles comprising the Trevose cod closure. Smaller vessels fished more frequently in the closure area during summer (Fig. 3.4.12).

As expected, the catch composition of fixed netters using 100-219mm mesh is dominated by pollack and ling on or near wrecks and rough ground, and by hake on the banks in the offshore areas of the Celtic Sea between Cornwall and SE Ireland (Appendix 3, Fig. A-3.11a,b). The quarterly species diversity of the catches of this gear is higher in the areas closer to the coast, presumably reflecting the greater variety of habitats fished by the inshore fleet. Note that the diversity in individual hauls will be much lower than this due to targeting on individual trips. Some cod is taken on the wrecks between Cornwall and SE Ireland throughout the year. Tangle netters using 220mm+ mesh predominantly catch anglerfish, turbot, elasmobranchs and spider crabs (Appendix 3, Fig. A-3.12a,b).

The fixed-net fishermen interviewed indicated that their activities were seasonal, with hake, pollack and ling being targeted mainly in the autumn-winter-spring period (though caught year-round) whilst tangle netting for benthic species such as anglerfish, turbot and brill is mainly in spring-summer-autumn. The under-15m netting fleet typically fishes for pollack and ling (140mm mesh) on wrecks and hard ground from January to April, then tangle nets (220mm) for anglerfish and turbot from April – August, then hake nets (120mm) or “ground gear” or bass nets until the end of the year (NFFO/CFPO AFR 2008/09). The seasonality of the tangle net fishery is evident in Appendix 3, Fig. A-3.12a,b. Vessels may also switch between hake netting and wreck netting due to changes in fish prices and demand (the major markets for species such as pollack and hake are in mainland Europe although the UK market for pollack is increasing due to sustainability credentials relative to depleted stocks such as cod). The NFFO/CFPO Annual Fisheries Report highlighted very poor hake prices in 2008/09, due in part to increased landings by Scottish vessels in the North Sea.

Netting activities are predominantly around neap tides due to the difficulties in setting and fishing the nets in strongly tidal conditions. For example, fishermen reported that strong tides in the St George’s Channel (between Wales and Ireland) allow offshore netting on only three tides per year, and for three days on each favourable tide. The activities of the smaller vessels are also very weather-dependent. A major issue raised by the fishermen, and also raised in the NFFO/CFPO Annual Fisheries Reports for 2008/09 is the impact of seal depredation at nets. One fishermen claimed that £15,000 of anglerfish had been destroyed by seals in May and June, and that up to 70% of fish may be damaged at some wrecks. This has forced the netting vessels to operate over a wider area.

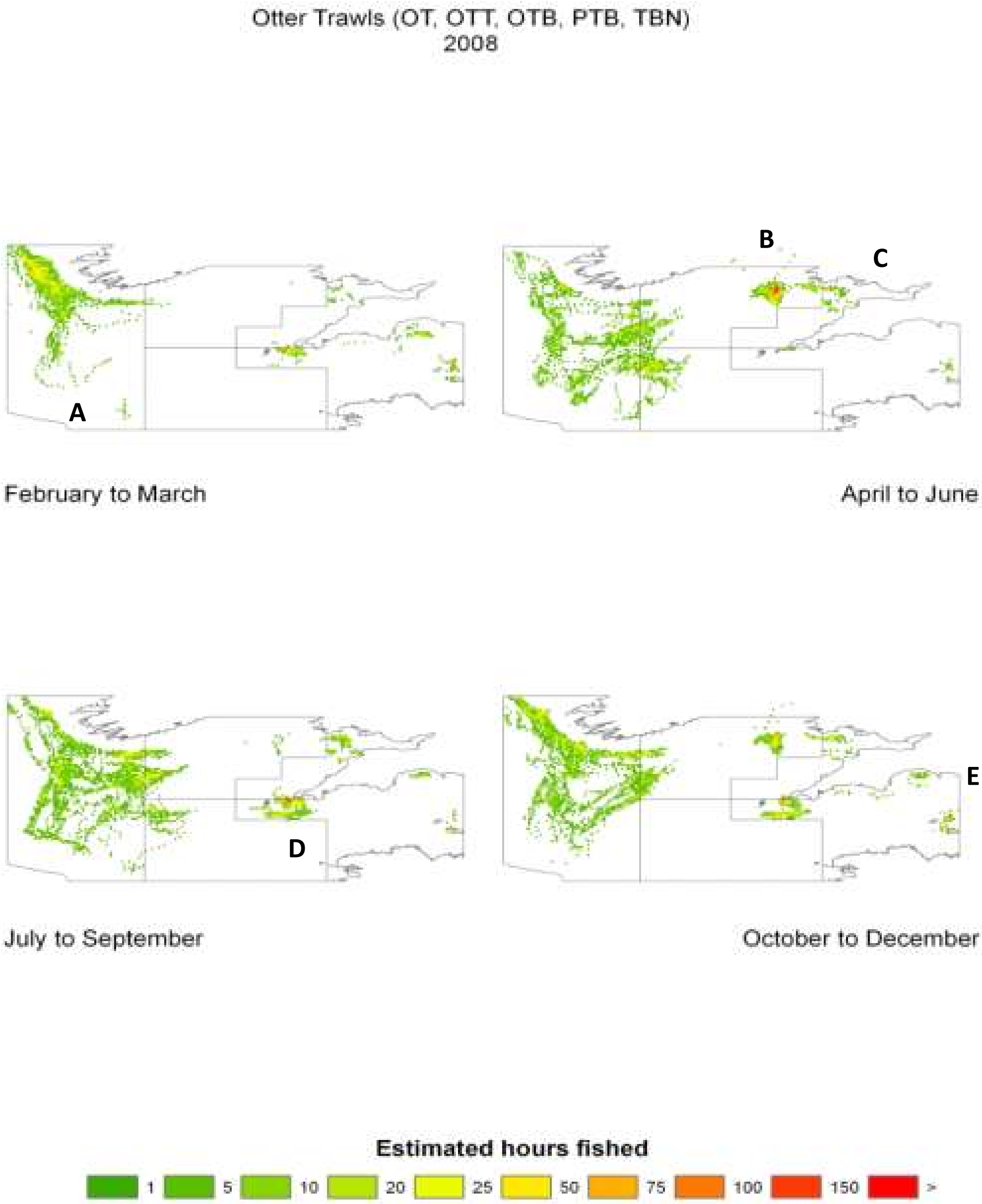


**Fig. 3.4.8**. UK otter trawlers (15m+): VMS position data for four periods of 2008 in VIIe,f,g,h&j.

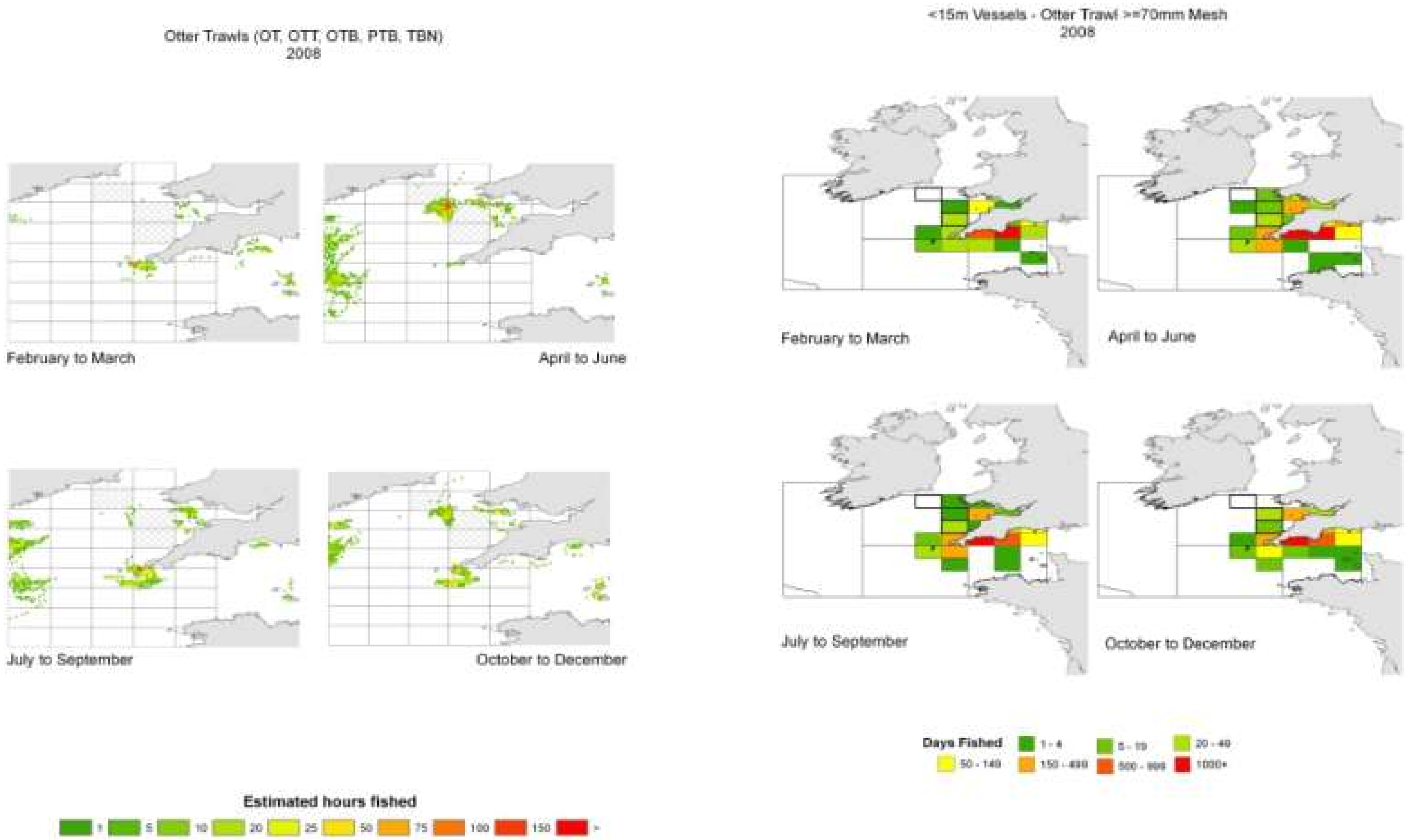


**Fig. 3.4.9**. Fishing activities of UK demersal otter trawlers in 2008 (all mesh sizes). Left hand plots: VMS position data for 15m+ vessels in VIIfgh, relative to the February-March Trevose cod closure (hatched area). Right hand plots: Effort by rectangle (days fished) for <15m vessels.

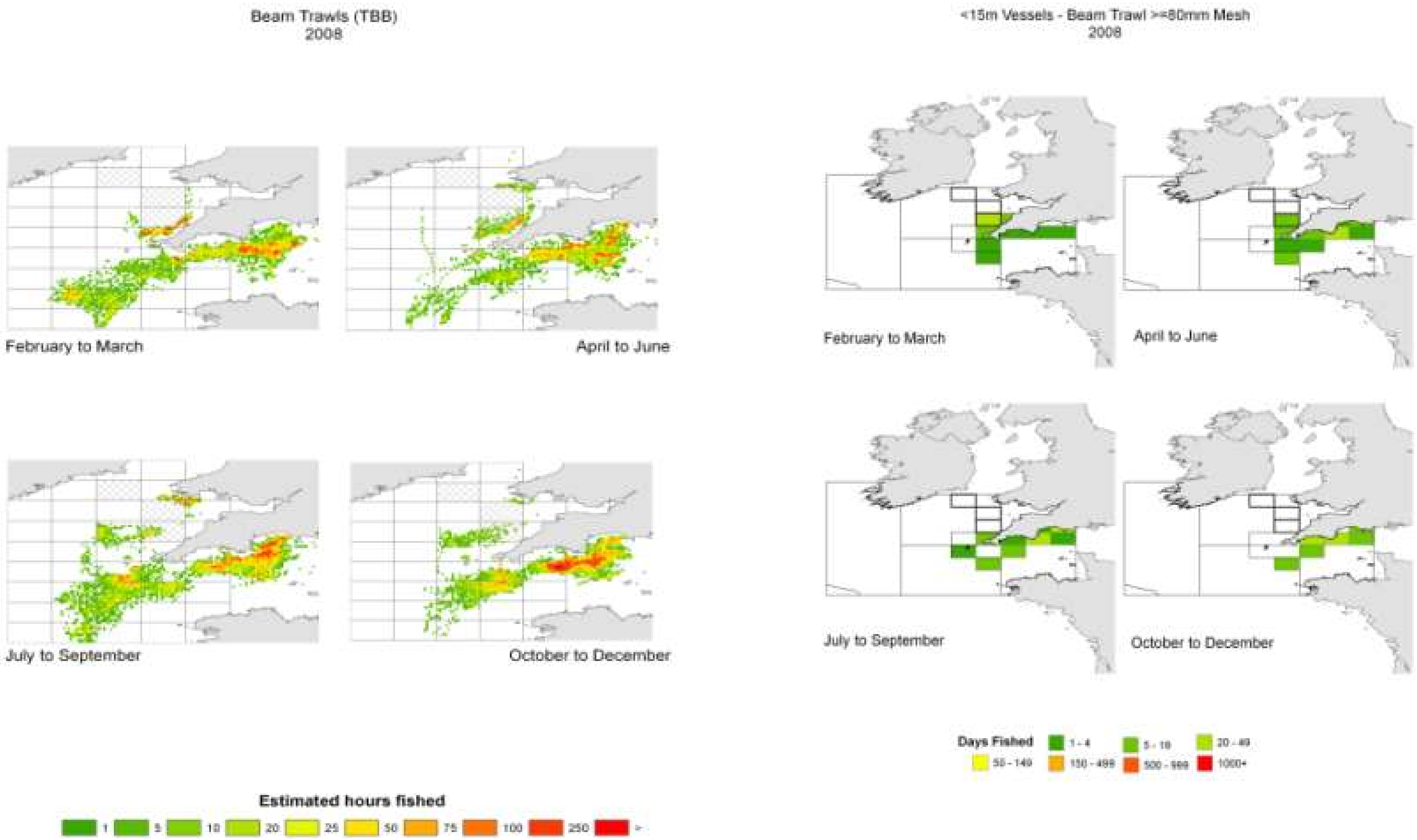


**Fig. 3.4.10**. Fishing activities of UK beam trawlers in 2008. Left hand plots: VMS position data for 15m+ vessels in VIIfgh, relative to the February-March Trevose cod closure (hatched area). Right hand plots: Fishing effort by ICES rectangle (days fished) for <15m vessels. No beam trawl effort was recorded in VIIj.

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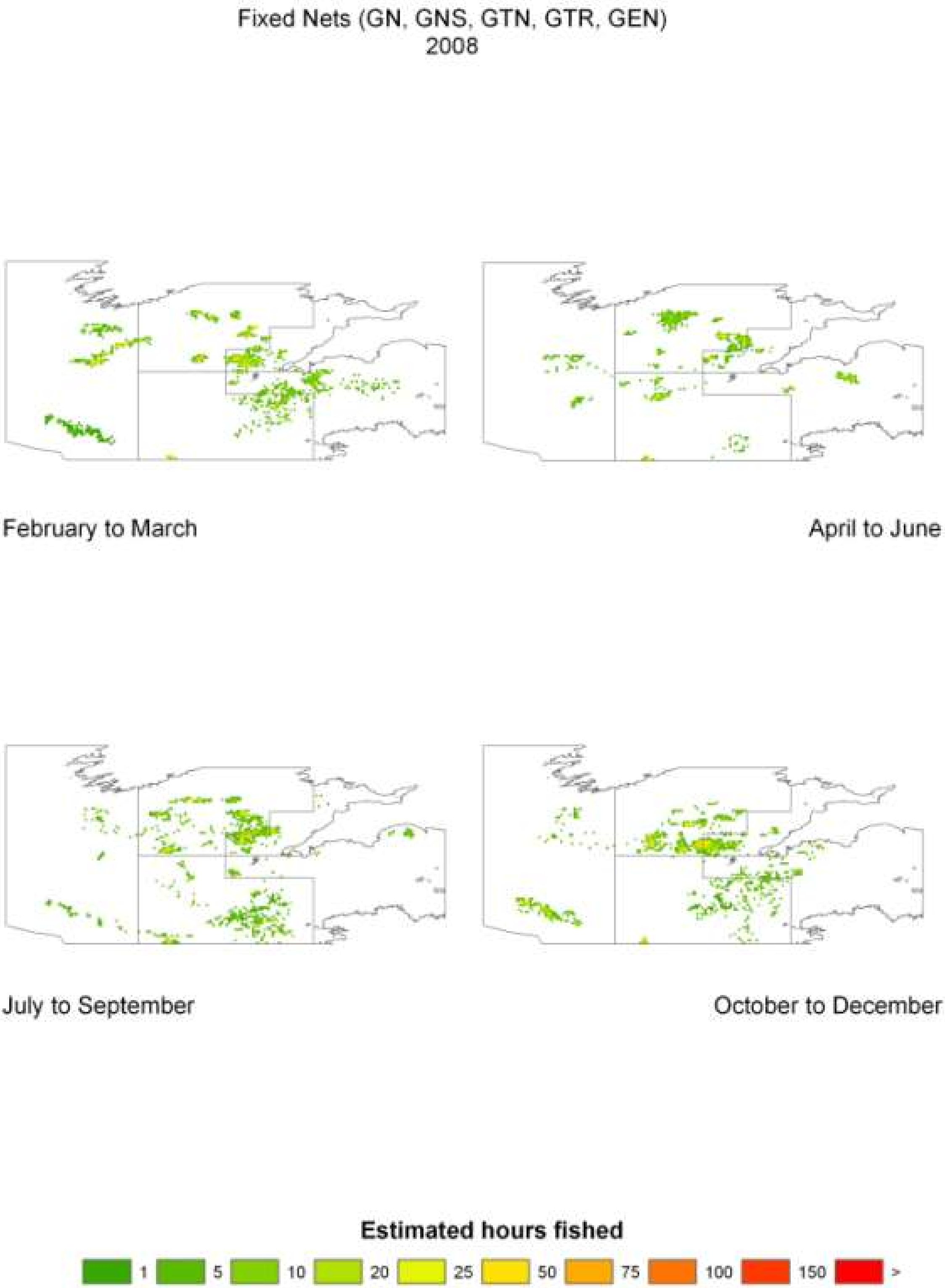



**Fig. 3.4.11**. UK fixed netters (15m+; all mesh sizes): VMS position data for four periods of 2008 in VIIe,f,g,h&j.

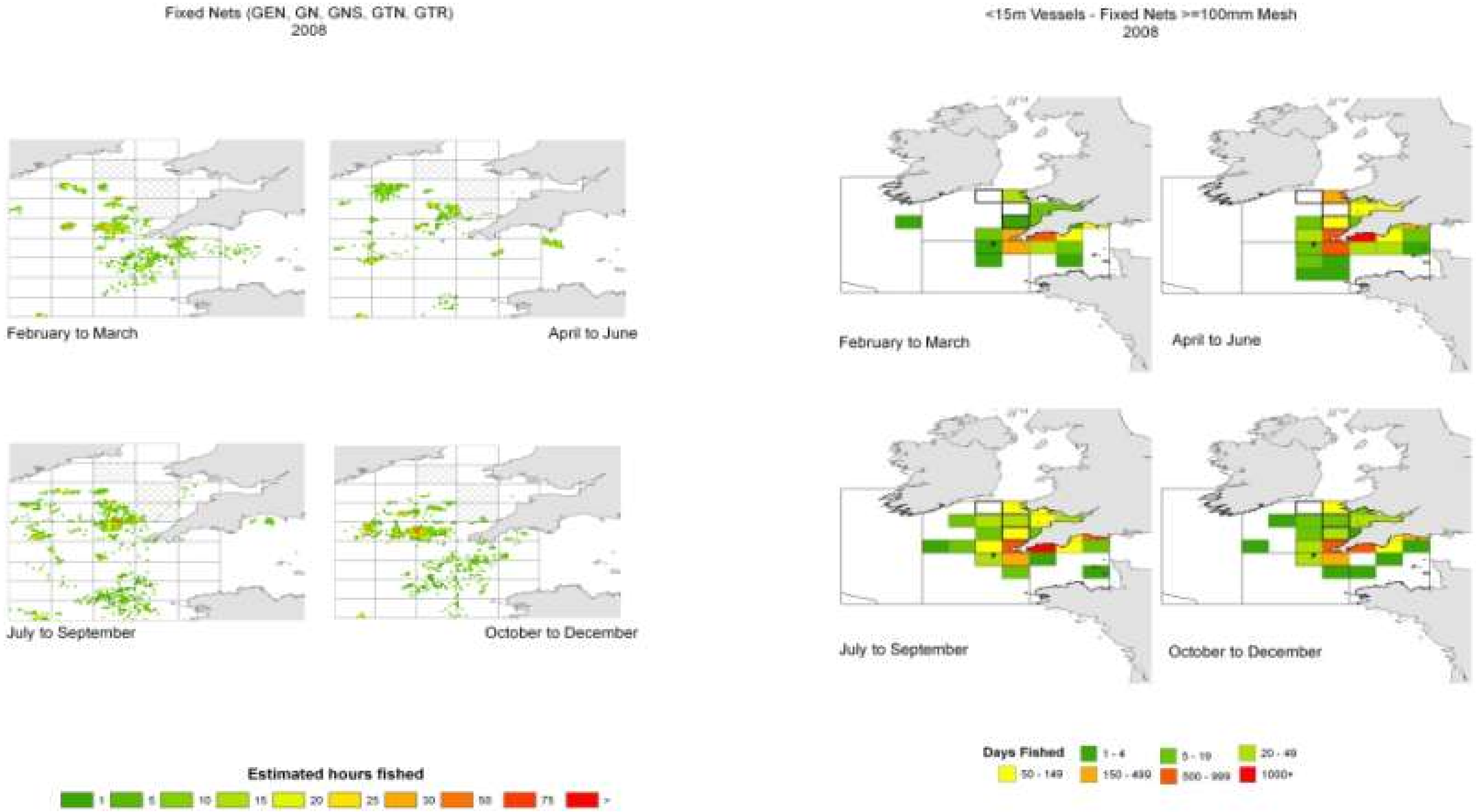



**Fig. 3.4.12**. Fishing activities of UK fixed netters in 2008(all mesh sizes). Left hand plots: VMS position data for 15m+ vessels in VIIfgh, relative to the February-March Trevose cod closure (hatched area). Right hand plots: Fishing effort by ICES rectangle (days fished) for <15m vessels.

#### 3.4.2.3 Task 2: Technological changes affecting fishing efficiency.

The NFFO/CFPO Annual Fisheries Report for 2008/09 lists a number of technological developments in the demersal fleet in the Southwest of England that could affect fishing efficiency. These include:

- Olex 3-d mapping systems allowing greater confidence in trawling in areas where damage is possible as well as avoiding sensitive areas. It also allows greater fuel efficiency as vessels can tow down slopes and avoid banks. The system also facilitates more accurate deployment of gill nets and tangle nets. Gill/tangle net skippers consider that this aspect of “technical creep” peaked a few years ago and there has been zero subsequent increase in technology.

- Most over-15m trawlers and some under-15m vessels have ability to twin-rig, and most have multiple net drums giving greater flexibility in changing fishing operations to suit quota availability and minimise down-time when damaged.

- Trammel nets are increasingly being used for anglerfish, turbot and other benthic species and in the under-15m sector are considered at least 10-15% more efficient than traditional single-wall nets. However due to the heavier weight, cost and time taken to clear nets, a shorter length of net can be used so overall efficiency is balanced out.

A number of other technological developments have helped to improve fuel efficiency, such as the use of wheels rather than traditional sleds on beam trawls, use of low reduction gearboxes and Kort Nozzles, improved engine design, better navigation systems to minimise travel distance.

Additional information on technological changes was obtained from a small number of owners/skippers who completed the questionnaire on gear/vessel characteristics and fishing activities (Table 3.4.5). Although this represents a very small sample it indicates the move from single-rig otter trawls designed for fishing on clean ground to multiple-rig and single rig rock-hopper gears allowing trawling in a greater number of ground types. There is no evidence from this small sample for a major increase in the dimensions of individual nets over the last 20 – 30 years although the use of twin rigs obviously increases the overall area swept. The questionnaire completed by a beam trawl vessel owner indicated virtually no change in the gear design over the last 25 years that could lead to increased fishing efficiency (this was a relatively small vessel using 4.5m beams; larger vessels may use 12m beams). The questionnaire return on gillnets showed an increase in the length of nets in the 1990s but relatively stable gear design subsequently. The tangle net return showed that a much greater length of net is shot nowadays compared to the 1970s, but that the use of trammel nets after 2005 has resulted in a reduction in total net length and more frequent hauling, as discussed in the fleet description section for fixed netters.

**Table 3.4.5.** Information on temporal changes in gear design based on questionnaires received from several respondents in the Cornish Fish Producers Organisation.

| | Year: | 1965-69 | 1970-74 | 1975-79 | 1980-84 | 1985-89 | 1990-94 | 1995-99 | 2000-04 | 2005-09 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Otter trawl** | Gear type single / twin | | | single | single | single | single | single | single | single |
| | Ground gear type (clean ground; bobbins/hoppers) | | | both | clean | both | hoppers | hoppers | hoppers | hoppers |
| | Ground gear length and extensions per net (m) | | | 37 | 27 | 22 | 27 | 27 | 27 | 27 |
| | cod end mesh size mm | | | 80 | 80 | 85 | 90 | 90 | 90 | 90 |
| **Otter trawl** | Gear type single / twin | | | | | single | single | single & twin | single & twin | single, twin & triple |
| | Ground gear type (clean ground; bobbins/hoppers) | | | | | clean | clean & hopper | hopper | hopper | hopper |
| | Ground gear length and extensions per net (m) | | | | | 14 | 16&14 | 18&22 | 18&22 | 20&28 |
| | cod end mesh size mm | | | | | 80 | 80 | 80 | 80 | 80 - 100 |
| **Otter trawl** | Gear type single / twin | single | single | single | single | single | single | single | single | single, and twin from 2007 |
| | Ground gear type (clean ground; bobbins/hoppers) | clean | clean | clean | clean & hopper | clean & hopper | clean & hopper | clean & hopper | clean & hopper | clean & hopper |
| | Ground gear length and extensions per net (m) | 18 | 18 | 18 | 27 | 27 | 15 | 15 | 20 | 20&25 |
| | cod end mesh size mm | 70 | 70 | 80 | 80 | 80 | 80 | 80 | 80 | 80 & 100 |
| | fishing circumference per net (m) | 23 | 23 | 23 | 49 | 49 | 50 | 50 | 52 | 52 & 54 |
| **beam trawl** | No. beams fished | | | | | 2 | 2 | 2 | 2 | 2 |
| | Individual beam width | | | | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| | Type (open or chain mat) | | | | | Chain mat | Chain mat | Chain mat | Chain mat | Chain mat |
| | Flip-up role | | | | | no | no | no | no | no |
| | Mesh size | | | | | 80 (86 guage) | 80 (86 guage) | 80 (86 guage) | 80 (86 guage) | 80 (86 guage) |
| | Wheels | | | | | yes | yes | yes | yes | yes |

## Table 3.4.5 continued

| | Year: | 1965-69 | 1970-74 | 1975-79 | 1980-84 | 1985-89 | 1990-94 | 1995-99 | 2000-04 | 2005-09 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gill nets** | Combined length of all net panels in each set (km) | | | | | | 10 | 15 | 17 | 17 |
| | Average soak time (hours) | | | | | | 12-24 | 12-24 | 12-24 | 12-24 |
| | Net type | | | | | | gillnet | gillnet | gillnet | gillnet |
| | Sets lifted per day | | | | | | 100% | 100% | 100% | 100% |
| **Tangle nets** | Combined length of all net panels in each set (km) | | | 9.1 | | | | 32 | 64 | 51 |
| | Average soak time (days) | | | 36 | | | | 36 | 36 - 48 | 24 - 36 |
| | Net type | | | single wall | | | | single wall | single wall | trammel |
| | Sets lifted per day | | | 25% | | | | 33% | 33% | 33% |
| **Long-lines** | No. hooks per line | | | | | 100 | | 100 | 100 | |
| | Total length of each line (m) | | | | | 200 | | 1000 | 1000 | |
| | Average soak time (h) | | | | | 24 | | 5 | 5 | |
| | No. lines lifted per day | | | | | 10 - 20 | | 1 | 1 | |

#### 3.4.2.4 Task 3: Impacts of management measures: effect of the Trevose cod closure on UK fleets

Around thirty UK vessels accounted for the top 95% of the UK cod landings from the Trevose cod closure rectangles (30E4, 31E4 and 32E3) in February and March of 2003&2004, the two years prior to the closure coming into force. These vessels included otter trawlers, beam trawlers and netters. This subset of UK vessels is referred to as the "Trevose vessel subset" in the following analysis, which describes how the fishing effort of these vessels were redistributed to surrounding areas when the Trevose closure was in place from 2005 onwards, and the effect on species compositions of their landings.

*Otter trawlers*

In 2003 and 2004, 39% of the otter trawl fishing effort in February and March by vessels in the Trevose vessel subset was deployed in ICES rectangles 30E4 and 31E4 (Fig. 3.4.13a). In subsequent years (2005-2009) the effort of these vessels in February and March was displaced well away from the Celtic Sea, and into the Irish Sea, West of Scotland and the North Sea (Fig. 3.4.13b). The effort distribution in February to March from 2005 onwards was more similar to the effort distribution in January and April to December in 2003-2004 (Fig. 3.4.13c), indicating that the Trevose closure made it no longer economically attractive to travel to the Celtic Sea to take advantage of the high cod catch rates that would have been available in the closure rectangles. From 2005 onwards, there was a trend for more of the effort of the Trevose vessel subset to be distributed in the North Sea (Fig. 3.4.13d).

For those otter trawl vessels in the Trevose vessel subset that remained in the Celtic Sea and western Channel, effort was displaced slightly and there was no evidence for a major shift in species targeting (Fig. 3.4.16) other than an increase in crustacea in some recent years. The major impact was a large reduction in landings from the Celtic Sea and Western Channel from 2005 onwards, and a clear reduction in cod landings. The reduction in cod landings is therefore a consequence of effort displacement out of the Celtic Sea, as well as the displacement of remaining vessels away from the closure rectangles in Feb-March, where elevated catch rates of adult cod would have otherwise been recorded.

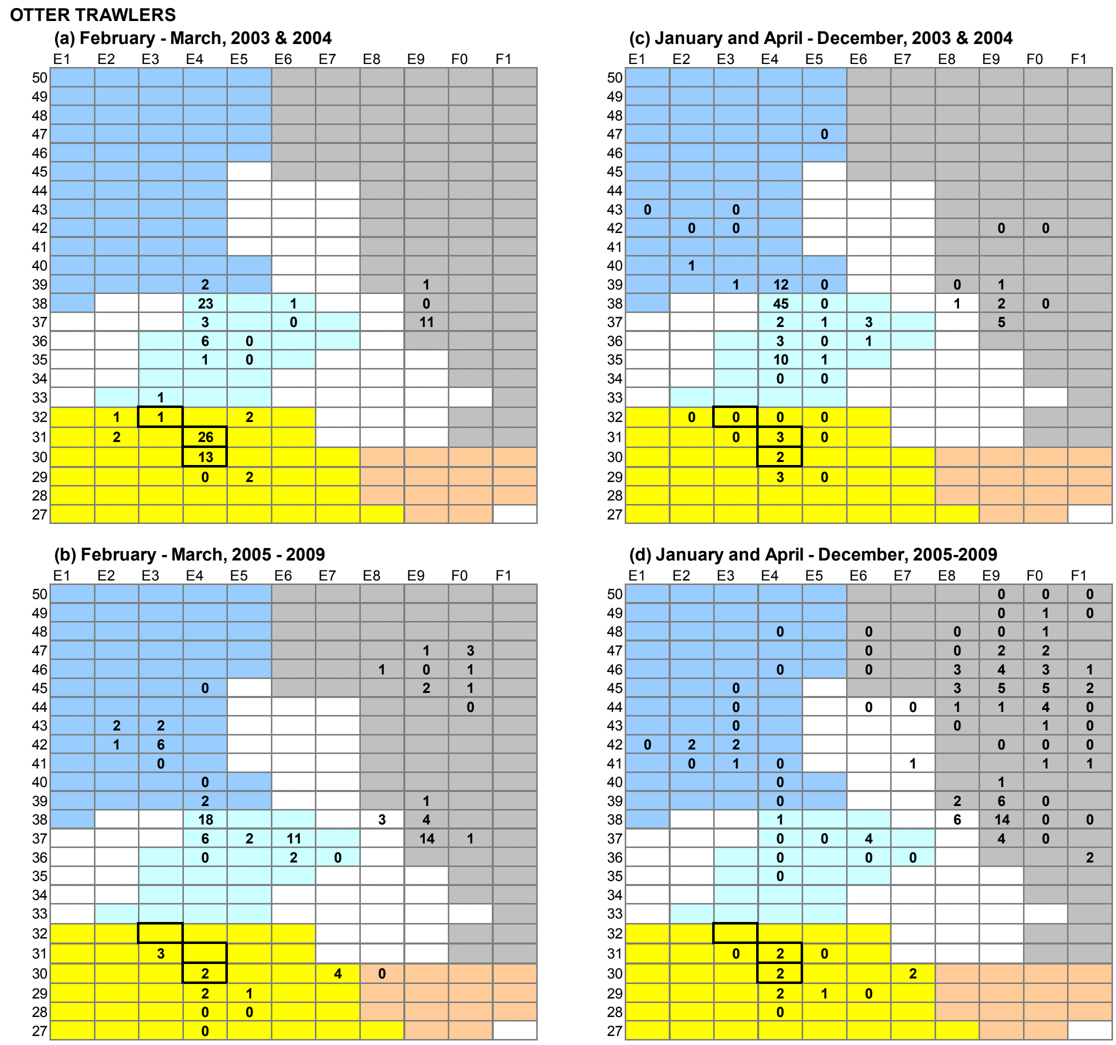



**Fig. 3.4.13** Percentage distribution of fishing effort by ICES rectangle for the subset of UK registered vessels that reported the top 95% of the cod landings in the Trevose closure rectangles (30E4, 31E4 and 32E3 – rectangles with highlighted borders) in February and March 2003&2004 (after ranking the vessels from largest to smallest cod landings). A value of zero indicates a positive value less than 0.5%. **Data are for otter trawls only**. Panels (a) and (b) show the change in distribution of effort between 2003&2004 (pre-closure years) and 2005-2009 (post closure years). Panels (c) and (d) show the effort distributions during January and April – December. Colour codes: yellow = Celtic Sea and VIIe; pale blue = Irish Sea (VIIa); dark blue = west of Scotland (VIa); grey = North Sea; orange = eastern Channel (VIId).

*Beam trawlers*

In February-March 2003&2004, 15% of the fishing effort of beam trawlers in the Trevose vessel subset came from the closure rectangle 30E4 (Fig. 3.4.14a). In February-March 2005 onwards, the percentage in 30E4 declined to 5% (Fig. 3.4.14b). The remaining effort in the closure presumably represented vessels fishing for plaice and sole in the extreme SE corner of 30E4, within 6 miles of the coast, which was opened from 2006 onwards. The FSP survey of Celtic Sea sole and plaice (Fig. 3.4.5) in 2005 showed aggregations of sole and plaice in this part of 30E4. In contrast to otter trawlers in the vessel subset, effort displacement of beam trawlers was mainly within the Celtic Sea, in a generally south-west direction towards the offshore grounds where anglerfish and megrim are targeted. This represented a return to patterns of fishing observed during the remainder of the year (Fig. 3.4.14c&d). The species compositions of the landings of the beam trawlers in the Trevose vessel subset was hardly changed by the closure (Fig. 3.4.16). In general, cod landings by the subset of beamers were very low in February – March before and after the closure came into force in 2005.

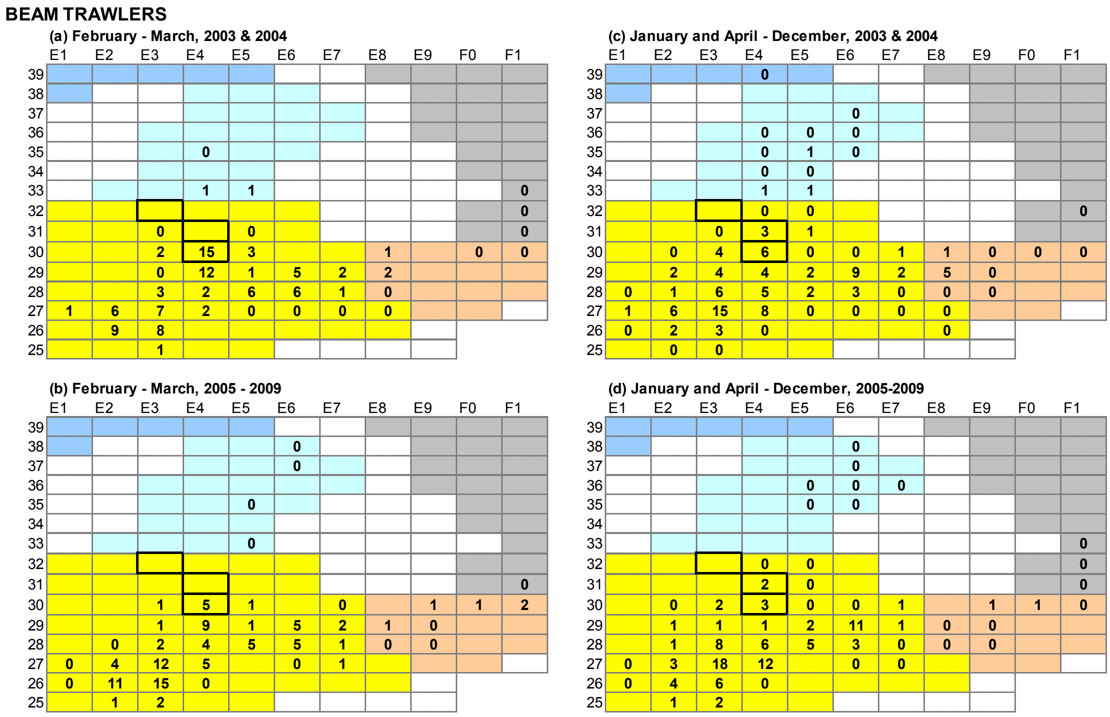


**Fig. 3.4.14** Percentage distribution of fishing effort by ICES rectangle for the subset of UK registered vessels that reported the top 95% of the cod landings in the Trevose closure rectangles (30E4, 31E4 and 32E3 - highlighted) in February and March 2003&2004 (after ranking the vessels from largest to smallest cod landings). **Data are for beam trawls only**. See Fig. 3.3.3.16 legend for full description.

*Gillnet and tangle net vessels*

In February-March 2003&2004, 46% of the fishing effort of fixed-net vessels in the Trevose vessel subset came from the closure rectangles 30E4, 31E4 and 32E3 (Fig. 3.4.15a). In February-March 2005 onwards, the percentage in declined to 2% (Fig. 3.4.15b). As with the beam trawlers, effort remained within the Celtic Sea and western Channel after the Trevose closure came into force in 2005, and was displaced to the south and southwest. The effort distribution in February-March 2005 onwards did not extend as far west (into the E2 rectangles) as observed at other times of year (Fig. 3.4.15c&d). The species composition was also hardly affected by the effort displacement, remaining dominated by pollack and ling during February and March (Fig. 3.4.16). A small fraction of the landings comprised cod throughout the 2003-2009 period, representing cod taken on wrecks and rough ground targeted by netters.

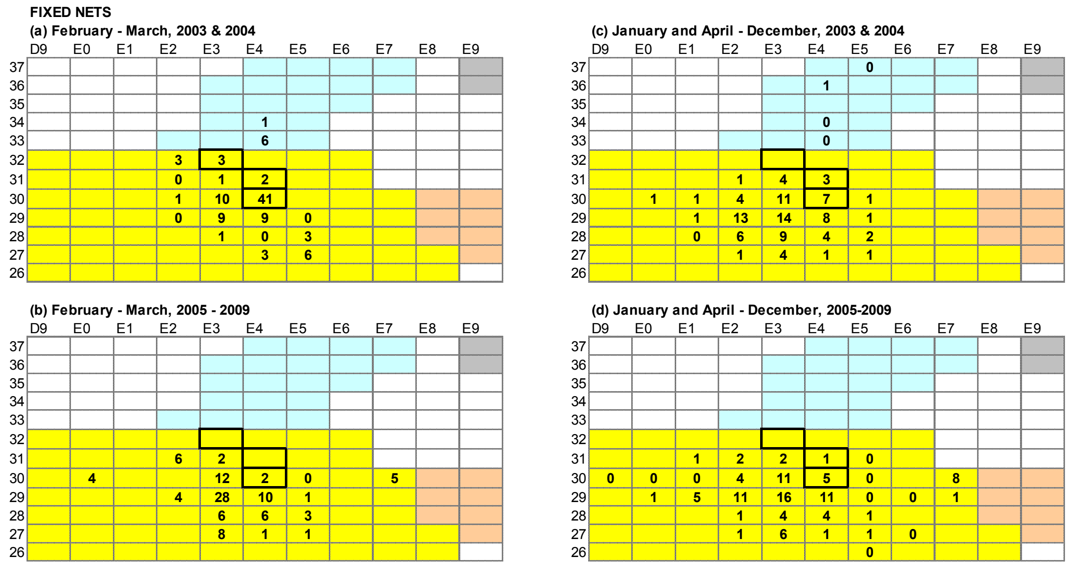



**Fig. 3.4.15** Percentage distribution of fishing effort by ICES rectangle for the subset of UK registered vessels that reported the top 95% of the cod landings in the Trevose closure rectangles (30E4, 31E4 and 32E3 - highlighted) in February and March 2003&2004 (after ranking the vessels from largest to smallest cod landings). **Data are for gillnets and tangle nets only**. See Fig. 3.3.3.16 legend for full description.

*Industry views*

The questionnaire circulated to Cornish Fish Producers Organisation members included a series of questions on the Trevose closure to understand how individual fishermen operated in the closure area before and after the inception of the closure, and their views on its effectiveness. Only a small fraction of the questionnaires were returned, and the following information was provided:

Otter trawl fisherman 1:
*Previous pattern in February-March*: 50% of fishing time was in the Trevose closure area prior to 2005, targeting ray, cod and haddock using single and twin rig otter trawls.
*Fishing pattern in Feb-March from 2005 onwards*: now targets lemon sole and rays in other areas.
*Views on closure*: considers that the effectiveness of the closure is reduced by the amount of fishing effort re-entering the area when it is re-opened. Considers that the closure was initially discussed as a method for protecting all spawning fish, not just cod.

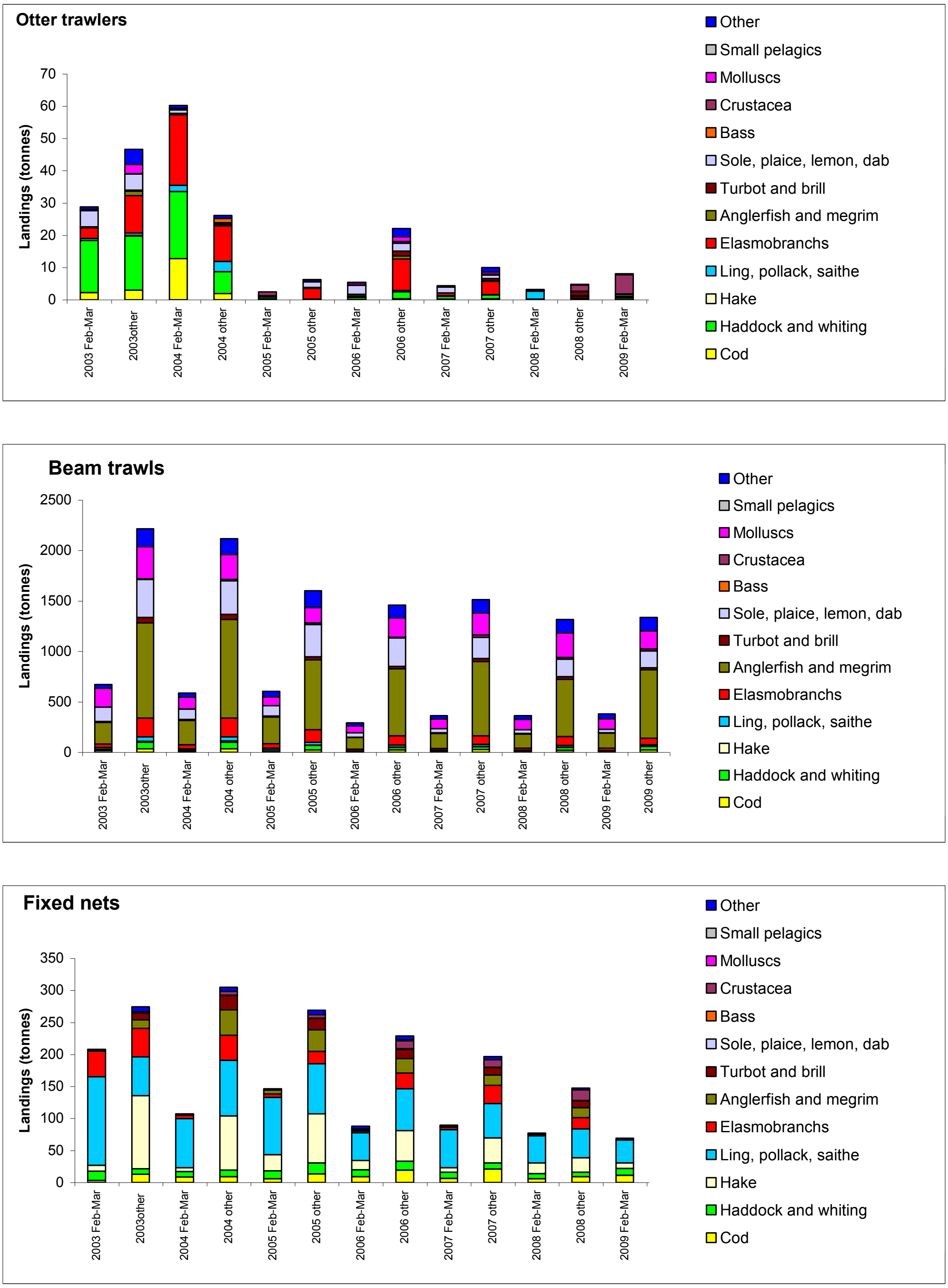
Otter trawl fisherman 2:
*Previous pattern in February-March*: Historically fished for mixed species over a wider area, spending no more than 20 days in the closure area, targeting whiting, cod, pollack, plaice, haddock, sole and lemon sole using single rock-hopper otter trawl.
*Fishing pattern in Feb-March from 2005 onwards*: Now fishes in the western Channel VIIe (28E4 and 28E3) and Celtic Sea VIIf (29E3 and 29E4: immediately south and southwest of closure). Cod taken in the Trevose closure was spawning stock. Catches are now a mix of large and medium fish, but not in any quantity.

*Views on closure*: considers that the closure has been very effective in stopping all un-necessary by-catch and black landings of cod. However the closure has had an impact on beam trawling activity.

Gill/tangle net fisherman:
*Previous pattern in February-March*: Spent 100% of time in the closure area, using 156mm gillnets to target cod, pollack and ling.
*Fishing pattern in Feb-March from 2005 onwards*: now fishes south-west of the Hurd Deeps (the deep trough in the middle of the western English Channel, at around 4°W), using 140mm and 120mm gillnets to target pollack, ling, hake and black bream. No longer catches any cod in February and March unless fishing on spring tides in Irish waters, where the size of cod is the same as in previous years (large fish of 9kg).
*Views on closure*: Fishing mortality on cod obviously cut by 100% in the closed area, but the overall benefits of the closure are yet to be seen. There used to be 50-60 netters operating in the closure area, this is now reduced to 10 (80% reduction). There is insufficient cod quota for directed cod fishing, only for by-catch. Some netters have moved south into French waters to target pollack instead.

Beam trawl fisherman:
*Previous pattern in February-March*: Virtually 100% of time spent in the closure area, using beam trawl to target sole. Pattern was to commence fishing at Lundy (31E5) in January then work southwest down north coast of Cornwall into the closure area. Then start to work further south by mid-March.
*Fishing pattern in Feb-March from 2005 onwards*: now fishes just south of the closure. Does not catch enough cod to comment on changes in size composition.
*Views on closure*: Unsure of effect on cod. Belgian beam trawlers re-enter the closure as soon as it re-opens. Has noted an increase in the catches of starfish in the closed rectangles indicating changes in the benthos due to reduced trawling – considers this an indication of reduced productivity for the fish stocks.

Crab fisherman:
*Previous pattern in February-March*: fishes inside 6-mile limit – i.e. inshore of the closed area.
*Fishing pattern in Feb-March from 2005 onwards*: as before
*Views on closure*: Has negative effect of concentrating beam trawl activity into a smaller inshore area in February and March, towing repeatedly over the same ground, and causing conflict with pot fishermen.




**Fig, 3.4.16** Landings by species groups in February-March and the rest of year from 2003 to 2009, in ICES Divisions VIIe,f,g,h,&j only, for the subset of UK registered vessels that reported the top 90% of the cod landings in the Trevose closure rectangles (30E4, 31E4 and 32E3) in February and March 2003&2004 (after ranking the vessels from largest to smallest cod landings).

### 3.4.3 Discussion

Fishery scientists in England have a long history of collaboration with the fishing industry to address topics such as fishing gear selectivity or otherwise use fishing vessels as a platform for data collection. The Fisheries Science Partnership since 2004 has provided an opportunity for fishermen to propose ideas for collaborative research which are then developed in collaboration with Cefas scientists and then put out to tender. The FSP projects and time-series surveys in the Celtic Sea and western Channel have produced extremely useful data for interpreting fishery data collected through the EU logbook census, as shown in the Lot 1 project, and for tracking changes in abundance and catch composition from year to year.

The NFFO/CFPO Annual Fisheries Report, which is due to be extended to other areas around England, is another industry initiative which should prove very valuable for interpreting changes seen in fishery activity data, and to help inform fishery managers. An aim of the Cefas-CFPO collaboration in the present project was to examine ways in which the often quite complex fishery activity data can be presented in easy-to-assimilate visual plots, possibly through a web-based application. The spatial VMS, rectangle-effort and species composition plots are provided as examples of possible ways in which voluminous data could be synthesised (other approaches are possible and should be considered as well).

Although relatively few responses were obtained to the questionnaire on long-term changes in vessels, gears and fishing activities, the results indicated that the major changes in technological efficiency occurred in the 1970s – 1980s with changes in trawl gear design such as the development of rock-hopper type ground gear allowing trawling on harder ground, the introduction of multiple rig trawls, and improvements in electronics. Fishing gears have become more stable in recent years, although recent developments in improving gear selectivity and reducing discards will result in further changes in gear efficiency (at least for some species and size classes) as these designs become more widely used.

Several analyses of the impact of the Trevose cod closure have been carried out in recent years, but have not been conclusive in demonstrating a reduction in fishing mortality on cod directly attributable to the exclusion of vessels from the three closed rectangles in February – March. The analysis of effort redistribution conducted in the Lot-1 project indicated a tendency for fixed-net vessels and beam trawlers to return to the fishing grounds within the Celtic Sea targeted at other times of the year, whilst the otter trawlers that were responsible for a large part of the cod catch in the closure area in 2003&2004 appeared to be displaced farther afield, including to the Irish Sea, North Channel and North Sea. For vessels remaining in the Celtic Sea and western Channel, they did not noticeably change their metier during the annual closure period, but typically shifted to the south and south west of the closed area.

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## 3.5 Celtic Sea Pilot project: France

### 3.5.1 Methods

The French pilot project covers the tasks on *fishery descriptions* and *responses to management measures*. As with the English, Belgian and Irish studies, the main management measure examined is the Trevose cod closure.

#### 3.5.1.1 Fishery descriptions

To evaluate the activity of the French vessels in the Celtic Sea, the following ICES sub-divisions are considered, 7F, 7G, 7J, 7H, 7E. Different sources of data are available to present the activity of French fleet in this area. The most exhaustive is the national calendar activity. This database has been developed by Ifremer in order to have a minimum of information for all French vessels. At the beginning of each year, the Ifremer observers contact all the skippers of their sector to establish the fishing calendar of the previous year. For each month, the two principal “metiers” associated with the two main fishing areas are reported. Some gear characteristics or their number are also recorded. By this means, exhaustive information is known for the all-French fishing vessels.

For each size class, the following information is known: the number of vessels, the number of harbours where the vessels come from, the number of metier practised and the limit of the fishing area. The area within 12miles of the coast, and the larger area beyond 12 miles, are considered. The mixed area has been created for the vessels that fish around the 12-mile limit. The foreign waters designate areas under the jurisdiction of a foreign country.

The species compositions of landings were evaluated using the same methods applied to UK vessels. Pie charts were produced for each gear/mesh combination in 2008 showing the species composition by ICES rectangle, by period of the year (February – March [i.e. Trevose cod closure period]; April – June, July – September and October-December), and scaled so that the diameter of the pie is proportional to the square root of the total landings per rectangle. Species were grouped in a logical way taking account of the species associations in the fisheries, to reduce the number of slices in the pies – e.g. anglerfish and megrim have very similar spatial distributions and are grouped. Small flatfish species are also grouped (plaice, sole, lemon sole, dab). These plots need to be viewed in colour. The species composition plots are grouped with those of other countries in Appendix 3.

#### 3.5.1.2 Impacts of management measures

In order to measure the impact of the Trevose cod closure on French vessels, we selected the vessels that have fished significantly in it, based on VMS data. A monthly analysis provided position data for each trip showing the sequence of locations where the vessels fished according to different size spatial grids. A list of vessels was then selected comprising vessel that fish during at least one part of the year in the cod closed area. The period covers 2005-2008. For the specific study in the cod closed area, we only analysed the data of the trawlers.

From the list of trawler that fished the in cod closure area, a further selection was made representing trawlers dependant on the closure area for more than 10% of their fishing time during the 2 months January and April (i.e. the month before and the month immediately after the closure. This method selects vessels that specifically choose to fish in this area. In order to understand the strategy of the vessels during the cod closed period and one month before and after, the distribution of the effort was mapped using VMS and the landing composition was analysed. From the VMS data, considering a threshold average speed of 4.5 knots to be the maximum speed when fishing, we used a cell grid of 10*10 minutes to present the effort distribution. In order to look the impact of the closed period, the fishing effort during the period of February-March was mapped.

### 3.5.2 Results

#### 3.5.2.1 Description of the fisheries

*Fleet structure and areas of operation*

The activity of French vessels in the Celtic Sea (Table 3.5.1) was compiled using several variables. The most important statistic is the number of vessels present in the area. In 2008, 1232 vessels fished at minimum one month in the Celtic sea. The largest number of vessels is found in the size class less than 10 meters (511 vessels). Apart from seven vessels, the under-10m fleet fishes the coastal area. These vessels operate all along the north coast of Brittany and the west coast of Normandy from Brest to Cherbourg (Figure 3.5.1). These vessels are distributed in a large number of small harbours where they need relatively little infrastructure and which are close to their fishing area.

The second most numerous vessels are in the 15 meter and over fleet segment. This class of vessel operates in all the Celtic sea area and beyond. These vessels operate come in part from harbours outside of the French coasts boarding the Celtic sea. Many of the vessels come from harbours in the South Brittany and in the East of Normandy (Figure 3.5.1).

Table 3.5.1: Description of the activity of the French vessel that fish in the Celtic sea in 2008.

| Vessel size | Total numbers | | | No. of vessels in different categories | | | |
|---|---|---|---|---|---|---|---|
| | vessels | harbours | métiers | Coastal area <12miles | Mixed area | Beyond 12 miles | Foreign waters |
| <10M | 511 | 85 | 100 | 508 | 7 | 0 | 0 |
| >=10 and =<15 | 334 | 61 | 90 | 316 | 42 | 25 | 4 |
| >15M | 387 | 54 | 84 | 105 | 57 | 208 | 230 |

The third most numerous class of vessels is those of 10 m and over and under 15m overall length (334 vessels). This fleet segment is dependent on the coastal area. Nevertheless, some vessels fish in the mixed area around the 12-mile limit and the larger area beyond 12 miles from the coast. The foreign water considered for the four vessels is in waters around the British Isles.

Depending of the vessel class size, the type of gears used are the same (Table 3.5.2). Nevertheless, the metiers practised are different. Vessels of 15 meters and over are mainly otter trawlers or pelagic trawlers. The smaller boat are mainly netters, liners or potters. The diversity of metiers by gear represents the strategies of fishermen who target a lot of species.

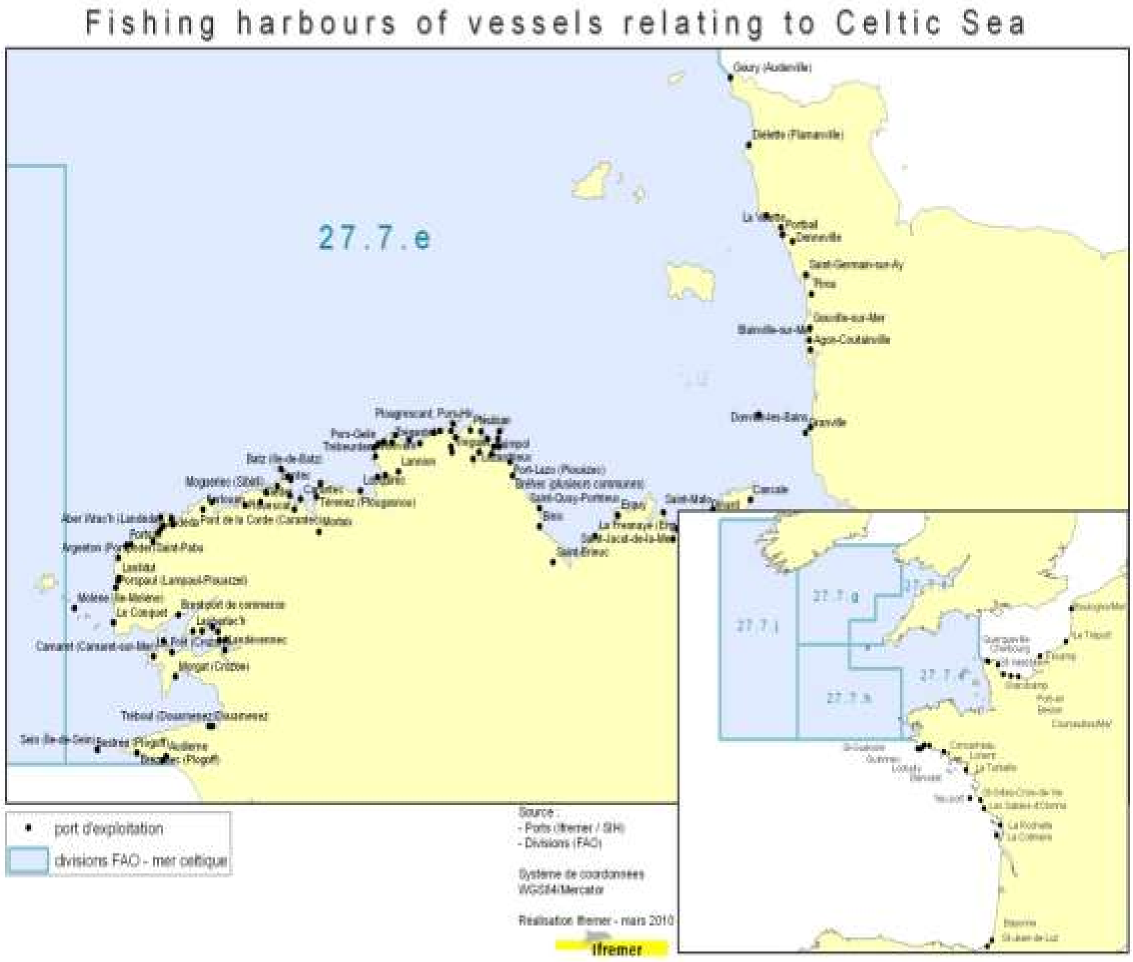


Figure 3.5.1: Fishing harbours where some vessels are dependant to Celtic sea.

Table 3.5.2: Number of different métiers recorded in the three vessel class sizes.

| | Number of metier by vessel call size | | |
|---|---|---|---|
| **Gear** | **<10M** | **>=10 and =<15** | **>15M** |
| Dredge | 12 | 13 | 7 |
| Pot | 10 | 7 | 2 |
| Net | 32 | 21 | 11 |
| Line | 19 | 5 | 5 |
| Hand Line | 13 | 11 | 1 |
| Otter Trawl | 6 | 22 | 34 |
| Pelagic trawl | 0 | 2 | 13 |
| Beam Trawl | 0 | 1 | 1 |
| Purse Seiner | 0 | 6 | 7 |
| Scoubidou | 1 | 1 | 0 |
| Diving | 4 | 0 | 0 |
| Tamis | 3 | 1 | 0 |

Strong seasonality in fishing activities is apparent for some gears (Figure 3.5.2) particularly for vessels under 15 meters. These vessels are more dependent on the effects of weather conditions and fish distribution or catchability. In consequence, the strategy is to use different types of gear during the year. The dredge is mainly used to catch scallop. The seasonality of this metier is well known because it is forbidden to fish for scallops during summer. Moreover, in many places during winter, shellfish such as scallop and warty venus are the more profitable species. The seasonality of the pot metier is linked to the seasonal catchability of the targeted species spider crab and lobster. For vessels of 15 meters and over, the seasonality in the Celtic sea is more linked to their capacity to move between different fishing areas. In general, these boats can easily change their targeted species but not their gear (Table 3.5.3).

Table 3.5.3 : Number of gears used on average, by vessel size class.

| | **<10M** | **>=10 and =<15** | **>15M** |
|---|---|---|---|
| Number of gears used on average | 2 | 2 | 1.2 |

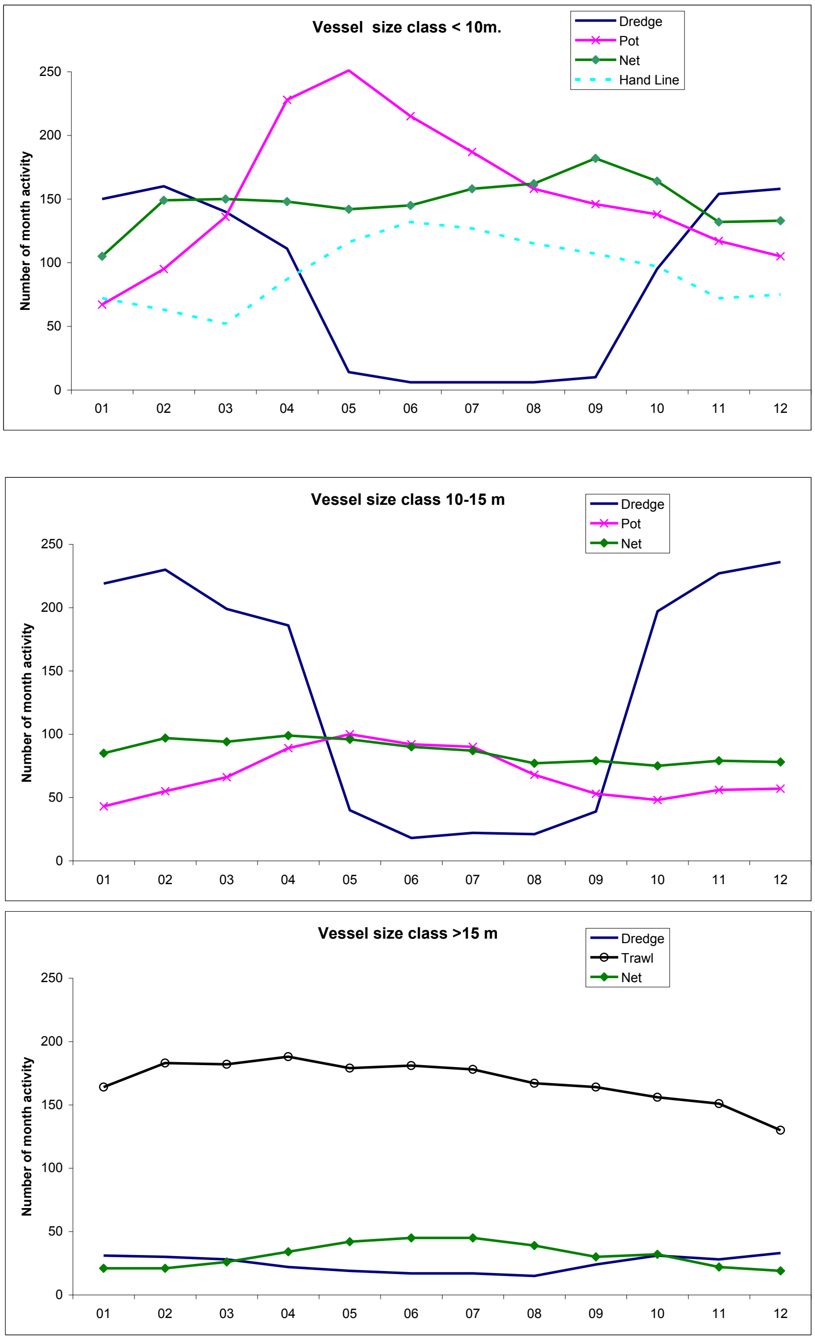


Figure 3.5.2. Monthly activity for the main gear by vessel size classes.

*Composition of landings from the Celtic Sea in 2008*

Vessels using fixed nets

In the north of Brittany, the majority of the netters used a mesh size over 220 mm and target two species in volume, anglerfish and spider crab (Appendix 3 Fig. A-3. 16a,b). These two species are linked to different strategies in different fishing grounds. The anglerfish is fished more in the west of Brittany and the main by-catch species are turbot and elasmobranchs. In the other area, spider crab represent more than 95% of the landing. For these two main species, there are seasonal patterns of the catch. The spider crab landings are important from autumn to spring. The anglerfish landings are important during spring and summer.

For the netters with mesh size under 220 mm (Appendix 3 Fig. A-3. 15a,b), the target species are more diverse. Depending on season, it is possible to change target species, for example red mullet in autumn, pollack in winter and sole in spring and summer. The majority of the net landings come from ICES rectangles along the Brittany coast. Only a few netters operate in the middle of the Celtic sea. In this case, they mainly target hake or cod and megrim. These vessels come from harbours in the south of Brittany and some of them are Franco-Spanish.

Vessels using otter trawls

Trawlers that used a mesh size over 100 mm operated mainly in 7H, 7F and 7G (Appendix 3 Fig. A-3.14a,b). In this area there are three different fisheries. Vessels in the south (7H) target anglerfish and elasmobranchs. In this area, the trawlers use mesh sizes under and over 100 mm but the composition of the catches is much the same. In the northern part of 7H and in the South of 7G, *Nephrops* and anglerfish are targeted, whilst in the north and east of this area, cod, haddock and megrim are an important catch. Cod landings are affected by seasonal migrations. During the spring and summer, cod are caught in a large number of ICES rectangles. The activity of the French trawlers (mainly in 7G) is equally seasonal. During the winter, fewer vessels fish in this area due to bad weather and low catchability of *Nephrops*.

Demersal otter trawlers using mesh size under 100mm operate in ICES Divisions 7E and 7H. In the Western Channel there is a division between the northern and the southern part. In the north, haddock and megrim are caught depending on ground type (Appendix 3. Fig. A-3.13a,b). In the south and in the direction of the 7H division, the trawlers target anglerfish and elasmobranchs. There are some seasonal fisheries such as for bass in winter and molluscs in spring and autumn.

Vessels using beam trawls

This gear is little used in France. The main species targeted is the sole. In the areas fished using this gear, plaice are not very common. The other group of species is elasmobranchs, where the skate *Raja undulata* represents a large part.

#### 3.5.2.2 Impact of management measures: Trevose Cod closed Area

French vessels that fished at least once in the Trevose cod closure area in 2005-2008 are listed in Table 3.5.4. The majority of French vessel in the area are trawlers, and more than 80% of these vessels are exclusively bottom trawler. The others can change to become pelagic trawler. But, they become pelagic trawler during the summer when they target tuna.

Table 3.5.4: Number of vessel by fleet that fish in the cod closed area.

| YEAR | FLEET (FRENCH NAME) | FLEET (ENGLISH NAME) | NO. OF VESSELS |
|---|---|---|---|
| 2008 | Bolincheurs exclusifs | Purse seiner | 1 |
| 2007 | Bolincheurs polyvalents Arts dormants | Purse seiner | 1 |
| 2005 | Caseyeurs exclusifs | Potter | 6 |
| 2006 | Caseyeurs exclusifs | Potter | 4 |
| 2007 | Caseyeurs exclusifs | Potter | 4 |
| 2008 | Caseyeurs exclusifs | Potter | 4 |
| 2006 | Chalutiers Arts dormants | Trawler-netter | 1 |
| 2008 | Chalutiers Arts dormants | Trawler-netter | 1 |
| 2005 | Chalutiers de fond exclusifs | Bottom trawler | 91 |
| 2006 | Chalutiers de fond exclusifs | Bottom trawler | 94 |
| 2007 | Chalutiers de fond exclusifs | Bottom trawler | 99 |
| 2008 | Chalutiers de fond exclusifs | Bottom trawler | 86 |
| 2005 | Chalutiers Dragueurs exclusifs | Trawler-dredger | 2 |
| 2006 | Chalutiers Dragueurs exclusifs | Trawler-dredger | 1 |
| 2005 | Chalutiers mixtes exclusifs | Bottom-pelagic trawler | 20 |
| 2006 | Chalutiers mixtes exclusifs | Bottom-pelagic trawler | 19 |
| 2007 | Chalutiers mixtes exclusifs | Bottom-pelagic trawler | 11 |
| 2008 | Chalutiers mixtes exclusifs | Bottom-pelagic trawler | 9 |
| 2005 | Fileyeurs exclusifs | Netter | 2 |
| 2006 | Fileyeurs exclusifs | Netter | 2 |
| 2007 | Fileyeurs exclusifs | Netter | 2 |
| 2008 | Fileyeurs exclusifs | Netter | 2 |
| 2005 | Fileyeurs Métiers de l'hameçon exclusifs | Netter-Liner | 4 |
| 2006 | Fileyeurs Métiers de l'hameçon exclusifs | Netter-Liner | 2 |
| 2007 | Fileyeurs Métiers de l'hameçon exclusifs | Netter-Liner | 4 |
| 2008 | Fileyeurs Métiers de l'hameçon exclusifs | Netter-Liner | 4 |
| 2007 | Palangriers exclusifs | Liner | 1 |
| 2008 | Palangriers exclusifs | Liner | 1 |

*Distribution of effort:*

The fishing effort of the French trawlers is highly seasonal (Fig. 3.5.3) with a maximum in October-November and in January and April around the closed period. When we consider the annual fishing time, we can really observe a decrease of the fishing activity in the cod area (Table 3.5.5). Effort in 2005 in Jan-April was particularly low as the cod area was closed in January too. This trend in effort is directly linked to the decrease of the number of trawlers (Table 3.5.4). This trend is identical to the trend from 1999 to 2005 observed from the logbook data (Biseau and Bellail, 2006).

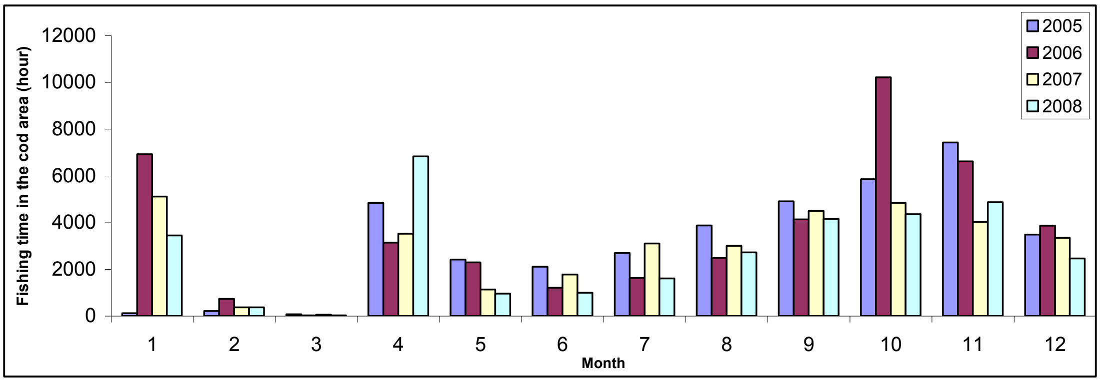


Figure 3.5.3: Annual evolution of effort in the cod area for trawlers.

Table 3.5.5 : Distribution of the fishing activity (hours and vessel number) in the Trevose cod closure area for different periods.

| | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| Hours in cod closure area: whole year | 39133 | 43902 | 34801 | 32863 |
| Hours fished in cod closure area: Jan -April | 5260 | 10838 | 9068 | 10675 |
| Nos. vessels in the cod closure area: Jan-April | 48 | 78 | 75 | 69 |
| Nos vessels with dependency >10% in the cod area: Jan - April | 24 | 46 | 37 | 44 |

In order to focus on the fishing activity in the cod area, we first select the vessels that have a dependency on this area for >10% of the fishing time in January and April. During February and March of 2005-2008 (Figure 3.5.4), a substantial proportion of the fishing effort of these otter trawlers was aggregated around the margins of the closed rectangles. Effort was also distributed widely throughout the Celtic Sea and Western Channel during the 4 years. An aggregation of effort was observed along the south-east coast of Ireland in 2006&2007.

During January and April, fishing effort was relatively high in the three closed rectangles (Figure 3.5.5), particularly in 2006 and 2008. For 2006, we can suppose that the concentration of fish was present in the three rectangle of the cod area, whereas in 2008, it seems to be more important in the two southern rectangles. A consequence of the closure is that a part of the effort displayed by the otter trawlers in the three rectangles before or after the closure is then displaced to areas where the catch of mixed species (mainly gadoids) is still profitable, particularly in the rectangles neighbouring the closed area (rectangles 32E4, 32E2, 31E2, 31E3, 30E3, 29E3, 29E4) or in a more distant and still shallower rectangle 31E1. Another part of the effort is displaced to the rectangles 29E1, 28E1, where the vessels target *Nephrops*, monkfish, megrim and elasmobranchs.

*Evolution of the catch during the closed period*

In order to measure the impact of the closed period, we analysed the landings of the trawlers that depended on the Trevose closure area for more than 10 % of their effort during the 2 months January and April. We consider three variables, the percentage of landings comprising cod, the percentage of the landings comprising cod, whiting and haddock, and the fishing dependency on the closed area in January-April. Fewer vessels had VMS equipment in 2005 due to the different vessel length requirement in that year, so the data are more limited.

The percentage of cod in the landings was similar in February -March and January-April across all dependency values (Figure 3.5.6). The same observation can be made for the percentage of cod, haddock and whiting in the catches (Figure 3.5.7). The absence of change must link to the effort distribution where we observe that the fishing effort is elevated near the boundary of the cod area during the closed period. On the other hand, this situation really shows that the strategy of the majority of vessel does not change during the closed period. Although the number of vessels fishing in the Celtic Sea has declined (Biseau and Bellail, 2006), the interest of the cod area for several vessels remains important.

For the high dependency vessel (dependency >0.3), two types of strategy exist. The first one is represented by the vessels targeting whitefish with a high percentage of gadidae in the landing. A second group is represented by vessels targeting *Nephrops*. In the low dependency vessels, we also observe these 2 groups with different strategy.

*Discussion of impacts of Trevose closure*

The analysis shows that part of the French trawl fleet that has fished in the Celtic Sea since the introduction of the Trevose closure continue to fish around the margins of the closure during February and March, as well as becoming displaced to other parts of the Celtic Sea including areas where the vessels change tactics to target benthic species in more distant rectangles 28E1, 29E1. The vessels remaining near the cod closure area in February and March tend to have similar catch compositions as trips in January and April when aggregation of effort occurs in the Trevose closure rectangles. This analysis does not consider the reductions in overall effort of French trawlers due to displacement out of the Celtic Sea that may be a consequence of the reduced opportunities to fish on cod aggregations in the closure.

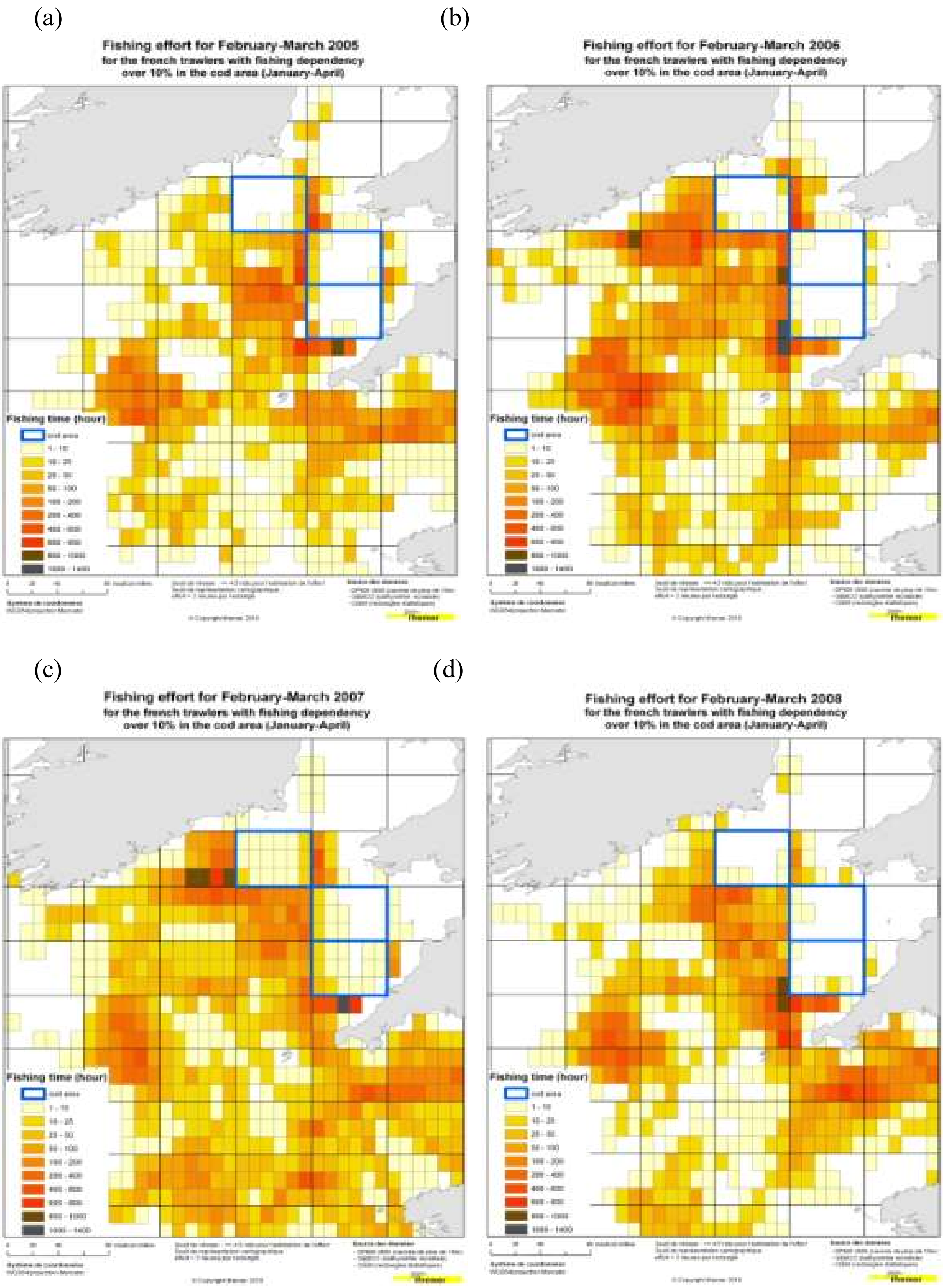


Figure 3.5.4: Distribution of the fishing effort during the cod closed period (February and March) for the French trawlers with dependency of over 10% in the Trevose cod closure area in January and April. (a):2005; (b) :2006; (c) :2007; (d) :2008.

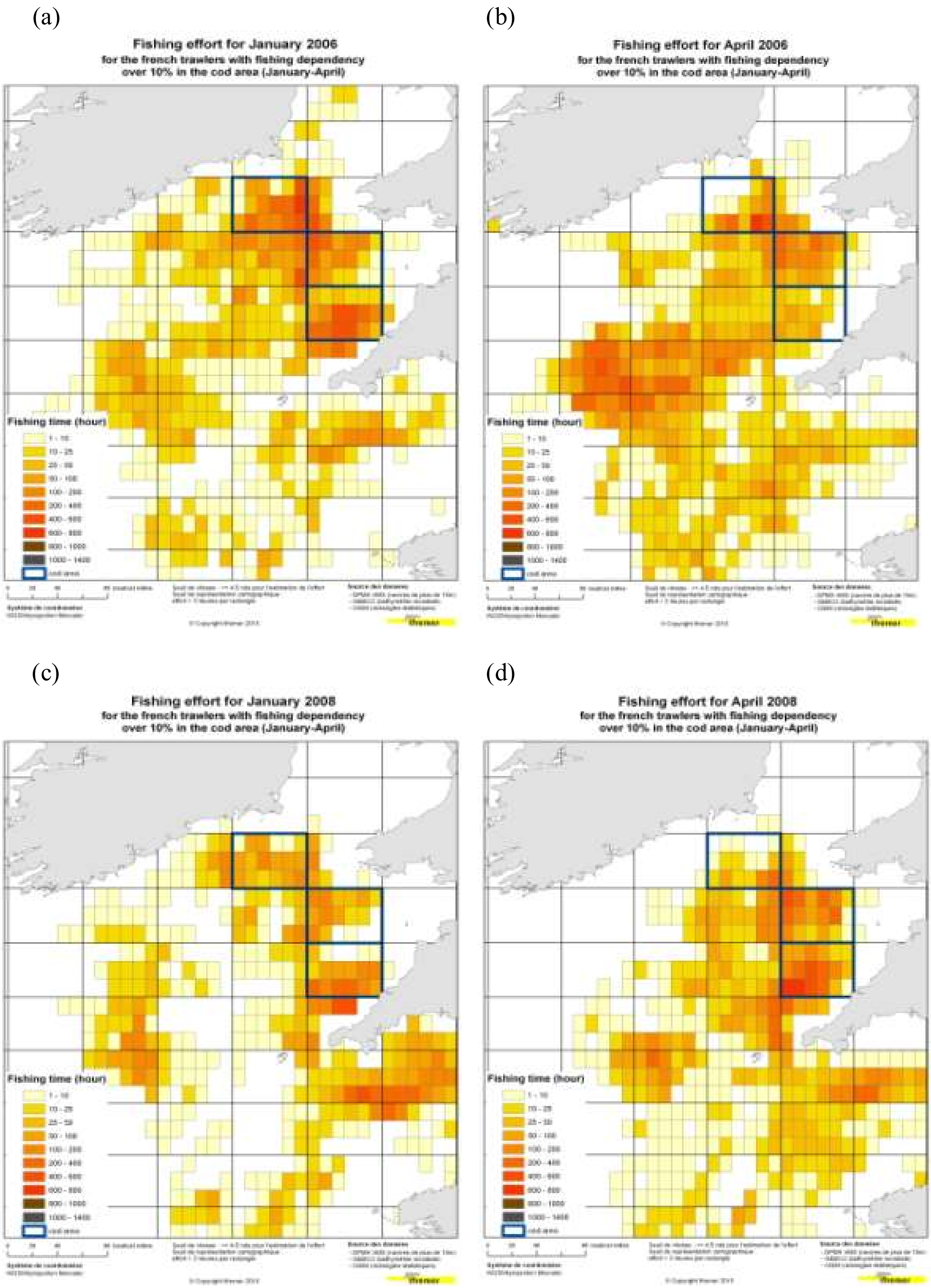


Figure 3.5.5: Distribution of the fishing effort before and after the cod closed period for the French trawlers with dependency of over 10% in the Trevose cod closed area (January-April). (a) and (b):2005; (c) and (d) :2008.

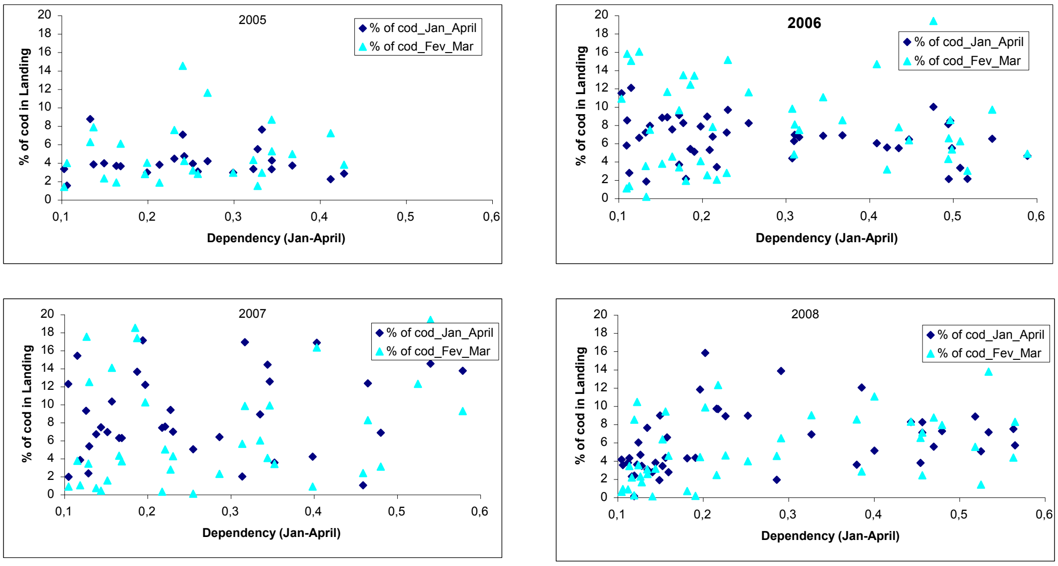


Figure 3.5.6: Percentage of cod in the landings as a function of the fishing dependency (January - April) in the cod area. The landing of 2 periods are considered (January-April and February-March).

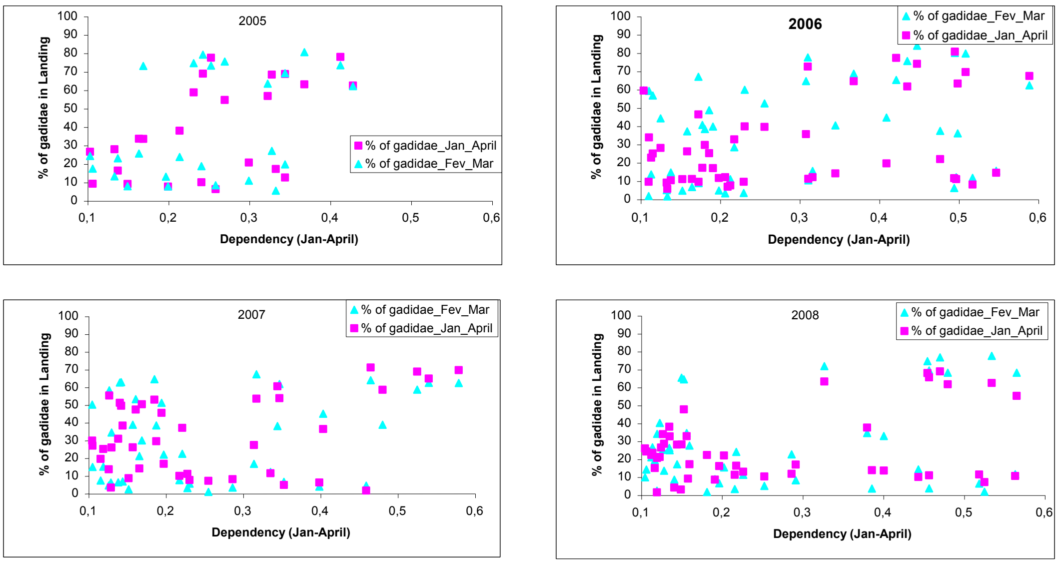


Figure 3.5.7: Percentage of the landings comprising whiting, cod and haddock as a function of the fishing dependency (January & April) in the cod area. The landings of two periods are considered (January - April and February-March).

### 3.6 Celtic Sea Pilot project: Conclusions regarding added value to DCF data collection

The success of the Celtic Sea pilot project in addressing some specific questions posed by the European Commission is considered below:

*What information exactly is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?*

Some of the major deficiencies in the scientific assessments of Celtic Sea and Western Channel stocks are related to the quality of fisheries data (e.g. missing or poor quality data on discarding and high-grading) or the paucity of suitable survey data (e.g. VIIe-k cod). It was not the intention of the present project to examine ways of resolving the fishery data quality problem through collaborative data collection, although this remains a potentially valuable approach, for example through self-sampling schemes to improve discards estimates. The focus was rather on the involvement of the fishing sector in the interpretation of data and development of fishery information reports to support assessments and development or evaluation of fishery management proposals. An important conclusion was that, at an international level, a wide range of information on fishing fleets, fishing activities and historical developments in the Celtic Sea area is available but very poorly collated and documented in formats useful for informing fisheries scientists, fishery managers and stakeholder-led groups, particularly the RACs.

*What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?*

The project partners from the fishing sector demonstrated a willing cooperation throughout the project. Individual fishermen often have extensive, long-term knowledge of the fisheries and stocks in a region that is not formally captured through any existing data collection schemes, and are interested in imparting this knowledge if considered beneficial to themselves. The most accurate knowledge of fisheries comes through the synthesis of robust data and the expert knowledge of the people involved in the relevant fishing sectors, and this has been the approach adopted successfully in the present project. Considerable volumes of fishery data are now collected routinely in the form of log-book data, VMS records, vessel activity data from inspection activities, fleet data maintained by producer organisations, and observer and port sampling data. Tools are now readily available to synthesize and present these data in informative ways, particularly using spatial mapping. This provides a powerful framework to facilitate the collection of the other knowledge held by the fishing sector, to help interpret the data and use them most effectively for supporting stock assessment and fishery management.

One approach used in the present project was the use of structured questionnaires to gather longer-term information on changes in fishing activity, gears and other technology. As a pilot, this had varying degrees of success, and it is clear that if extended to a full-scale project, such approaches (not unexpectedly) would require sufficient investment of funds for follow-up contacts and provision of help in completing the forms. The most accurate information is obtained when the questionnaires are used during structured interviews. The Belgian and Irish pilot projects were able to provide useful, coherent information from relatively small numbers of questionnaires and interviews.

*To what extent is there a need, from the stock perspective, to merge/compare these national data sets into regional/international data sets and analysis?*

A strength of the present study was the ability to collect and present information using consistent approaches that gave a comprehensive picture of international fleet activities in the Celtic Sea. This type of approach would be essential, for example, to inform the NWWRAC when responding to EC management proposals or developing new proposals for this area.

*Are there drivers for designing or keeping alive such projects, for instance national interest in managing local fisheries, or interest of the sector in obtaining a sustainability label?*

As discussed in Section 3.1.2, the reform of the CFP, including regional devolution of fishery management and concepts such as “reversal of the burden of proof” is likely to be a major driver for designing and sustaining collaborative studies involving the fishing sector and fishery scientists. The ability of the RACS to respond to Commission proposals or develop alternatives will depend on having a credible evidence base, and this was an important driver in the establishment of this pilot project between fishery scientists and NWWRAC members. Increasing interest in accreditation schemes to improve market competitiveness is a further driver.

*Is “added value" provided to the recurrent data collection under the EU Data Collection Framework?*

An important aspect of the DCF is “data management and use” including provision of data sets for stock assessment. This is a very specific use of the wide range of biological, transversal and economic data collected with DCF funds. The present project has shown that it is possible to add considerable value to DCF data through collaboration with the fishing sector to ensure the correct interpretation and use of fishery data.

# 4 Pilot Project 3: Study with electronic logbook in the Basque trawling fishery

## 4.1 Introduction

### 4.1.1 General background

All skippers of European fishing vessels longer than 10 metres are required to keep a logbook of their operations. Up till now, paper logbooks have been used. Number of fishing operations, location (ICES rectangle) and landings are recorded on a daily basis in paper format. However, the process of gathering, analysing and transmitting the information to authorities is often slow. It increases the risk of errors, and this, in turn, reduces the quality of the data.

The current manual process will be replaced with an electronic recording and reporting system (ERS) which will make the process, more efficient and accurate. Therefore, EU fishing vessels greater than 24 metres in overall length are required to electronically record and transmit logbook data on a daily basis from 1st January 2010 (Council Regulation (EC) No 1966/2006, and Commission Regulation (EC) No 1077/2008). The same requirement will apply to EU fishing vessels greater than 15 metres in length overall as from 1 July 2011. The aim of this pilot study is to take the opportunity to collect supplementary information from the fishing industry, information on the practical fishing operations and on the decisions made about the fisheries, gear choice, target species and distribution of fisheries in space and time. Thus, the idea was that the incorporation of a few new simple questions to skipper's routine log-book fill-up requirements, collected during long enough time period, will help to identify metiers, (management units) a priori and also improve the knowledge of the decisions taken in fisheries dynamics. Studying changes in the overall tactical adaptation of fishing vessels; how do they occur and why do they occur, evaluate the impact of the new regulation measures.

The intention of collecting data on tactics is the better description of the fisheries. Being a multispecies fishery the tactics used for choosing the species or assemblage of species will define whether that trip will belong to one or another metier/fishery, and this is more relevant after the entry in force of the new DCF (Data Collection Framework) where fishery-related data should be collected by type of fishing activity or metier.

The case study dealt with 2 of the 3 tasks specified in the tender to the EU commission

1. Design and implementation of pilot programmes to obtain supplementary information from the fishing industry on the practical fishing operations and the decisions made about the fisheries
2. Involvement of industry in data quality assurance and interpretation

All vessels involved in this pilot study belong to OPPAO (Organización de Productores de Pesca de Altura de Ondarroa), who has been AZTI's subcontractor within the project. This organization, based in Ondarroa (Basque Country, Spain) is comprised, nowadays, by almost all the Basque bottom trawlers, and in a lesser extent, long liners.

This study has been focused on bottom trawl fleets, composed by single “baka” otter trawlers operating in Bay of Biscay (ICES Divisions VIIIabd), and West of Scotland (ICES Divisions VIab), and bottom pair trawlers operating with Very High Vertical Opening nets (VHVO) in Bay of Biscay. Fishing characteristics of these fleets change according to the gear used. Hence, a “baka” otter trawler can be defined as a single vessel which trawls a “bottom net” operating in contact with the seabed. Trips last 6 days on average depending on the area being fished, and the haul duration is between 4 and 5 hours. The catches are generally landed in Basque and Scottish ports, from where the catch is transported by trucks to be sold on local Basque markets. The “baka” trawlers target different groups of species like hake, megrim and anglerfish, or squid and mullets, depending on the sea area, year period and fishing quotas they have (Iriondo et al, 2008).

On the other hand, bottom pair trawlers are composed by two vessels trawling a single very high vertical opening net (VHVO). The most common VHVO net is between 25-35 meters height and 75 to 90 meters width. The mean days per trip are 5 or 6. In this case the haul duration is longer, 7-8 hours on average for each haul. Catches are landed at French ports including Lorient, Brest and La Rochelle and are transported by trucks to the Basque ports (Ondarroa and Pasaia) or landed at these main Basque ports and sold on their local markets. This fleet targets mainly hake (80-85% of total catch).

The approach was to take the advantage of the new electronic recording and reporting system (ERS) regulation and use it to collect scientific data in addition to the data required for control purposes. The electronic log-book was installed in 9 vessels of the trawl fishery of the Basque country comprising 47% of the total fleet. All vessels had their base port in Ondarroa, and were considered representative in their behaviour, in relation to the overall fisheries that they belong to.

#### 4.1.2 Data requirements for assessment

The European Commission posed a number of specific questions in reviewing the first draft of this report. These are considered below in the context of the Basque trawl fleet, and the success of the project in addressing these is reviewed in section 4.5.

*What information exactly is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?*

The Data Collection Regulation (DCR) established in year 2000 a community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy (EC, 2000). Until last year single stock data collection has been the basis for advice and management of different fisheries. However this approach has long been recognized as inadequate, particularly when applied to mixed fisheries due to interaction across species and the use of different technologies depending on the target species. Hence the process of moving towards an ecosystem approach was being developed. The move towards an ecosystem approach to fisheries management requires that the ecosystem, rather than single fish stocks, is the focus for management However, multifleet and mixed-species fisheries management is currently based on single-species assessment and advice, with some adjustments based on other information to take into account the mixed nature of the fisheries. Thus, there is only limited integrated advice given for an area, and well-defined targets for the management of such fisheries are also largely missing.

In 2008, the DCR was reviewed by the European Commission's Directorate of Fisheries, resulting in new legislation that came into effect on 1st January 2009 (Council Regulation (EC) No 199/2008). Under the new Data Collection Framework (DCF), fishery-related data should be collected by type of fishing activity or metier. The required data collection covers economic data and "transversal" variables (landings, effort, etc,.) by fleet segments, and biological sampling data by fleet metier. However, the data collected under the DCF relate to the outcomes of decisions that fishermen make on a day-to-day basis and provide relatively few insights into the tactical decision-making process.

*What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?*

EU fishing vessels greater than 24 metres in overall length are required to electronically record and transmit logbook data on a daily basis from 1st January 2010. The present project was designed on the basis that the fishermen would be willing to record additional data through this medium.

*What "added value" can the project provide to the recurrent data collection under the data collection framework?*

The type of additional electronic log-book data collected under the Lot 1 project would add value to the existing DCF data collection by providing ancillary information to define the metier and target species of each trip more accurately. Furthermore, the existence of more highly resolved fleet-based data collected under the new DCF is not in itself sufficient to guarantee more effective fleet-based management, unless there is adequate understanding of how fishermen's tactics alter in response to management measures and other drivers. The approach adopted in present project was to develop a simple means of collecting such information from fishermen using electronic logbooks.

## 4.2 Methods

### 4.2.1 Design phase

During June 2008, preliminary contacts took place between scientific personnel, Victor Badiola (OPPAO's manager & President of the South Western Waters Advidsory Committee (SWWRAC)) and Basque fishermen to agree on the steps to follow for the design of the electronic log-books installation on board. In August 2008, AZTI personnel in close collaboration with some selected skippers started with the electronic tool design. The main premises were: i) ERS has to be user friendly, and ii) additional information has to be useful for scientific purpose and easy to collect by the skippers.

With that aim in mind, three questionnaires had to be filled in during the trip. First one, at the beginning of the fishing trip, second, during the trip and by fishing haul, and finally, at the end of the trip (Annex 3). To ease the task to the skippers, multiple-choice answers by questionnaire were designed.

Data to be collected were:

a) At the beginning of each trip

**Questionnaire on the tactics and reasons for doing so:** Tactics could be understood in different ways, depending on which resolution or time scale we are considering. In this case, tactic is considered as the choice of different variables that skippers can change from trip to trip: choice of gear, area and group of target species. These variables were chosen based on TECTAC (Technological developments and tactical adaptations of important EU fleets, EU project no. QRS-2002-01291) project experiences and adapted, in this case, to the *modus operandi* of the fleet.

During the TECTAC project, information on tactics was collected with the main objective of supplying fisheries managers with a modelling tool that will allow them evaluating the impact of regulations (TACs, MAGPs, area and season closures) on the dynamics of fleets. The questionnaire below (a, b, c & d) was designed with the objective of collecting such data in a routine way, data useful for the investigation of the dynamics of the elements that cause changes in fleet dynamics, changes in the overall tactical adaptation of fishing vessels; how do they occur and why do they occur.

**a) Gear:** Otter bottom trawl, pair bottom trawl or long line;

**b) Area:** By ICES Area or Division.

**c) Group of target species:** Target species were *a priori* defined at AZTI by means of analysis of previous year's catches using Principal Component and cluster analysis approach (Iriondo *et al.*, 2008).

**d) Reasons for decisions taken** (determining trip/vessel behaviour): i) Is there any limitation factor? Quota, effort, etc. If not, ii) which is the principal reason? Experience, other skipper's information, market price, fuel saving, any other information.

This information will help to identify *a priori* which fisheries/metiers a trip belongs to. Metiers should reflect the fishing intention, e.g. the species targeted, the area visited, and the gear used, at the start of a fishing trip. Within the study case fleet, six different metiers have been described in the last years (Iriondo *et al.*, 2008). The more extended description of the six metiers is below:

**Metier 1:** Very high vertical opening bottom pair trawler fishery targeting hake as single species. Some times whiting (*Merlangius merlangus*) is also a target species together with hake. This metier operates mainly in Divisions VIIIabd, with a constant effort during the whole year except the summer season when the effort decreases.

**Metier 2**: Bottom otter trawl, targeting mixed demersal species (hake, megrim, monkfish, catshark, and pouting), and mainly operating in Divisions VIIIabd.

**Metier 3**: Bottom otter trawl, targeting mixed cephalopods (squids and cuttlefish) and demersal fish like red mullet and sea bass, mainly in Divisions VIIIa,b,d. It is a clearly seasonal fishery from October to February.

**Metier 4:** Bottom otter trawl, targeting small pelagic fishes, mackerel in Divisions VIIIa,b,d. It is a seasonal fishery from December to February. As the inshore fleet is not working is these period of the year, trawlers go for mackerel to supply the market.

**Metier 5**: “Typical” pure mixed fishery, performed in sub-area VII during all years, mainly from April to June and composed only of trips made by “baka” otter trawlers. This metier mainly targets megrim, anglerfish and hake (even if there are other species in their landing compositions).

**Metier 6**: Pure mixed fishery with hake, monkfish and megrim as predominant species and deep water species. They work throughout the whole year. In addition to these main species, a large number of other deep water species with blue ling as one of the most important between April to June are targeted. Performed in sub-area VI and composed only of trips made by “baka” otter trawlers.

Being mostly multispecies fisheries, the tactics used for choosing the species or assemblage of species will define whether that trip will belong to one or another metier. For mixed fisheries, it is important to define and characterise the effort deployed in the different metiers. Under the new PPC, efforts in management are moving from a stock based management to an effort based management regime. To be able to manage the fleets/fisheries in that way, it is important to characterise and know effort deployed by the different metiers (species area & gear).

<u>b) During the trip</u>

**Data by haul in Geographical Information System (GIS):** Initial and final time and geographical position, initial and final depth, and retained catch (species weight & size categories). Note that the difference with the previous official logbook is in the data spatial resolution. In the AZTI tool the resolution is by haul, while in the official logbook it was by day.

<u>c) At the end of the trip</u>

Information about **changes in previous plan**, skippers should mention if there has been any unexpected change in the fishing plan in relation to area change, gear change, target species change, duration of the trip, and reasons for that Also information about fuel consumption was collected.

#### 4.2.2 Implementation phase

In December 2008, the first project meeting with the industry took place at OPPAO's headquarters in Ondarroa. A group of vessels was selected as a sample: 7 otter bottom trawlers (OTB) and 2 pair bottom trawlers (PTB). First ERS software installations and trials were carried out in February, taking advantage of the presence of observers on board for the compulsory discards annual sampling program.

In May 2009 a new meeting with Spanish fisheries control authorities (MARM) took place in Madrid. The main objective of this meeting was to clarify differences between the ERS software developed by AZTI and the new official electronic logbook developed by the Spanish authorities to accomplish with the Council Regulation (EC) No 1966/2006 and of compulsory installation on vessels from 1$^{st}$ January 2010. In that occasion and when reviewing variables collected in both software systems, the possibility of combining both logbooks in relation to the tactical variables was mentioned. This was considered interesting and with possibilities of an easy implementation.

During the next six months, between June and November 2009, data collection took place in the sample group of vessels that had the ERS system installed. In December 2009, data collection was terminated to avoid confusion with the new official electronic logbook.

In the middle of December 2009, the last project meeting between scientists and fishing industry members took place. The achieved results were discussed between all involved project partners, underlining the importance of the industry participation on data collection and interpretation.

### 4.3 Results

Thirteen fishing trips and 337 hauls were completely and correctly filled by three different OTB skippers. Moreover, another 31 fishing trips were partially filled, belonging to 8 different fishing units. Only one out of 9 vessels did not fill in any data on the electronic tool. In addition, it is important to mention that all the partially filled trips had the questionnaire on tactics correctly completed.

Catch information in Geographical Information System (GIS) allowed easy analysis of catch spatial distribution by species, LPUE spatial distributions, etc. (Figs. 4.3.1 – 4.3.3). In addition, information obtained from surveys on tactics allowed achieving the main objective of the study, which was to improve the understanding of the fleet dynamic and its whole short term behaviour.

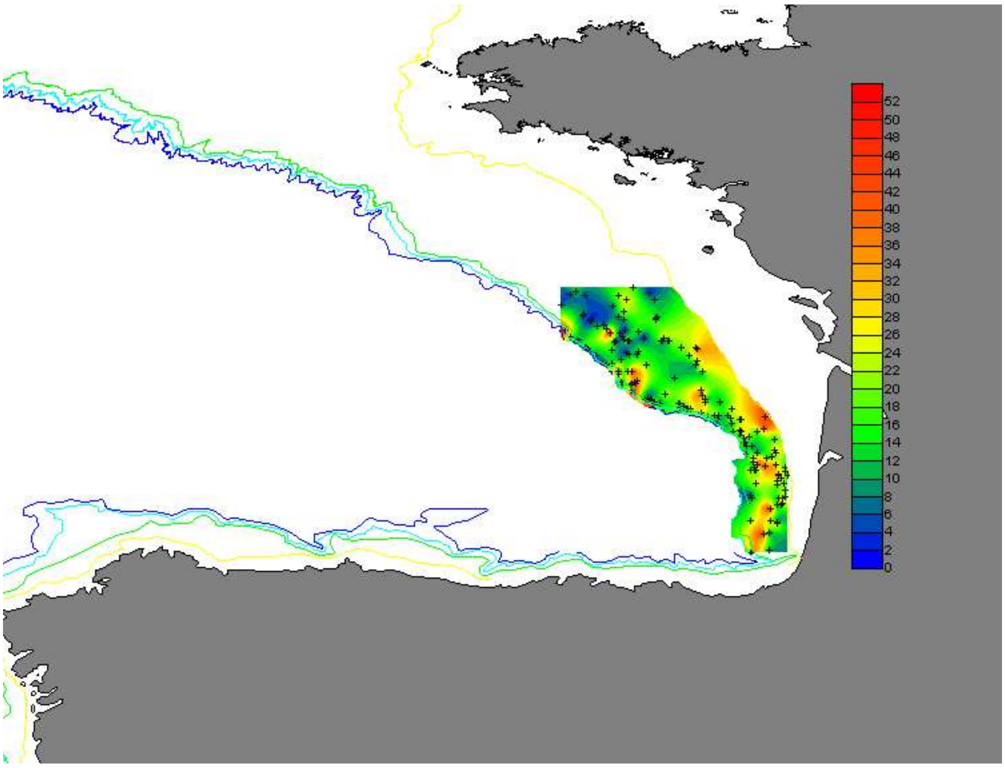


**Figure 4.3.1.** Hake LPUE (Kg/hour) of the fishing trips that selected hake, anglerfish & megrim as target species and Divisions VIIIabd as fishing ground.

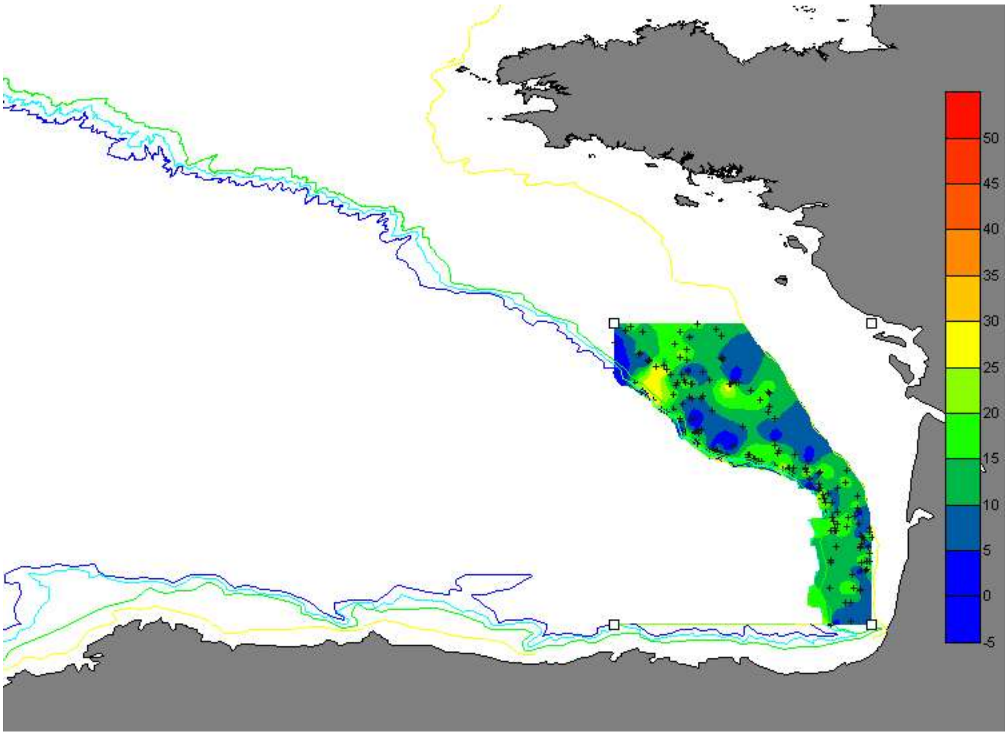


**Figure 4.3.2.** Anglerfish LPUE (Kg/hour) of the fishing trips that selected hake, anglerfish & megrim as target species and Divisions VIIIabd as fishing ground.

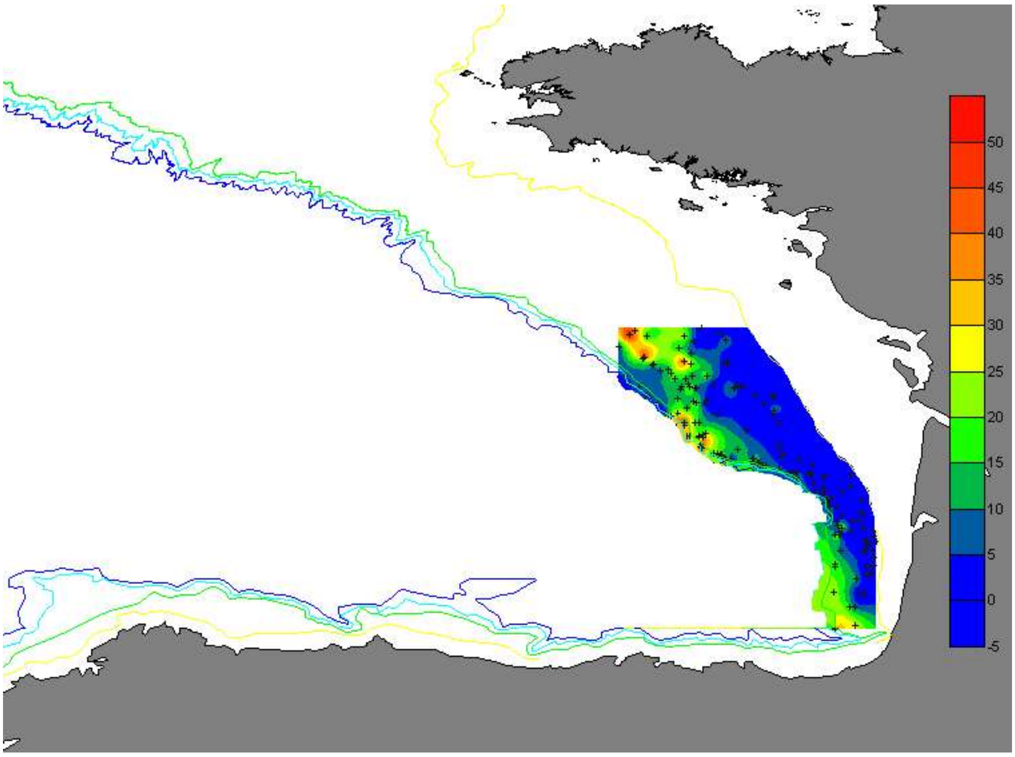


**Figure 4.3.3.** Megrim LPUE (Kg/hour) of the fishing trips that selected hake, anglerfish & megrim as target species and Divisions VIIIabd as fishing ground.

Selection of a specific tactic defines the metier to which this trip belongs. In the following section, reasons for choosing one or another metier are analysed.

#### 4.3.1 Results on tactics: Pair bottom trawlers

Choice of the metier

All the pair bottom trawlers had chosen the same tactic, ICES Divisions VIIIabd as fishing ground and hake (*Merluccius merluccius*) as target species. Furthermore, the reason to behave like that was always the same, and trips onsets were done simply because the have been always done like that, due to previous years experience. An inertia effect is appreciated, understanding inertia as the tendency of vessels to return to areas and target species where experience gives a comparative advantage.

Choice of the fishing trip ending

More than fifty percent of the pair bottom trawl trips changed their fishing plan during the trip. Fifty-seven percent of the trips had become shorter than planned, due to market price reasons. Shorter fishing trips improved the fish freshness. Also, it was detected that vessels coordinated the entries to base ports sequentially during the week, avoiding, in this way landing all catches in the same traditional two days of the week (Monday-Thursday). In this way, fish auctions take place throughout the week which could raise the market price of the catch. In this sense, collaboration between producer organisations was observed, in order to not saturate the market and get the best prices for the species landed.

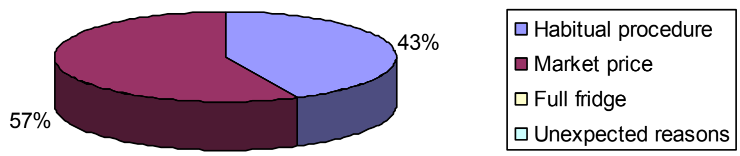


**Figure 4.3.1.1**. 57 % of the trips had become shorter than planned, due to market price reasons; meanwhile 43 % of the trips did not suffer any change in their previous plan.

#### 4.3.2 Results on tactics: Otter bottom trawlers operating in Sub-Area VI

Choice of the metier

Sixteen percent of the "baka" otter bottom trawl trips had ICES Subarea VI as selected fishing ground, and hake (*Merluccius merluccius*), monk (*Lophius piscatotius*) and megrim (*Lepidorhombus whiffiagonis*) as target species. All these trips had experience as the main reason for behaving like that. However, 50% of the answers were combined, and experience was chosen together with marker price.

Choice of the fishing trip ending

Except for unexpected reasons, the main reason for the trip ending in "baka" otter trawlers operating in ICES Subarea VI, is to maintain the historical duration of the trips, in which the yield, freshness and store capacity is optimised.

#### 4.3.3 Results on tactics: Otter bottom trawlers operating in Divisions VIIIabd

Choice of the metier

Eighty four percent of the "baka" otter bottom trawl trips had ICES Divisions VIIIabd as selected fishing ground. In this case, different target species groups were selected (Fig. 4.3.3.1). Twenty percent of the trips chose mullet (*Mullus surmuletus*) and cephalopods as target species, 40% hake, monk and megrim, 5% mixed group of species, and 35% of the trips chose together hake/monk/megrim and mullets/cephalopods. Some groups of species, as pelagic species, were no chosen in any of the trips. This is just simple caused by lack of sampling in the first quarter of the year, when this metier target pelagic species.

In the case of "baka" otter bottom trawlers operating in ICES Divisions VIIIabd, trips onsets were done, again, simply due to previous year's experience. However, 35% of the answers were combined with more than one reason, 25 % combined with other skipper's information, and 10% combined with market price reasons.

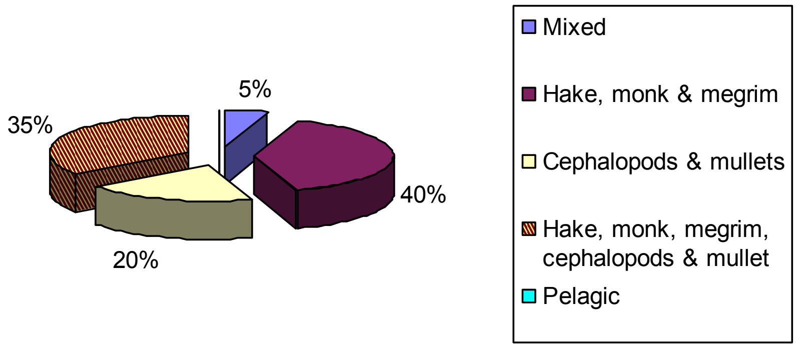


**Figure 4.3.3.1.** Groups of target species selected in "baka" otter bottom trawlers operating in Divisions VIIIabd.

Choice of the fishing trip ending

Except for unexpected reasons, the main reason for the trip ending in "baka" otter bottom trawlers operating in Divisions VIIIabd, is to maintain the historical duration of the trips, in which the yield freshness and store capacity is optimised.

#### 4.3.4 Electronic logbook assessment survey

Although some interesting results were obtained from ERS data (LPUE detailed maps or new market tactic observed in pair trawlers), the skippers' collaboration was not as wide as expected. With the intention of identifying the main reasons for this shortfall in data entry using the new tool; a new survey was carried out between skippers who had collaborated in the project.

Different answers were obtained for some common questions regarding: i) computer user knowledge and experience, ii) opinion about logbooks usefulness, etc. It was significant that 100 % of the polled skippers have the same response for the next two questions;

- Do you think ERS is necessary?

  *Categorical: NO*

- Why?

  *It is an additional control measure*

## 4.4 Discussion

As the electronic logbook assessment survey shows, all the skippers polled understood that the electronic logbook was just a control measure. Nevertheless, although they had sometimes had some inconvenience filling detailed catch data, none of them would have had inconvenience filling in the “additional information” required for the survey on tactics.

These surveys show that previous year’s experience and historical, traditional or routine and inertia, are the main reasons to select a specific tactic. These results are similar to those obtained in the past during the TECTAC project.

It is significant that when we ask about the reasons to choose a specific tactic, the variability in the responses is low. Nevertheless, sometimes changes could be detected in the tactics in a particular fishery at a particular time. This is the case of the new behaviour observed in pair trawlers during this pilot project (fishing trips shorter than planned, due to market price reasons, and the organisation of producers to achieve gradual auctions during the week and avoid market saturation).

On the other hand, the data collection period within the project (six months), could be too short to understand the reaction of the fleet to a specific management strategy that affects them directly. As an example, important changes in regulations such as a discards ban, would certainly affect the way fleets behave. Tactics and moreover strategies, in the long run, are expected to be highly variable in the medium term. Routine collection of tactic variables information during long periods would give us the required information to identify, understand and even predict fleet behaviour.

More detailed outputs are expected to be achieved with more detailed questionnaires. However, much bigger effort will be necessary to obtain a wider collaboration from the industry. Longer and more tedious questionnaires would be a costly process (requiring personal interviews, etc). Such costs could only be supported within projects targeted at this type of data collection.

The way in which fishermen have been collecting data over a period of years is difficult to change especially when they do not perceive benefits in the short to medium term. Data collection has to be placed in a context in which fishermen would be able to see the direct benefit for them when collecting this data.

This project experience has showed that a wide collaboration of the industry on data collection is not easy to attain. Nevertheless, this distrust is mainly due to the relation they appreciate between data collection and fisheries control. Although they sometimes had some inconvenience filling detailed catch data, none of them would have difficulties filling “additional information” on tactics, if suitable tools are supplied to the skippers. Some useful data series could be obtained over longer periods of time, including new data collected for scientific purpose as part of the fishermen’s routine, with short and easy questionnaires. The inclusion of this kind of surveys in the upcoming official compulsory electronic logbook could be the way to train skippers and add new useful data to the DCF.

## 4.5 Conclusions regarding added value to DCF data collection

The success of the Basque trawl pilot project in addressing some specific questions posed by the European Commission is considered below:

*What information is missing to improve the stock assessment? Does this concern local management or regional / Community management?*

This new information could be in different ways helpful to improve the stock assessment of the species caught by the Basque trawling fleet. This information is consistent with the Data Collection Framework of European Commission (EC, 2008) and it is essential to define metiers *a priori* properly. The identification of metier a *priori* means that the metier is defined by fishing intention of the skippers before the fishing operation starts and this information is not available nowadays. Better identification/understanding of metiers targeting a fish stock provides improved definition of fleets and metiers that would be used as tuning fleets in the stock assessment and provides a more reliable picture of the stock abundance.

Moreover, taking into account that this is a mixed fishery and currently fisheries management is moving towards ecosystem bases approach, the intermediate approach is a mixed-species and multi-fleets fisheries assessment. In this step some development has been done with the implementation of Fcube methodology. This method involves a forecast of the effort by fleet corresponding to single stock Total Allowable Catch (TAC), and based on this effort, a forecast of the catch of each stock under different scenarios. In this method the input data are catches and effort by fleet and metier, so a good metier definition is essential to get reliable results.

This pilot project only introduced the electronic logbook in the Basque trawling fleet as first trial of the viability of the use of new electronic tools in data collection. But the inclusion of the rest of the fleets would be necessary for the correct fleet-based management; the rest of the international fleets exploiting the same fish stocks, as well as the local coastal fleets. For instance, in the actual situation of the southern hake stock, under recovery plan situation, the “metier and tactics survey” information would be interesting in the management of the effort directed to hake. If the metier definition is done, only these vessels targeting hake would be influenced by this regulation, and not all the vessels of the coastal fleet. This appropriate metier definition would improve the management of the fleet getting better implementation of the regulation and having the support of fishing sector and stakeholders. Any way, we must be aware that the utilization of electronic tools in coastal small boat is always more complex.

*What information has the sector shown willing to collect and could this information , when structured, cover parts of the data needs?*

The skipper’s collaboration was not as wide as expected after the first project meeting. Some of them were cautious, and preferred not to include such detailed catch information in the pilot-logbook. It seems that they did not understand the real purpose of adding new scientific value to the collected data, and they only viewed this trial as a control measure. Although the coincidence in time with the entry in force of the new electronic logbook developed by the Spanish fishing authorities could explain this distrust, a clear distinction between control and scientific purpose data collection is needed if we want to achieve a wide collaboration.

Nevertheless, although they sometimes had some inconvenience filling in the detailed catch data, none of them would have had inconvenience filling in the "additional information" required for the survey on tactics.

*Merging/comparing national data sets into international/regional data sets*

In 2009, the regional Coordination Meeting for de North Atlantic (RCM NA) provided and recommended a template for descriptions (homogeneity of the métier, target species, spatial and temporal distribution etc.) of the ranked métiers on a national level containing a subset of the information from the MS National Programmes, in order to allow the RCM to evaluate the compatibility of the fishing activities and generate a more complete regional overview. Different countries share the same métiers, and better knowledge of these métiers (assemblage of target species, reasons to choose one or other métier …) is necessary to merge international homogeneous métiers and to be able to identify opportunities for task-sharing.

*Management drivers for keeping alive such projects.*

In 2008 Member States had proposed their own metiers mergers, and during the ICES WGMERGE 2010, merging methodologies were discussed. As the group states, the sampling design should be adapted to ensure that sufficient data are obtained, in a representative manner, to cover the metiers for which data are required. The incorporation of a few new simple questions to skipper's routine log-book fill-up requirements, collected during long enough time period, will help to identify metiers, (management units) a priori, and ensure the minimum sampling coverage by metier.

*"Added value" to the to the recurrent data collection under the Data Collection Framework.*

As discussed in section 4.1.2, the type of additional electronic log-book data collected under the Lot 1 project would add value to the existing DCF data collection by providing ancillary information to define the metier and target species of each trip more accurately. The additional data provide understanding of how fishermen's tactics alter in response to management measures and other drivers, which is important for evaluating how fishermen may respond to different management measures. The present project successfully captured such information from fishermen using additional entries in electronic logbooks.

## 4.6 Recommendations

The new legal framework for fisheries controls developed by the European Commission, and the introduction of the new electronic recording and reporting system, could be the starting point for the routine collection of a new kind of data on fishing tactics. In the longer term (i.e. beyond the short term assessment period) this would inform decision-makers on the impact of their future choices, and how consistent the outcomes of the management strategies are with the objectives of the current and forthcoming Common Fishery Policy. Different models to evaluate a selected management strategy could be developed (Prellezo, *et al*. 2009), but reliable data are needed before they can be used by decision makers.

Some useful data series could be obtained over longer periods of time, including new data collected for scientific purpose as part of the fishermen's routine, with short and easy questionnaires, and of course, adapted to the *modus operandi* of the different fleets; data useful for i) the investigation of the dynamics of the elements that cause changes in fleet dynamics, changes in the overall tactical adaptation of fishing vessels; how do they occur and why do they occur, and evaluate the impact of the new regulation measures; and data also useful for ii) a better description/ knowledge of the fisheries, making easier the identification of the management units (metiers), making easier at the same time the change to an ecosystem based management instead of the single stock management. The inclusion of this kind of surveys in the official compulsory electronic logbook could be the way to train skippers and add new useful data to the DCF.

As the European Commission states, data collection systems to measure fish catches for short-term quota monitoring and for medium term structural evaluations are not satisfactory, and coherence has to be improved. If the forthcoming CFP reform is to improve the reliability of the data, a big effort to motivate the industry is needed. It is critical to the success of the reform that industry understands the need for it, supports it and has a genuine stake in its successful outcome. In a mostly top-down approach, which has been the case under the CFP so far, the fishing industry has been given few incentives to behave as a responsible actor accountable for the sustainable use of a public resource. Co-management arrangements could be developed to reverse this situation, and with a bigger industry commitment data quality could be improved, and new data collaboration programmes could be implemented. To be successful, such programmes should provide objective data that fishermen can easily collect with minimal impact on their fishing operations, whilst understanding the need for and purpose of the data. To avoid mistrust caused when fishermen provide data that they perceive as being analysed by third parties with limited knowledge of the fisheries and fishermen's behaviour, it is important that the programmes include provision of easily-collected data on tactics and decisions that help explain the data. Such information can also help in evaluating alternative management measures based on a better knowledge of how fishermen adapt to different types of control. This project has shown that this type of information can easily be collected using the electronic logbooks.

## 4.7 References


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# 5 Pilot Project 4: Portuguese artisanal deep-water longline fishery

## 5.1 Introduction

### 5.1.1 General background

The main aim of this Pilot Project was to design and establish a self-sampling scheme for data collection from the deep-water longline fishery in ICES Area IX. The case study is the artisanal fishery for black scabbardfish operating in Sesimbra (38º 26'2 N 9º 06'7 W, 32 km S of Lisbon, Mainland Portugal, Figure 5-1).

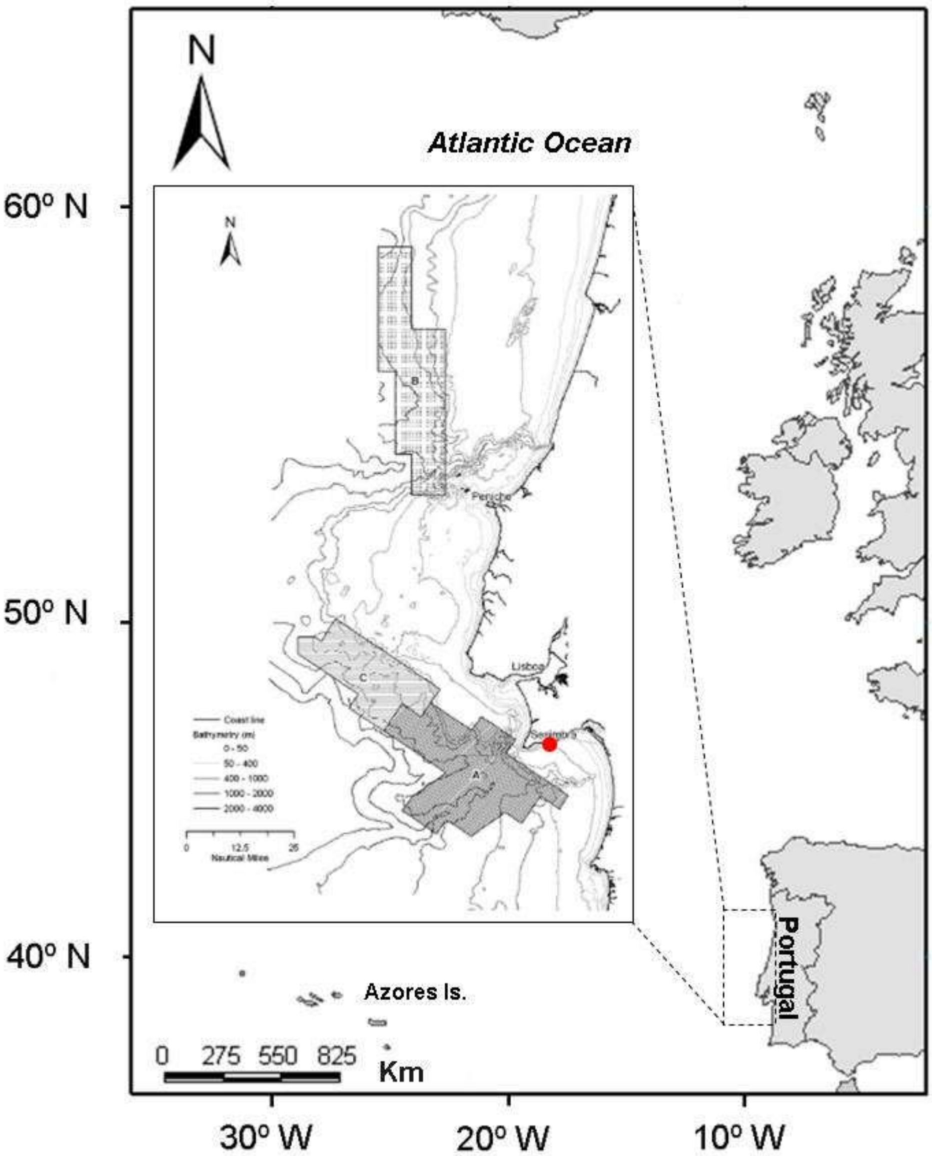



**Figure 5-1.** Location of Sesimbra's landing port (red dot) and main fishing areas (A, B and C) of the black scabbardfish fleet on the Portuguese continental slope. Adapted from Bordalo-Machado and Figueiredo (2009).

The fishery for black scabbardfish (*Aphanopus carbo*, Lowe 1839) (Figure 5-2) in ICES area IX was initiated in the early 1980's on the slopes near Sesimbra landing port. Sesimbra's fishing community had already a long tradition in fishing with longlines, and the deep-water fishing method and gear were modified from the traditional Madeira longline fishery, which dates back to the XIX century.

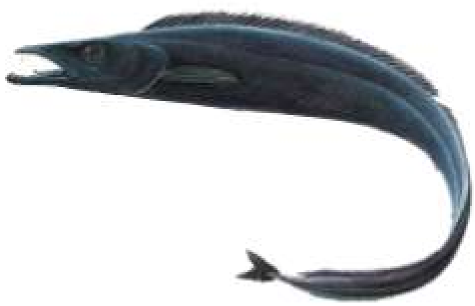


**Figure 5-2.** Black scabbardfish (*Aphanopus carbo*, Lowe 1839).

Sesimbra's fleet is composed by small vessels (length-over-all below 25 m) (Table 5-1) that operate with artisanal deep-water longline (Figure 5-3). Each vessel has its own fishing ground in a particular area.

**Table 5-1.** Characteristics of Sesimbra's artisanal longline fleet.

| Vessel | Length-over-all (m) | Power (kW) |
|---|---|---|
| V1 | 16 | 175 |
| V2 | 18.75 | 199 |
| V3 | 17 | 145 |
| V4 | 15.62 | 152 |
| V5 | 15.15 | 142 |
| V6 | 12.8 | 79 |
| V7 | 13.67 | 145 |
| V8 | 24.5 | 332 |
| V9 | 18.5 | 266 |
| V10 | 13.8 | 101 |
| V11 | 19.2 | 275 |
| V12 | 18.18 | 175 |
| V13 | 17.5 | 164 |
| V14 | 19.22 | 205 |
| V15 | 18 | 186 |
| V16 | 19.2 | 280 |
| V17 | 16 | 178 |

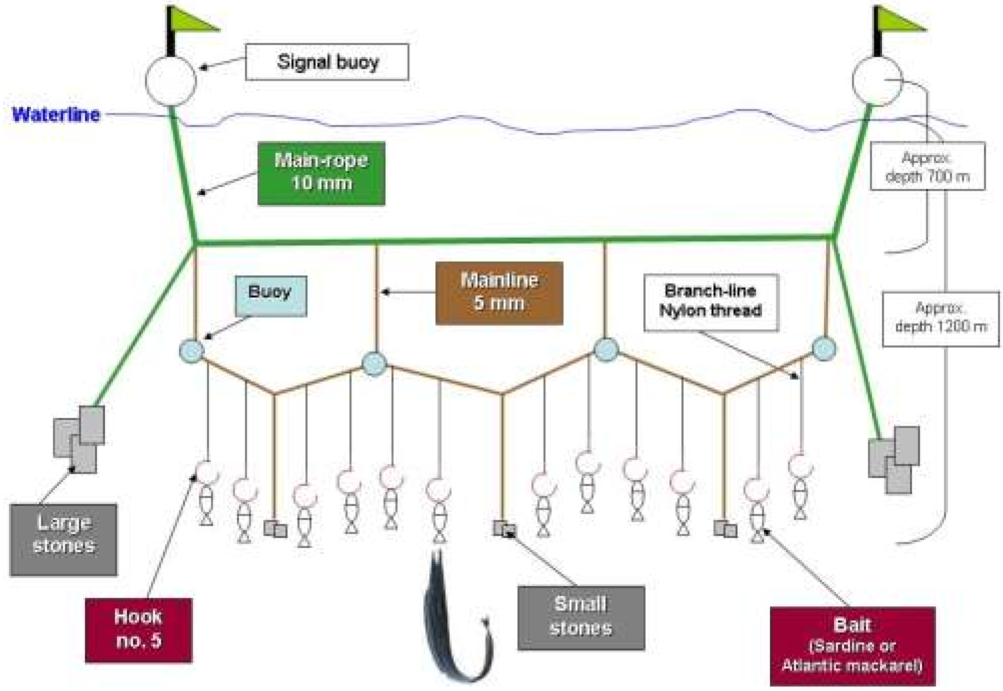



**Figure 5-3.** Schematic representation of the bottom longline gear used in Sesimbra's black scabbarfish fishery.

Total landings of black scabbardfish during the sampling period of LOT1 are shown in Table 5-2.

**Table 5-2.** Landings of black scabbardfish between November 2008 and December 2009. Data from the Portuguese Directorate of Fisheries.

| Year | Month | Landed weight (kg) |
|---|---|---|
| 2008 | 11 | 256691 |
| | 12 | 143244 |
| 2009 | 1 | 177639 |
| | 2 | 170825 |
| | 3 | 205607 |
| | 4 | 250743 |
| | 5 | 264806 |
| | 6 | 233491 |
| | 7 | 181614 |
| | 8 | 209456 |
| | 9 | 330622 |
| | 10 | 335535 |
| | 11 | 217140 |
| | 12 | 133624 |

Although little objective information is available on the stock structure and dynamics of the black scabbardfish, a single stock in the NE Atlantic area has been hypothesized. However due to the different exploitation patterns and fleets, the ICES Working Group on the Biology and Assessment of Deep Sea Fisheries Resources (WGDEEP) considers separately a northern component, which includes subarea Vb and areas VI, VII, and XII, and a southern component, which includes areas VIII and IX.

In both components the deepwater sharks *Centroscymnus coelolepis* and *Centrophorus squamosus* are the two most important by-catch species. Black scabbardfish and deep-water sharks are managed by Total Allowable Catches (TAC).

Under project *Lot 1: Joint data collection between the fishing sector and the scientific community in Western Waters* a collaborative scheme between scientist and fishermen was established for providing data that otherwise the scientists would not have access to, namely regarding fishing operations, catch composition and discards. The present case-study addressed the three tasks specified in the tender: (1) design and implementation of a pilot programme to obtain information from the fishing industry on fishing operations and the decisions made; (2) design and implementation of self-sampling programmes on board commercial vessels; (3) involvement of stakeholders in the use of the type of data described above for stock assessment and management evaluation.

The rational for the data collection within the black scabbardfish's pilot project was:

1. To collect information concerning the fisheries;
2. To collect and use of information which is not routinely available;
3. To assess and propose management measures on fishery resources;
4. To improve the use of existing information.

One of the objectives of this pilot project was to collect information to be used to estimate fishing effort expressed as number of hooks and soaking time of Sesimbra's bottom longline targeting the black scabbardfish and also the impact of the fishery on the ecosystem.

Although not a objective of the pilot but since it was a major concern by fishermen involved in project additionally information on marine mammals collected by fishermen were made available for the project. The marine mammals (cetaceans) are considered by fishermen as direct competitor for the resource, not so much for destroying the gear but mainly for eating and damaging the catch. The information collected allowed an evaluation of the impact of marine mammals on the fishery landed weight.

#### 5.1.2 Data requirements for assessment

The European Commission posed a number of specific questions in reviewing the first draft of this report. Several of these are considered below in the context of the Portuguese artisanal longline fishery, and the success of the project in addressing all the questions is reviewed in section 5.4.

*What information exactly is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?*

For the black scabbardfish case-study, one main gap on information from EU logbooks is related to the level of spatial detail of fishing operation (initial and final geographic coordinates and depth). This is particularly pertinent in the case of Portugal mainland in which the slope is very steep. Up to now spatial information was provided by ICES rectangle but is often missing or assigned to ICES division. For longline no information is required on the number of empty hooks and lost hooks at the end of the fishing trip. This will obviously improve the quality of CPUE estimates and be used to get efficiency estimates for the fishery.

Other variables, despite being required under the EU legislation are not fully understood by fishermen and most of the times not included in the logbooks or erroneously registered. These include haul duration, number of hauls and catch data.

*What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?*

The fishing community of Sesimbra which operates the black scabbardfish longline fleet, proved to be aware of the importance of self-sampling programmes as a tool to complement and rectify the standard EU Data Collection Framework, and were willing to contribute to such a programme.

The remaining questions posed by the Commission are dealt with in Section 5.4.

## 5.2 Methods

Self-sampling

All information was collected by fishermen and workers from the subcontractor partner ArtesanalPesca (a fishermen's association settled in Sesimbra, from hereon referred to as AP), following a self-sampling protocol designed by the scientists in collaboration with AP. Two types of forms were designed (and improved throughout the project according to its limitations and to fishermen's needs):

1. Electronic logbooks (Figure 5-4);
2. Paper forms (the Portuguese and English versions of the forms can be found in Section 5.8).

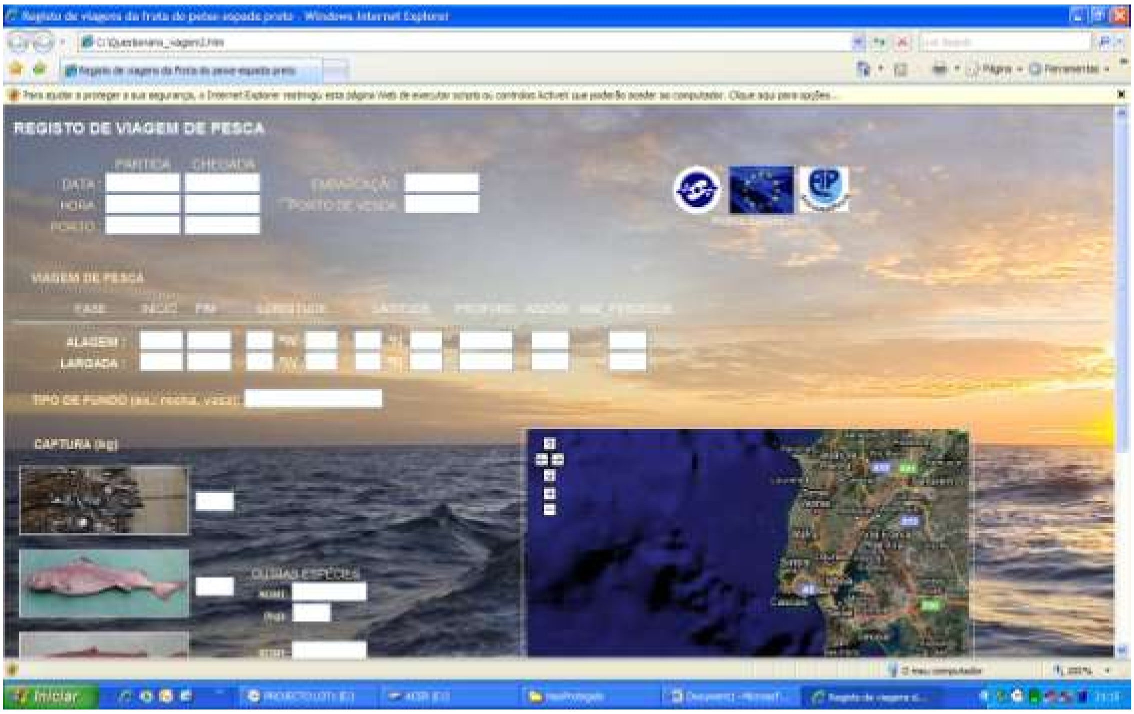



**Figure 5-4.** Copy of part of the electronic logbook's main page.

In both forms the information required dealt with:

1. Fishing effort;
2. Catch composition.

Accordingly, skippers provided the following information by fishing trip:

- Departure and arrival date, time and port
- Selling port
- For gear setting and hauling:
  - Starting and ending date and time
  - Geographical position
  - Depth
- Number of hooks used and lost
- Seabed geology
- Occurrence of scleractinian cold water corals
- Landed weight by species
- Discarded species
- Interaction between fishery and marine mammals

AP also assigned a team to be responsible for the monthly length frequency sampling of black scabbardfish and deep-water sharks landed by vessel. The minimum sampling effort by month was established to be one box of fish by size class (commercial size category according to landing sheet: "large", "medium", and "small") landed by vessel and randomly selected from the total catch.

In an attempt to evaluate the impact of cetaceans in the fishery, industry subcontractor AP acquired and circulated between the vessels that were actually participating in the project a number of acoustic deterrent devices, known as pingers. Hence, in addition to the information concerning the fishing operations, fishermen also provided information concerning the occurrence and behaviour of cetaceans, and the effectiveness of the pingers in preventing the attacks. To test the efficiency of the pingers, a simple protocol was designed: each vessel was given none, or 1 or 2 pingers that should be launched into the water at varying distances from the vessel during hauling or deployment of the gear.
An extra questionnaire was prepared to cover this experiment, asking about:

- Number of pingers in use
- Location, distance from vessel and depth of pinger
- Fishing operation during which cetaceans were seen
- Other vessels nearby and distance
- Occurrence of cetaceans
    - Time
    - Photographed?
    - No. individuals (adults and calves)
    - Species identification (An identification guide was provided)
    - Cetacean's behaviour
    - Approximate lost catch

The Portuguese and English versions of the forms can be found in Section 5.8.

#### 5.2.1 Results

***Receptivity and participation***

From the 17 vessels that compose Sesimbra's artisanal deepwater longline fishing fleet, 16 accepted to participate in the project (hereon referenced from V1 to V16). However, by January 2010 only 13 had provided data. A total of 473 trips were sampled between November 2008 and December 2009. The number of trips sampled by vessel varied between 7 and 104 (Figure 5-5).

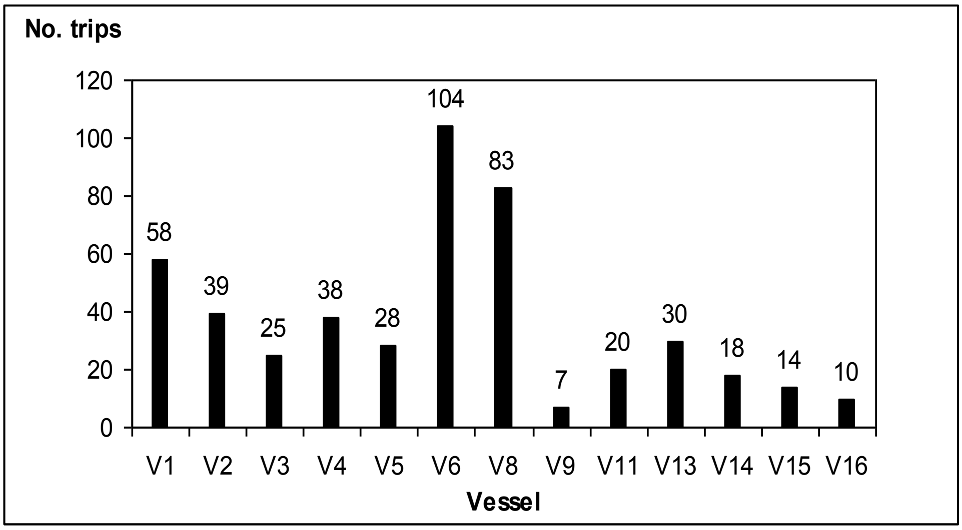



**Figure 5-5.** Number of trips sampled per vessel.

Between the beginning and the end of the 14-months period that was established for the data collection, the number of trips available by month was very unbalanced (Figure 5-6). While on the first three months only 28 trips were sampled, from March on the number of trips nearly doubled. April and August 2009 were the months when more trips were sampled.

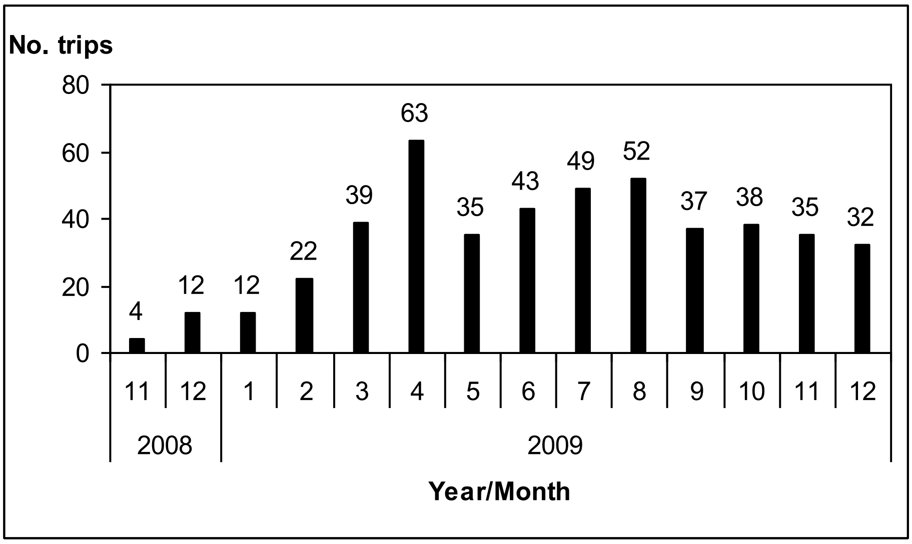



**Figure 5-6.** Number of trips sampled per month.

None of the vessels performed a continuous sampling during the project period (Table 5-3). In fact, one vessel (V9) sampled just 7 trips in one single month whereas vessel V6 collected data throughout all the year in 2009 (totalling 104 trips) and vessel V8 sampled 10 months (totalling 83 trips). More than half of the vessels presented data from March to May, but there was not any month when all vessels actually participated in the self-sampling programme.

**Table 5-3.** Chronological scheme of self-sampling by vessel.

| | 2008 | | 2009 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | No. trips |
| V1 | | | | 9 | 8 | 3 | | | 7 | 12 | 6 | | 7 | 6 | 58 |
| V2 | | | | | | | 7 | 12 | 7 | 10 | 3 | | | | 39 |
| V3 | | | | | 3 | 4 | | | | | | 7 | 10 | 1 | 25 |
| V4 | | | | | 5 | 12 | 4 | 7 | 10 | | | | | | 38 |
| V5 | | | | | 4 | 11 | 5 | | | | | | | 7 | 28 |
| V6 | | | 6 | 9 | 9 | 13 | 10 | 2 | 12 | 12 | 13 | 11 | 4 | 3 | 104 |
| V8 | | 6 | 6 | 4 | 6 | | 4 | 11 | 13 | 13 | 13 | 7 | | | 83 |
| V9 | | | | | | 7 | | | | | | | | | 7 |
| V11 | | | | | 4 | 13 | 3 | | | | | | | | 20 |
| V13 | 4 | 6 | | | | | | | | | 2 | 13 | 5 | | 30 |
| V14 | | | | | | | 2 | 11 | | 5 | | | | | 18 |
| V15 | | | | | | | | | | | | | 6 | 8 | 14 |
| V16 | | | | | | | | | | | | | 3 | 7 | 10 |
| No. trips | 4 | 12 | 12 | 22 | 39 | 63 | 35 | 43 | 49 | 52 | 37 | 38 | 35 | 32 | 474 |
| No. vessels | 1 | 2 | 2 | 3 | 7 | 7 | 7 | 5 | 5 | 5 | 5 | 4 | 6 | 6 | |

Regarding the length-sampling of black scabbardfish, the landings of 15 of the vessels were sampled between February and December 2009 (Table 5-4). The length-sampling started in February 2009 and none of vessels was sampled throughout the whole sampling period. February was the month when more vessels were sampled and more fish were measured. After that both values decreased until July. There was no length sampling in January, September, or October 2009 and in July and December only one box was sampled. During the self-sampling period, 43 boxes were sampled and 1091 fish were measured. Within the sampled fish, nearly 90% belonged to the size category “large”, being 80% of these sampled on the first half of the year. Moreover, size category “small” was only sampled in 3 occasions, in February, March, and November, summing only 64 individuals, which represented about 6% of the total.

The sampling effort adopted to estimate the length distribution of the landing by vessel was considered insufficient to get a good level of precision since in most cases it was not possible to cover the whole length range. For over half of the vessels (9 out of 15) only samples classified in the landing port as belonging to the large size category were measured and only 3 boxes of small specimens were sampled. In most of the cases the number of individuals sampled on each month was so small that it is not possible to perceive if there was any variation throughout the year.

In addition to the sampling under project LOT 1, data on the length-frequency of landed black scabbardfish was also collected under the national sampling programme (PNAB, EU Data Collection Regulation) throughout 2009. The distributions were compared side-by-side and differences in the length-sampling between the two projects were evident (Figure 5-7). In fact, during the first half-year, more fish were measured under LOT 1 whereas on the second half-year (excluding November) sampling under PNAB surpassed LOT1. Furthermore, there was no length sampling under LOT1 in January, September, and October.

**Table 5-4.** Number of specimens sampled by month, vessel and size category. Size cat = commercial size category according to landing sheet: L = large; M = medium; S = small. Each cell corresponds to a sample (a box of fish) randomly picked from a pile of boxes.

| | | Month | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Size cat** | **Vessel** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **11** | **12** | **Vessel total** |
| | **V1** | | 31 | 34 | | | | | | | 65 |
| | **V2** | 24 | | 25 | | | | | | | 49 |
| | **V3** | | 18 | | 14 | | | 31 | | | 63 |
| | **V4** | 62 | 27 | | | | 16 | | | | 105 |
| | **V5** | 18 | | 27 | | | | | | | 45 |
| | **V6** | 17 | 34 | | | | | | | | 51 |
| | **V7** | 14 | | 30 | | 34 | | | | | 78 |
| | **V8** | | | | 32 | | | | | | 32 |
| | **V9** | 16 | 35 | | 29 | | | | | | 80 |
| | **V10** | | 18 | | 35 | 34 | | | | | 87 |
| | **V13** | 33 | | 31 | 36 | | | 35 | | | 135 |
| | **V14** | | | | | | | | | 29 | 29 |
| | **V15** | 33 | 32 | 23 | | 27 | | | | | 115 |
| | **V17** | | | | | | | | 18 | | 18 |
| | **L Total** | 217 | 195 | 170 | 146 | 95 | 16 | 66 | 18 | 29 | **952** |
| **L** | **No. samples** | 8 | 7 | 6 | 5 | 3 | 1 | 2 | 1 | 1 | **34** |
| | **V2** | | 18 | | | | | | | | 18 |
| | **V5** | | | | | | | | 18 | | 18 |
| | **V9** | 15 | | | | | | | | | 15 |
| | **V14** | | | | | 9 | | | 15 | | 24 |
| | **M Total** | 15 | 18 | | | 9 | | | 33 | | **75** |
| **M** | **No. samples** | 1 | 1 | | | 1 | | | 2 | | **5** |
| | **V3** | | 10 | | | | | | | | 10 |
| | **V5** | 19 | | | | | | | 18 | | 37 |
| | **V12** | 17 | | | | | | | | | 17 |
| | **S Total** | 36 | 10 | | | | | | 18 | | **64** |
| **S** | **No. samples** | 2 | 1 | | | | | | 1 | | **4** |
| **Monthly Total** | | **268** | **223** | **170** | **146** | **104** | **16** | **66** | **69** | **29** | **1091** |
| **No. samples** | | **11** | **9** | **6** | **5** | **4** | **1** | **2** | **4** | **1** | **43** |

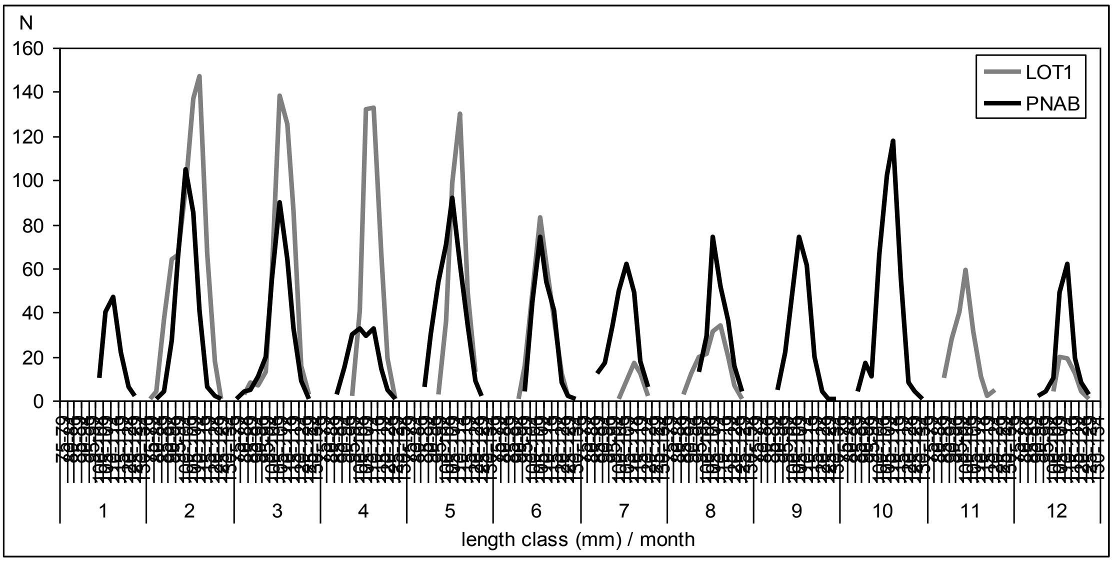



**Figure 5-7.** Black scabbardfish length-frequency distribution per month in 2009. Data collected under project LOT 1 and the national sampling programme (PNAB/EU DCR), from January to December 2009. Length classes are of 5 cm and vary from 75 to 134 cm.

*Fishing effort*

In average, each vessel carries out 12-13 trips per month (3 per week). During each trip one longline gear is deployed and another gear that had been deployed two days earlier is hauled back. Hence, in general each vessel leaves the harbour every other day.

When considering mean total landings by trip and by vessel (ratio between landings in kg and number of trips) from November 2008 to December 2009 (Figure 5-8), the vessels can be separated into two groups: vessels with average landings above 1500 kg/trip (vessels V2, V8, V9, V11, V13 and V14); and vessels with average landings below 1500 kg/trip (V1, V3, V4, V5 and V6).

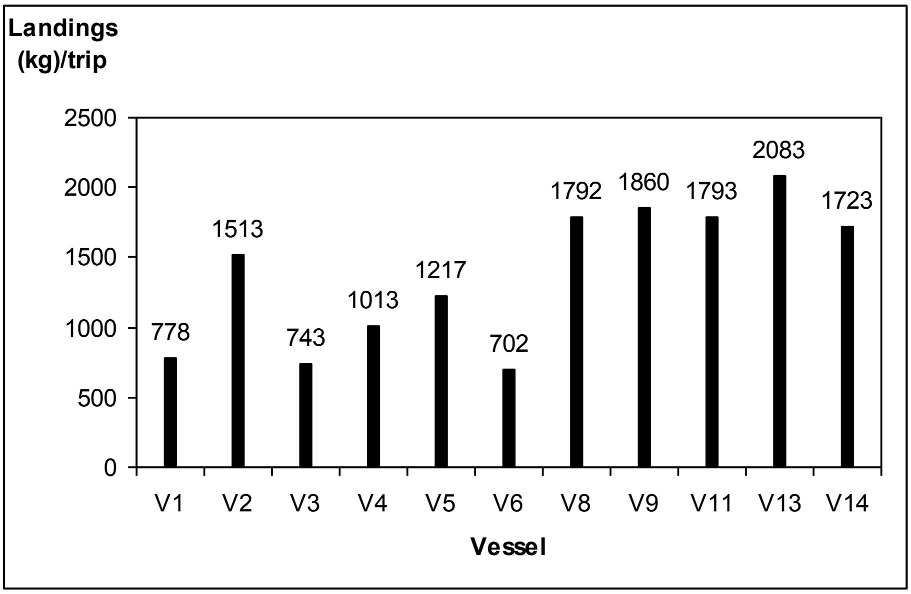



**Figure 5-8.** Catch per unit effort of black scabbardfish by vessel assuming total landings by number of trips from November 2008 to December 2009.

The differences between vessels were also noticeable when analysing the monthly catch-per-unit-effort (CPUE) of black scabbardfish in landed weight by trip (Figure 5-9). Within the vessels with the highest number of trips sampled (see Figure 5-5), V6 presented the lowest CPUE and the lowest variation (ca. 500-1000 kg/trip in 104 trips), whereas for V8 the CPUE varied from ca. 1300 to 3400 kg/trip (83 trips).

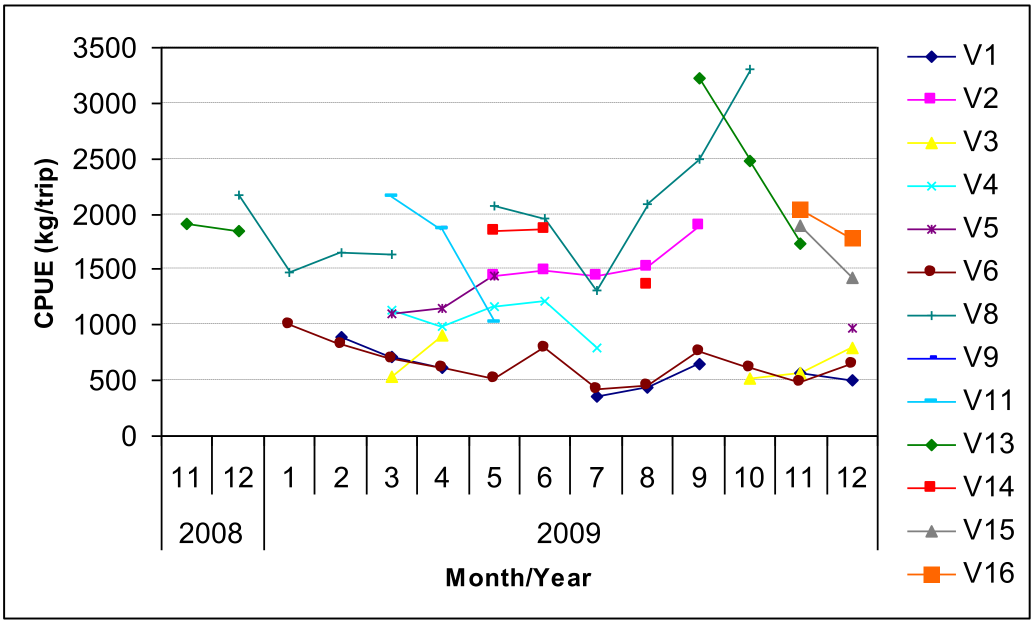



**Figure 5-9.** Catch-per-unit-effort (CPUE) of black scabbardfish by month and vessel in landed weight (kg) by number of trips from November 2008 to December 2009.

Another possible measure of the fishing effort is the number of hooks. In general, each vessel uses the same number of hooks on each trip, although they may increase or reduce it from time to time (Table 5-5).

**Table 5-5.** Average number of hooks used by each vessel during the sampling period.

| | Year | 2008 | | 2009 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Month | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | V1 | | | | 6000 | 6000 | 6000 | | | 6000 | 6000 | 6000 | | 6000 | 6000 |
| | V2 | | | | | | | 4571 | 5000 | 5000 | 5000 | 5000 | | | |
| | V3 | | | | | 6000 | 6000 | | | | | | 6000 | 6060 | 6000 |
| | V4 | | | | | 5600 | 5600 | 5600 | 5600 | 5600 | | | | | |
| | V5 | | | | | 6800 | 6800 | 7200 | | | | | | | 7800 |
| | V6 | | | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 | 5500 |
| | V8 | | 9000 | 9000 | 9000 | 9000 | | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 | | |
| | V9 | | | | | | 5500 | | | | | | | | |
| | V11 | | | | | 8875 | 8269 | 8000 | | | | | | | |
| | V13 | 9000 | 9000 | | | | | | | | | 10000 | 10000 | 10000 | |
| | V14 | | | | | | | 8000 | 8000 | | 8000 | | | | |
| | V15 | | | | | | | | | | | | | 10000 | 10000 |
| Vessel | V16 | | | | | | | | | | | | | 8500 | 8500 |

Boxplots of landed weight of black scabbardfish by 1000 hooks for each vessel are presented in Figure 5-10. The estimates of the median CPUE were similar between vessels, varying between ca. 100 and 230 kg/1000 hooks. Vessels V2 and V9 attained the highest CPUE values. This was expected because they presented higher landings using fewer hooks than the other vessels (see Figure 5-8 and Table 5-5). The number of hooks seems not to be an adequate fishing effort unit since it does not constrain the number and/or the size of fish caught.

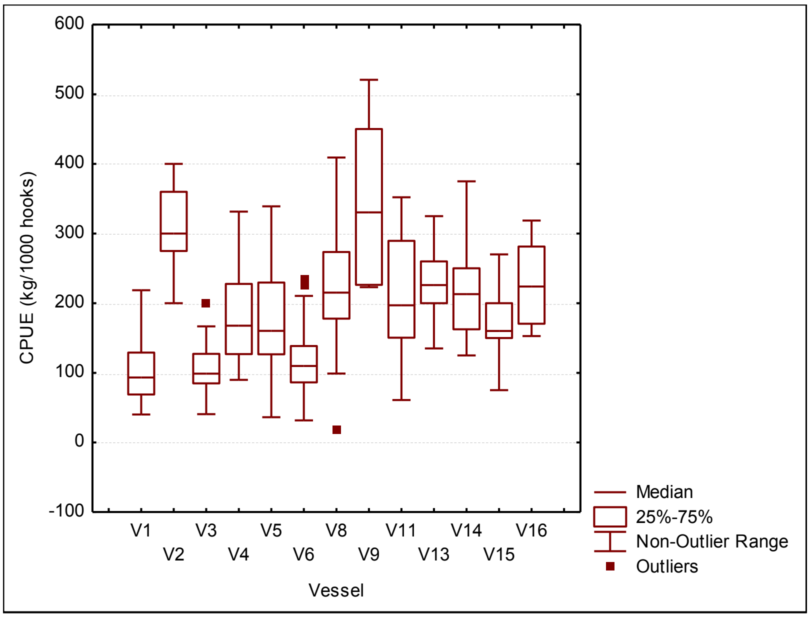



**Figure 5-10.** Landings of black scabbardfish by 1000 hooks for all participating vessels from November 2008 to December 2009.

The monthly evolution of CPUE was calculated as landed weight of black scabbardfish by 1000 hooks for the participating vessels (Figure 5-11). The separation in two groups according to CPUE was still evident, although the variation of the catch rates within each vessel was more obvious than when considering the number of trips.

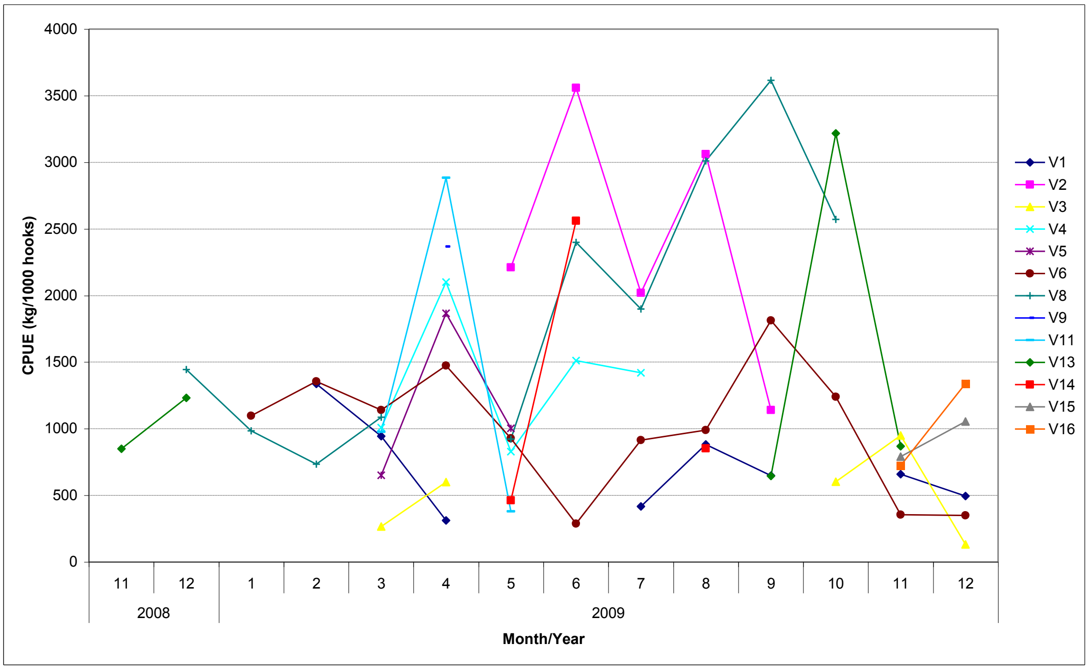



**Figure 5-11.** Catch-per-unit-effort (CPUE) of black scabbardfish in landed kg by 1000 hooks for each vessel from November 2008 to December 2009.

During the fishing operation, hooks are usually lost, most likely because of the attacks by cetaceans to the hooked fish and because some hooks get attached to rocky bottoms. The number of hooks lost in a trip varied between 120 and 2000, which corresponded to 2-25 % of the number of hooks used.

It was expected that the capture (in terms of landed fish) would decrease with the number of hooks lost. However, there seemed to be no relationship between the number of hooks lost during the fishing operation and the respective landing of black scabbardfish (in kg) (Figure 5-12). While for some vessels the catch decreased with the increasing number of hooks lost (e.g. V1, V4, V8, V11, and V16), for others the data pointed out to an unexpected increase (V3, V13, and V15) or else was inconclusive (V9). These results were highly unexpected and when fishermen were confronted with them, they admitted this would be very unlikely to happen. This may reflect lack of accuracy when filling the forms.

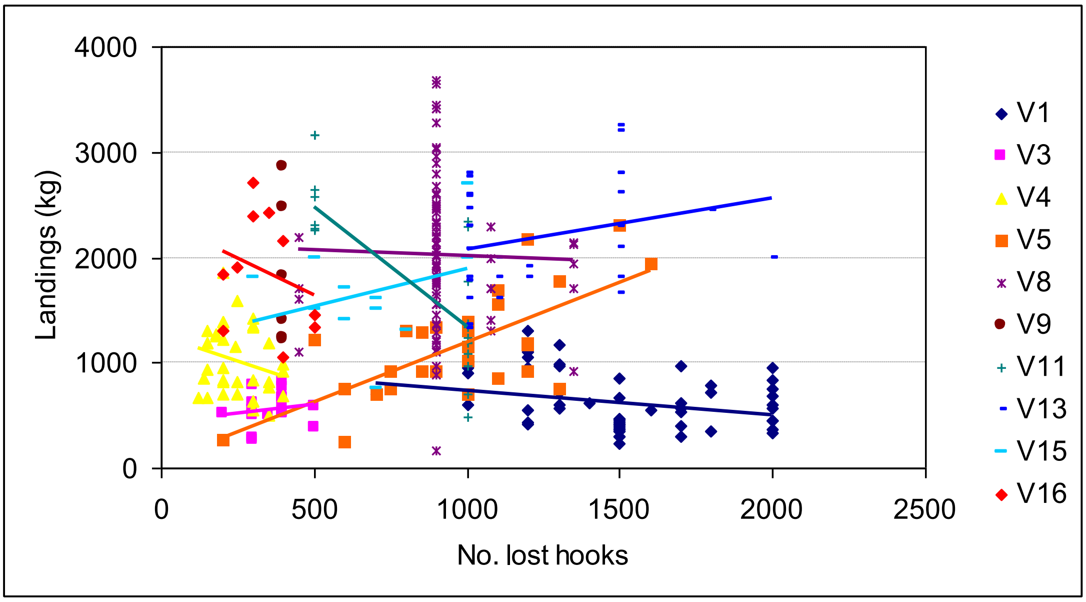



**Figure 5-12.** Landings of black scabbardfish (kg) by number of hooks lost during the fishing operation for each vessel from November 2008 to December 2009.

A third measure of the fishing effort is the soaking time. Soaking time was calculated as the time between the end of setting and the start of hauling of the gear. For the majority of the vessels, leaving the gear longer in the water increased the landings in weight (Figure 5-13), with the exception of vessels V2, V13, and V14, whose landings apparently diminished when leaving the gear in the water longer. This situation is not surprising since longer soaking time would lead to hooked fish having a greater probability of being taken by predators. Remarkably, these last two vessels attained the highest landings during the sampling period (see Figure 5-8).

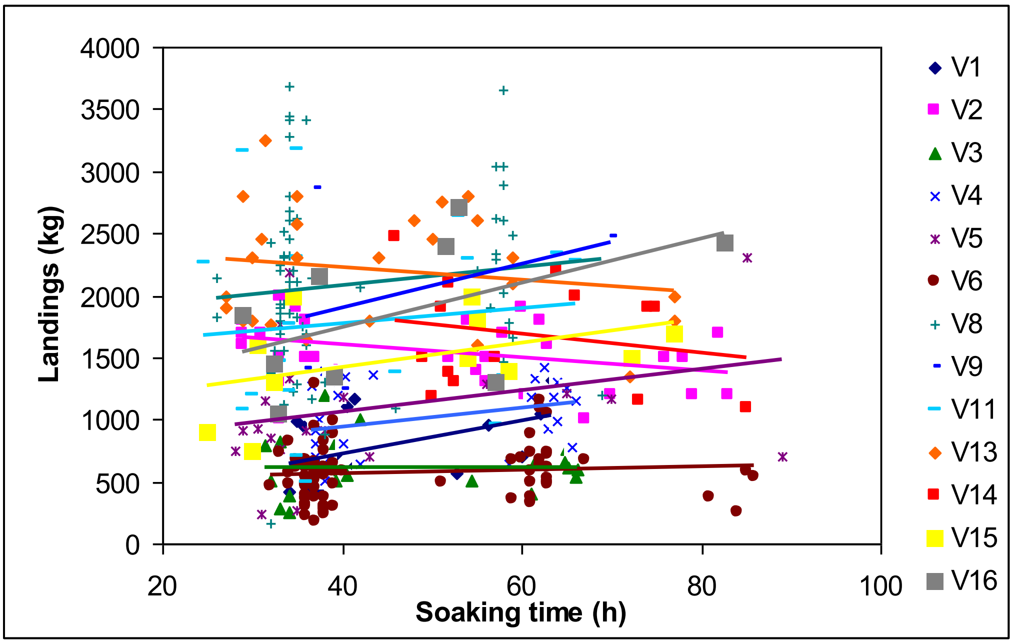



**Figure 5-13.** Landings of black scabbardfish (kg) by soaking time (h) for each vessel from November 2008 to December 2009.

Landings of black scabbardfish were also compared in terms of depth at which the gear stays during the soaking period (Figure 5-14). The depth corresponded to the average between depth at gear deployment (on the previous trip) and depth at hauling of the same gear. There was no direct relationship between average depth and the landings of black scabbardfish. For each vessel, the average depth did not vary greatly along the trips. V1 showed the widest range of depths and yet its landings were less variable than for most of the other vessels.

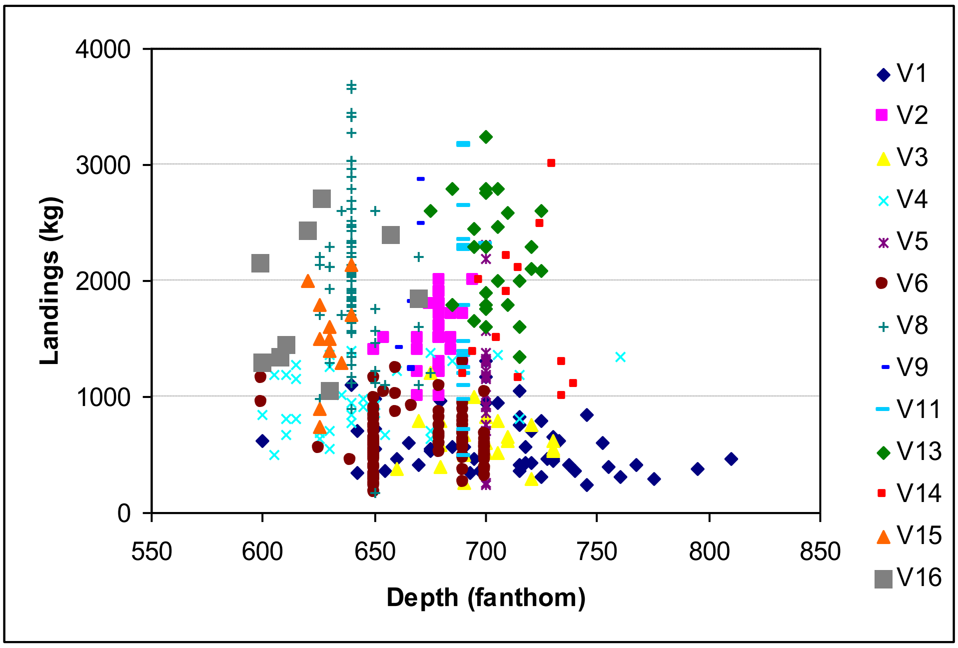



**Figure 5-14.** Landings of black scabbardfish (kg) by depth (fathom) of the gear for vessels from November 2008 to December 2009.

***Catch composition***

The artisanal longline fishery in Sesimbra is directed to catch black scabbardfish. Although the deep-water longline is a very selective gear, other species that are also attracted by the bait may be caught. These occasional by-catches are mainly deep-water sharks (Table 5-6) and species without commercial interest that are further discarded.

**Table 5-6.** List of deep-water sharks landed in the sampled trips between November 2008 and December 2009.

| Common name | Scientific name | No. trips | %Occurence |
|---|---|---|---|
| Portuguese dogfish | *Centroscymnus coelolepsis* | 91 | 19 |
| Leafscale gulper shark | *Centrophorus squamosus* | 427 | 90 |
| Knifetooth dogfish | *Scymnodon ringens* | 286 | 60 |
| Birdbeak dogfish | *Deania calceus* | 136 | 29 |
| Longnose velvet dogfish | *Centroscymnus crepidater* | 41 | 9 |

Landings of black scabbardfish (BSF) and deep-water sharks (DWS) were compared amongst all vessels that participated in the self-sampling programme (Figure 5-15). Landings of DWS did not vary much between vessels and the vessels with the highest values for BSF landings did not present the highest landings of DWS. Landings of DWS were approximately 15% of the total landings by trip.

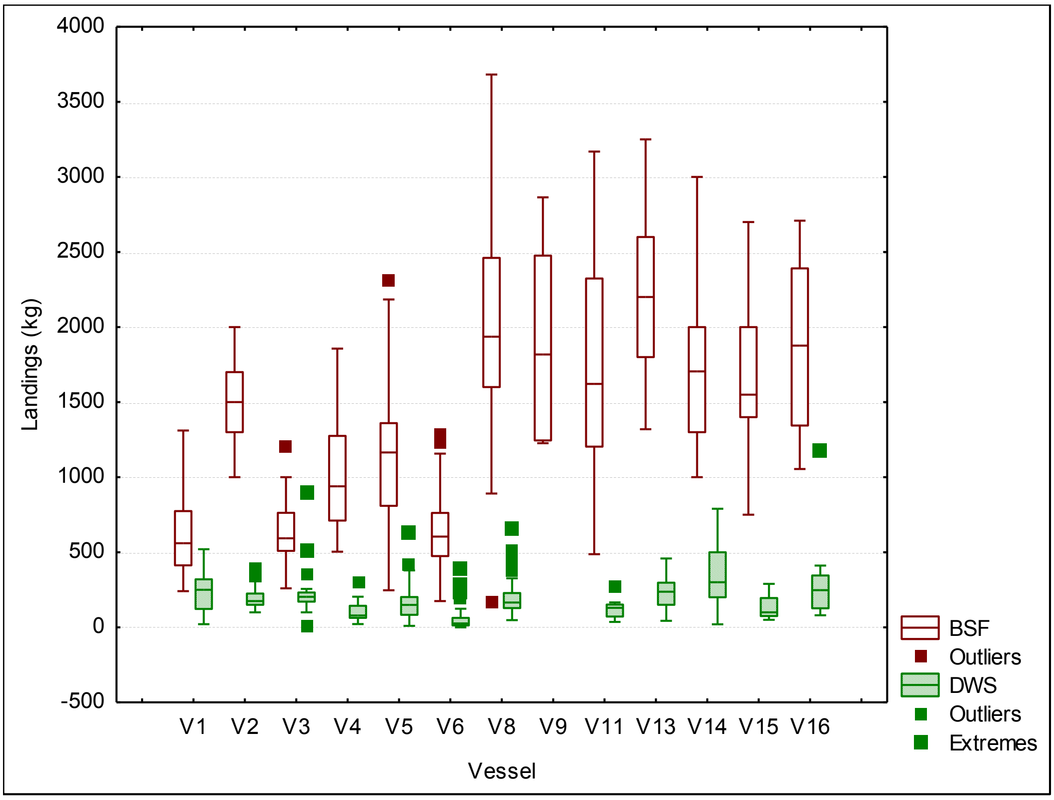



**Figure 5-15.** Landings of black scabbardfish (BSF) and deep-water sharks (DWS) from November 2008 to December 2009.

Comparing the total catch rates of BSF and DWS in landings (kg) per trip (Figure 5-16), the landings of DWS proved to be very low throughout the sampling period. The patterns of increase and decrease in CPUE of BSF and DWS were similar, although sometimes differed with a one-month interval.

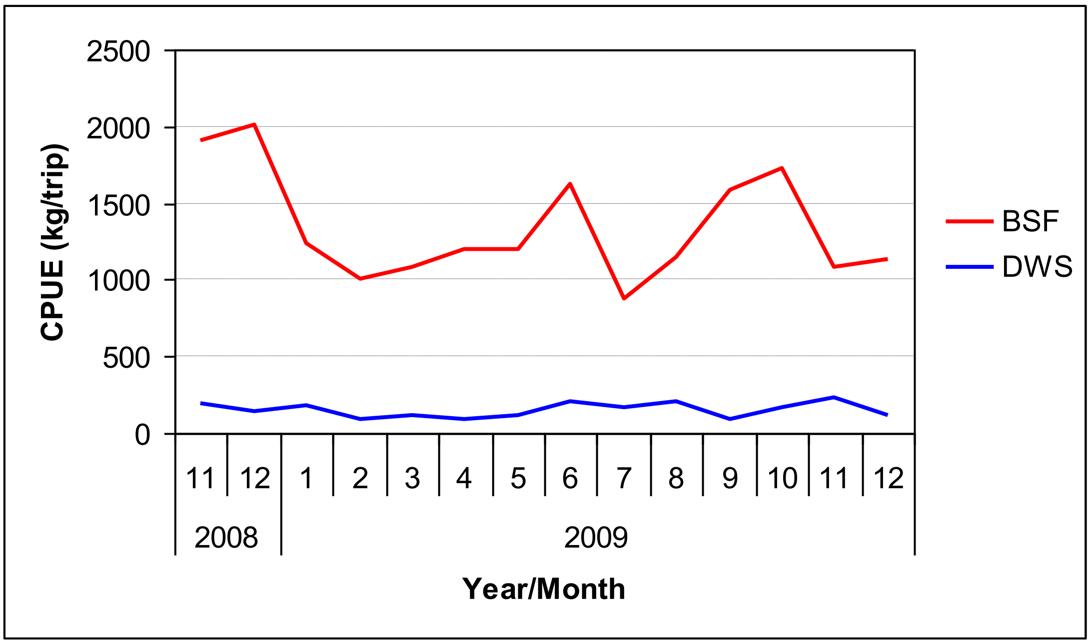



**Figure 5-16.** Total catch rates of black scabbardfish (BSF) and deep-water sharks (DWS) in landings (kg) per trip from November 2008 to December 2009.

According to the established protocol, the discards' information was recorded only in terms of species occurrence and number of specimens by trip. The lack of data on weight is due to the fact that no balance was available onboard. Other procedures are required in order to get reliable estimates that avoid fishermen guessing the weights. The percentage of occurrence of discarded specimens in the catches varied largely between vessels (Figure 5-17). For most vessels specimens without commercial interest were thrown overboard in less than 60% of the trips. Nevertheless, discards occurred in all trips sampled by vessels V4 and V14, and in contrast vessels V5, V9, V11, and V15 did not report any discarded specimens.

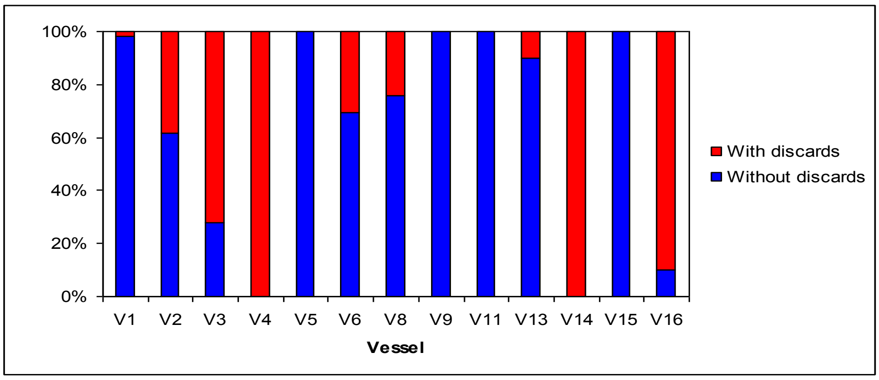



**Figure 5-17.** Percentage of occurrence of discarded specimens by vessel. Red = trips with occurrence of discarded specimens; Blue = trips without occurrence of discarded specimens.

The list of specimens without commercial interest that were discarded, as well as their percentage of occurrence in the self-sampled trips, is presented in Table 5-7. The most frequent species were longnose velvet dogfish, birdbeak dogfish, Risso's smooth-head, and Portuguese dogfish. Two damaged specimens of black scabbardfish with approximately 1 m were also discarded.

**Table 5-7.** Occurrence of specimens without commercial interest. n = number of trips where it occurred.; %O = percentage of occurrence in relation to the total number of trips.

| **Common name** | **Scientific name** | **n** | **%O** |
|---|---|---|---|
| Birdbeak dogfish | *Deania calceus* | 65 | 13.7 |
| Black scabbardfish | *Aphanopus carbo* | 1 | 0.2 |
| Blackmouth catshark | *Galeus melastomus* | 1 | 0.2 |
| European whiting | *Merlangius merlangus* | 1 | 0.2 |
| Forked hake | *Phycis blennoides* | 6 | 1.3 |
| Frostfish | *Benthodesmus elongatus* | 1 | 0.2 |
| Hollowsnout grenadier | *Coelorinchus caelorhincus* | 4 | 0.8 |
| Kaup's arrow tooth | *Synaphobranchus kaupii* | 20 | 4.2 |
| Knifetooth dogfish | *Scymnodon ringens* | 25 | 5.3 |
| Leafscale gulpershark | *Centrophorus squamosus* | 28 | 5.9 |
| Longnose lancetfish | *Alepisaurus ferox* | 1 | 0.2 |
| Longnose velvet dogfish | *Centroscymnus crepidater* | 78 | 16.5 |
| Mora | *Mora moro* | 5 | 1.1 |
| North Atlantic codling | *Lepidion eques* | 1 | 0.2 |
| Oreo Dory | *Allocyttus verrucosus* | 1 | 0.2 |
| Portuguese dogfish | *Centroscymnus coelolepsis* | 56 | 11.8 |
| Risso's smooth-head | *Alepocephalus rostratus* | 57 | 12.0 |
| Roughsnout grenadier | *Trachyrincus scabrus* | 3 | 0.6 |
| Smooth lantern shark | *Etmopterus pusillus* | 18 | 3.8 |
| Swallowerfish | *Pseudoscopelus altipinnis* | 1 | 0.2 |
| Velvet belly lantern shark | *Etmopterus spinax* | 40 | 8.4 |
| Wolf-fish | *Anarhichas spp.* | 1 | 0.2 |

### *Marine mammals*

Vessels started using the pingers in late March, coinciding with the time when the number of participating vessels increased from 4 to 8 (see Table 5-3). As expected, cetaceans were only seen during hauling. The occurrence of cetaceans was analysed throughout the self-sampling period, namely between November 2008 and December 2009 (Figure 5-18). Cetaceans were seen every month but in less than half of the trips. December 2009 was the month with the highest occurrence of cetaceans, whereas in November and December 2008 the occurrence was null and nearly null, respectively. It is important to stress that like in the previous analyses the months were not equally sampled and that the number of trips sampled was low (see Figure 5-6).

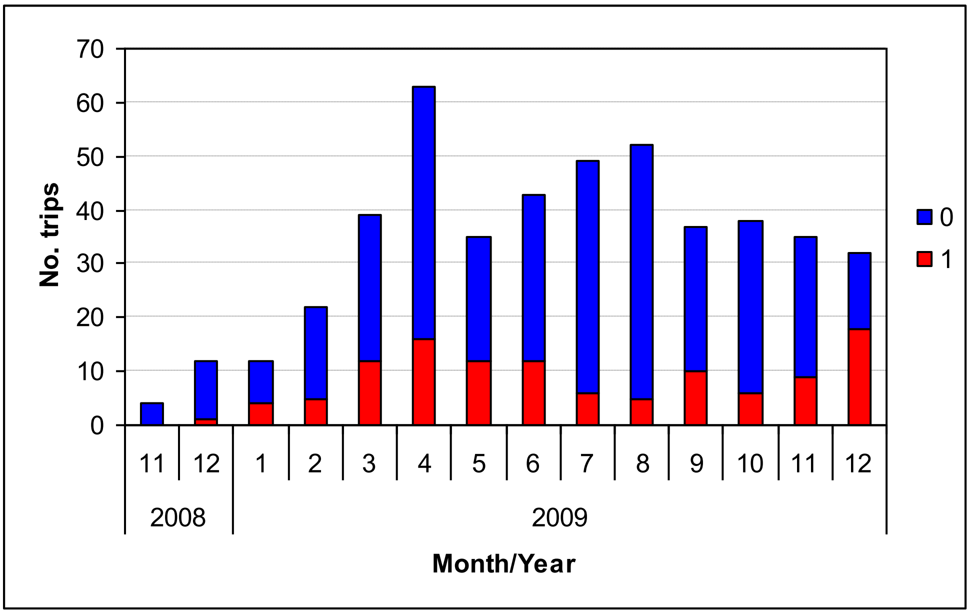



**Figure 5-18.** Occurrence of cetaceans from November 2008 to December 2009. 0 = cetaceans were not seen; 1 = cetaceans were seen.

Regarding the efficiency of the pingers, the occurrence of cetaceans was analysed for each vessel taking into consideration if pingers were being used or not (Figure 5-19). The frequency of sightings corresponds to the number of trips in which cetaceans were seen in relation to the total number of self-sampled trips by vessel. V2 was the only vessel that did not register the occurrence of marine mammals in any of its trips, whereas V16 encountered cetaceans in all of them. For most vessels, cetaceans occurred in less than approximately 25% of the trips, no matter the number of pingers. Vessels V13 and V14 never used pingers and encountered the cetaceans in half and nearly all of the trips, respectively. V1, V6, and V16 met cetaceans using either one pinger or none. V4 was the only vessel to use simultaneously two pingers and still met cetaceans in one quarter of its trips.

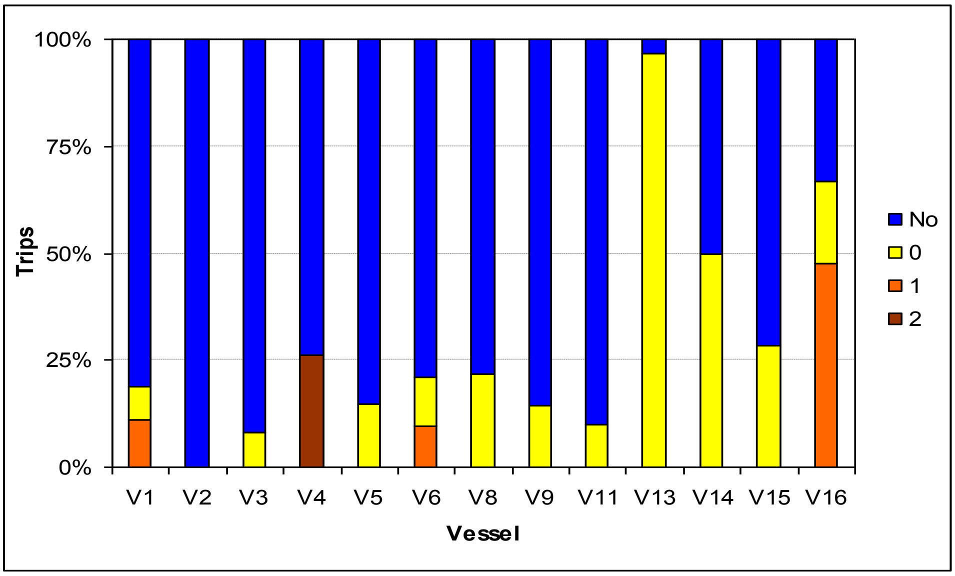



**Figure 5-19.** Frequency of sightings of cetaceans for each fishing vessels. No = No occurrence of cetaceans; 0 = Occurrence not using pinger; 1 = Occurrence using one pinger; 2 = Occurrence using 2 pingers.

Landings of black scabbardfish were compared between trips wherein cetaceans attacked or did not attack the catch (Figure 5-20). Landings from trips in which cetaceans attacked the catch (mean = 1483.0 kg) and landings from trips in which cetaceans did not attack (mean = 1228.8 kg) were significantly different ($F_{(1, 470)}$ = 7.7458, p = 0. 00560).

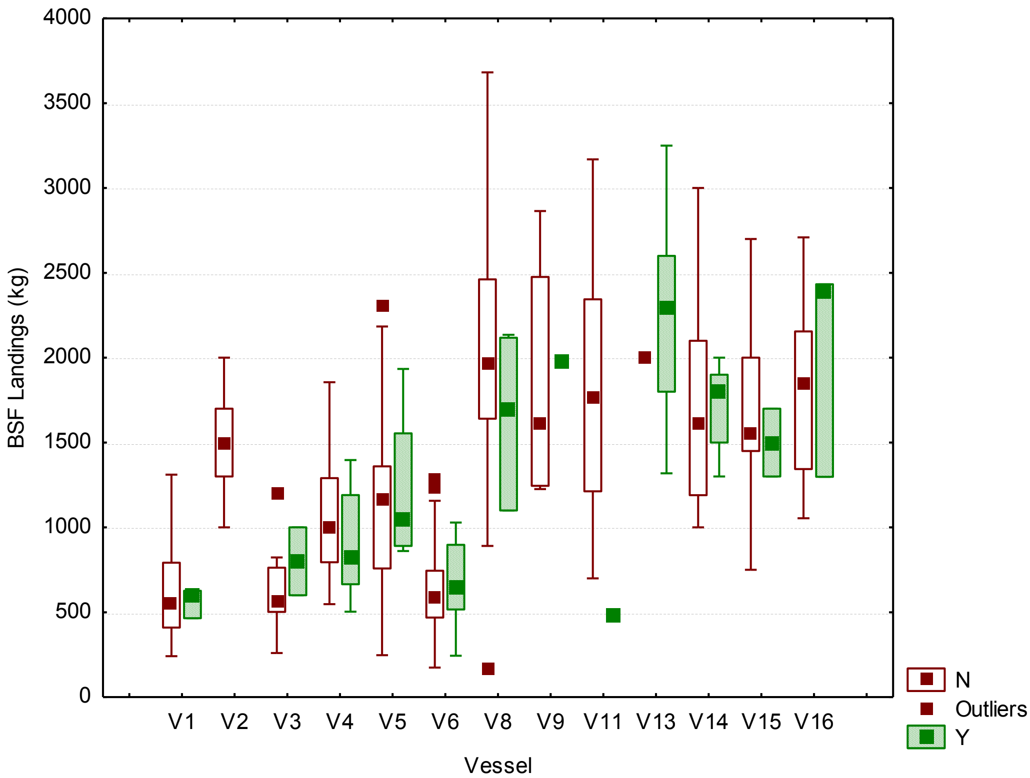



**Figure 5-20.** Landings of black scabbardfish from November 2008 to December 2009 considering the attacks from cetaceans to the catch. N = no attack; Y = attack.

To help fishermen with the identification of the marine mammals, a guide with photographs and a list of the most important diagnostic features was provided. Only three species of cetaceans were identified by the fishermen: short-beaked common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), and killer whale (*Orcinus orca*) (Figure 5-21). For three different occasions the occurrence of "whale" was also recorded but it was excluded from the analysis because the species was not identified (it was most likely a killer whale).

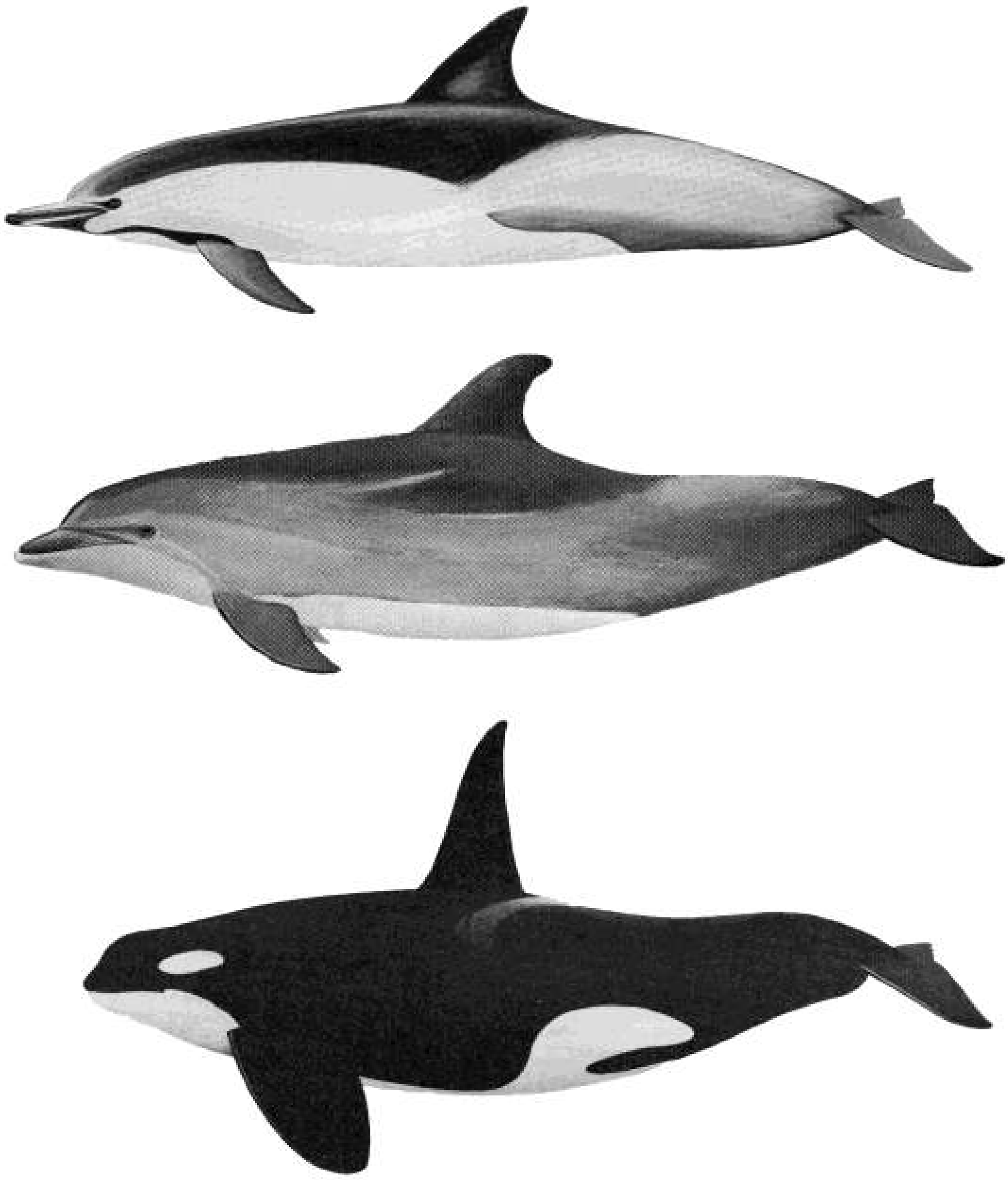


**Figure 5-21.** Cetaceans identified by fishermen of Sesimbra's longline fleet, from top to bottom: short-beaked common dolphin (*Delphinus delphis*); bottlenose dolphin (*Tursiops truncatus*); and killer whale (*Orcinus orca*). Source of drawings: Jefferson *et al.*, 1993.

The occurrence of cetaceans was analysed throughout the sampling period (Figure 5-22). The bottlenose dolphin was the most frequent cetacean identified by fishermen.

The number of sightings of short-beaked common dolphin and bottlenose dolphin was higher in months between April and June. The killer whale (orca) only occurred in January (1 trip), May (2 trips), and December 2009 (1 trip).

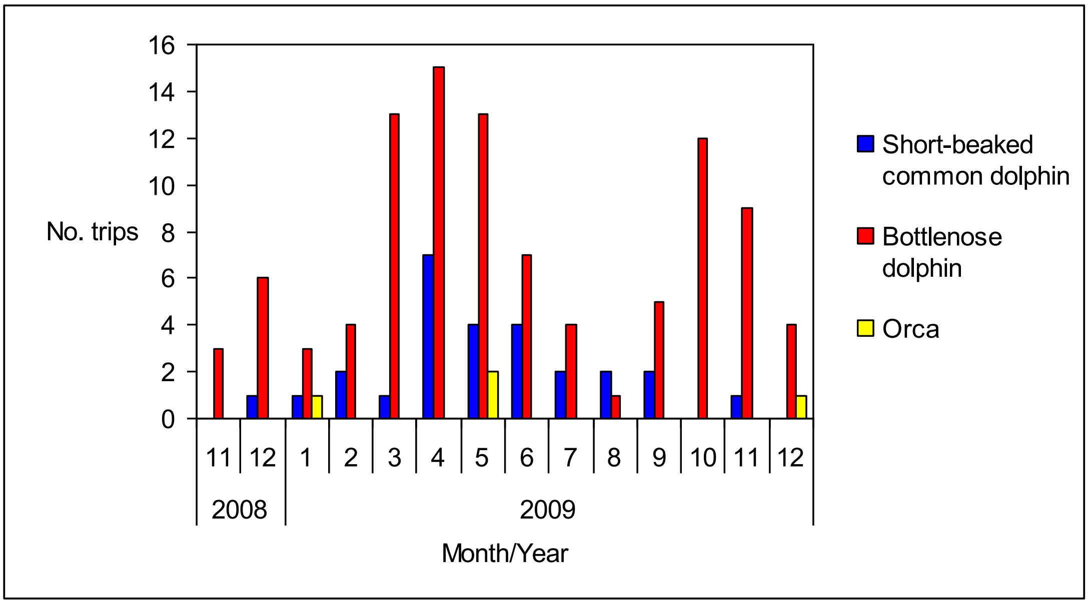



**Figure 5-22.** Occurrence of different species of cetaceans in self-sampled trips from November 2008 to December 2009.

Fishermen were asked to describe the behaviour of the cetaceans as follows: cetaceans turned away from vessel (A); cetaceans approached the vessel and turned away without attacking (M); cetaceans did not attack the catch (N); cetaceans attacked the catch (S). The behaviour of each species was analysed taking into consideration the number of used pingers (Figure 5-23). The most frequent behaviour of short-beaked common dolphin was not attacking the catch. In fact, this species only attacked in one occasion and remarkably the vessel was using two pingers simultaneously. Bottlenose dolphins attacked the catch on nearly 75% of the trips where it occurred. Their second most frequent behaviour was turning away from the vessel, which happened 24 times without the presence of any pingers. Half of the times that killer whales were seen, they attacked the catch.

Based on their experience, fishermen state that bottlenose dolphin attack only the hooked black scabbardfish while the killer whales attack the deep-water sharks.

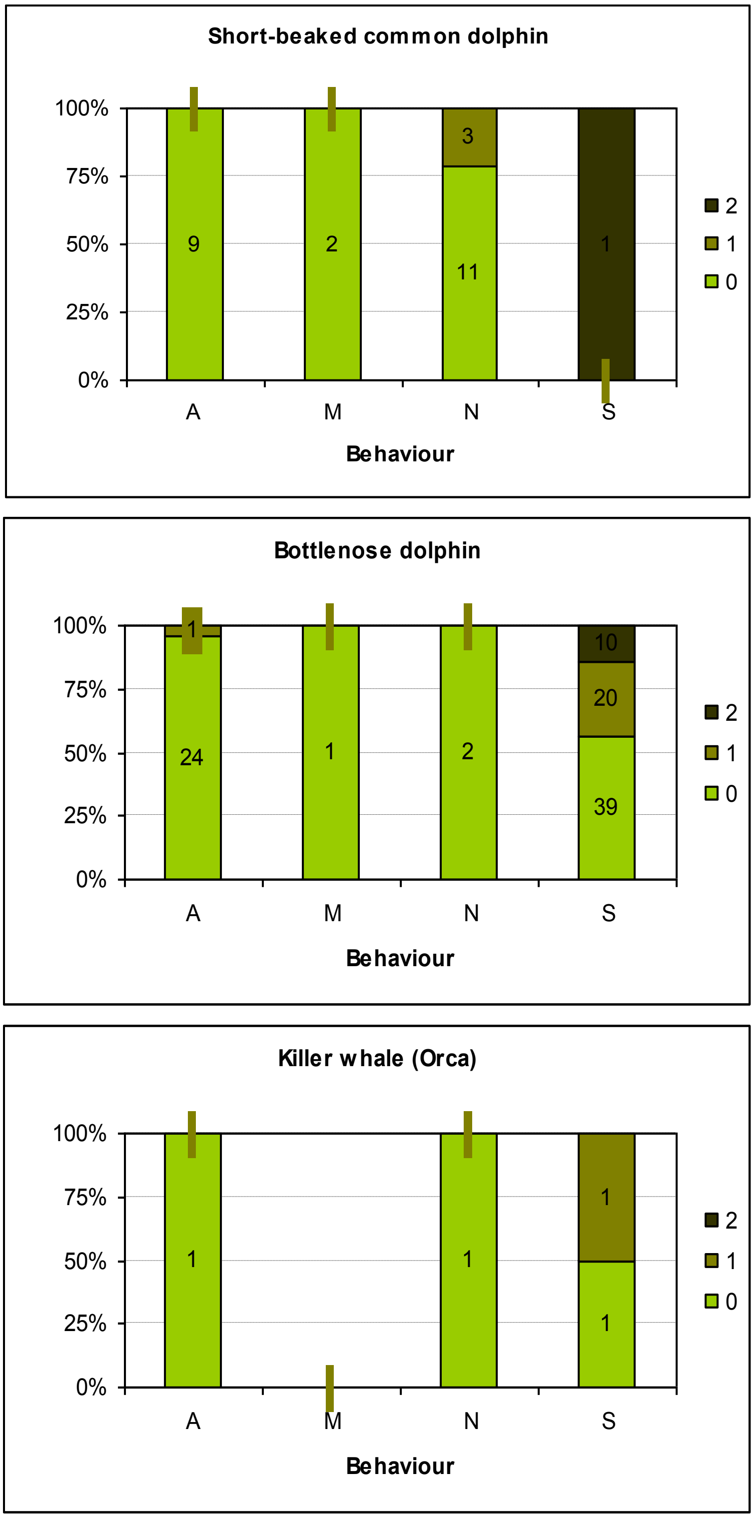



**Figure 5-23.** Behaviour of the cetaceans identified by the fishermen organized according to the number of pingers used. Behaviour: A = cetaceans turned away from vessel; M = cetaceans approached the vessel and turned away without attacking; N = cetaceans did not attack; S = cetaceans attacked. Legend: 2 = Using two pingers; 1 = Using one pinger; 0 = Without pinger.

Fishermen reported seeing short-beaked common dolphin and bottlenose dolphin in groups of 10-50 and 4-60 individuals, respectively. In some occasions when it was night or the weather was rough, they were not able to count the cetaceans. Vessel V13 recorded attacks by bottlenose dolphins in nearly all trips (see Figure 5-19) and reported their catches were seriously impacted by the attacks of 60 to 500 individuals in October and November 2009. Nonetheless, it reported the highest landings of black scabbardfish from all the vessels. The killer whales were reported to be in groups of two to ten individuals. It is important to note that in many cases these counts are in fact exaggerated because the animals keep diving and emerging in different positions and because there is an emotional aspect influencing fishermen as they get angry watching their catch being damaged.

## 5.3 Discussion

This pilot project was decisive for strengthening the relationship settled over 10 years ago between the fishing community of Sesimbra's longliners and the scientists at IPIMAR. The establishment of a plan to exchange data and information worked also as a kick-off to the collaboration within another EU financed project, *DEEPFISHMAN: Management And Monitoring Of Deep-sea Fisheries And Stocks*. Furthermore, after the first meetings between fishermen and scientists, the idea of proposing Sesimbra's longline fishery and the black scabbardfish for international certification started developing. By the end of LOT 1, both parties agreed to proceed with the self-sampling scheme (after some adjustments) having the certification as a goal.

On a general analysis, the outcome of Pilot Project 4 was positive. Although the initial participation was low, fishermen soon got enthusiastic with the project, which in turn helped motivating them for contributing to similar projects. Nonetheless, some of the most important goals were not achieved:

- Not all vessels that agreed to participate contributed to the project;
- The temporal and spatial evolution of the fishery were not totally covered;
- The electronic logbooks were not tested by the fishermen;
- The length sampling scheme was not set up on a monthly basis.

The main reason for the initial low participation of fishermen was their disbelief that the project outputs could provide long-term benefits and the fear that the collection of data would interfere with their work.

According to the legislation, the first phase of implementation of electronic logbooks, starting on January 2010, will apply to vessels with over 24 m (overall length) and the second phase will start in June 2011 and will apply to vessels longer than 15 m. Vessels from Sesimbra's artisanal deep-water fleet are smaller than 24 m, with the exception of one which is 24.5 m. Although most vessels are not yet covered by the legislation, fishermen and scientists within this pilot project have committed to test the use of e-logbooks in the forthcoming months.

Within the prolongation of the self-sampling plan, which is a necessary step to apply for the certification program, most failures and shortcomings of this pilot project will be rectified. One of the agreements is that AP will revise all data prior to delivering it to the scientists.

## 5.4 Conclusions regarding added value to DCF data collection

The success of the Sesimbra longline pilot project in addressing some specific questions posed by the European Commission is considered below:

*What information exactly is missing to improve stock assessment or other assessment according to the national institute? Does this concern local management or regional/ Community management?*

The pilot project showed that is possible to use collaborative approaches to collect data at spatial resolution finer than ICES rectangles, which is particularly pertinent in the case of Portugal mainland in which the slope is very steep. Up to now spatial information was provided by ICES rectangle but is often missing or assigned to ICES division. Information was also obtained on numbers of empty hooks and lost hooks at the end of the fishing trip, data that can improve the quality of CPUE estimates and be used to get efficiency estimates for the fishery. The project also helped fishermen to correctly record EU logbook variables that are often not fully understood by fishermen and most of the times not included in the logbooks or erroneously registered. These included haul duration, number of hauls and catch data.

*What information has the sector shown willing to collect and could this information, when structured, cover parts of the data needs?*

During the project, the fishermen were able to coordinate the filling of logbooks with the forms we provided. Furthermore they collected information that could be used to analyse the impact of cetaceans in this fishery. Another important contribution although not as active as the trip sampling, was the length sampling of black scabbardfish and deep-water sharks. Although monthly samplings are maintained under the DCF, with the participation of the sector, data was largely improved: more vessels were sampled by month, a longer period was covered.

*To what extent is there a need, from the stock perspective, to merge/compare these national data sets into regional/international data sets and analysis?*

Since it is not yet clear if there are one or more stocks of black scabbardfish in NE Atlantic, it would be of outmost importance to compare the landing and effort data from Portugal (mainland and Madeira), France, and other countries with significant landings of this species. It would be especially important to compare the Portuguese and the French fleets' impact because of the fishing technical differences amongst them. New sampling protocols among the main fishing fleets capturing the species might be required. A joint reanalysis of sampling programs actually in place in different fisheries taking the species should be undertaken particularly if analytical models to assess the stock are envisaged.

*Are there drivers for designing or keeping alive such projects, for instance national interest in managing local fisheries, or interest of the sector in obtaining a sustainability label?*

The self-sampling scheme designed and improved under LOT1 is still running, by decision of Sesimbra's longline fishery sector. The fishermen association is willing to apply for MSC's certification of the fish and the fishery. IPIMAR strongly support their collaboration and is willing to maintain regular meeting to inform the stock status and to discuss with them management alternatives.

*What "added value" do the projects provide to the recurrent data collection under the EU Data Collection Framework?*

- Access to more detailed information;
- Increase the sampling effort actually defined under EU legislation for deep-water species;
- Improve data accuracy
- In longer term to contribute for a better understanding by fishermen on how the exploitation status of stock is evaluate and on their recognition of the importance of having robust data to evaluate the stock.

### 5.5 Recommendations

In the case-study of the Portuguese artisanal deep-water longline fishery, the self-sampling programme has been improved and was adopted for fishery certification purposes. The collaboration plan established within project LOT1 will hence be extended during the preparation phase prior to the assessment process and throughout the certification program itself. To cover the self-sampling data quality concerns, the fishermen's association (ArtesanalPesca) has offered to review all data prior to delivering it to the scientists at IPIMAR. Furthermore, part of the data collected within this project will be adapted to the EU project DEEPFISHMAN, as mentioned before.

During this pilot project the importance of giving fishermen incentives was clearly demonstrated: after the fishermen's association bought and circulated the pingers, vessels started to participate more effectively. It is important to point out that, even though they have concluded that the pingers were not adequate in solving their problem with the cetaceans, most of them continued supplying data to the project. Hence, it seems that their belief in the value of this cooperative work superimposed their disappointment regarding the pingers' efficiency.

Looking back from the designing phase to the discussion of the results, it becomes obvious that apart from any incentives, the best way to engage fishermen to participate in a cooperative project is to first have established a strong relationship based on confidence and mutual help. One concern that arose in all of the meetings was the confidentiality of the information they provided: it was assured that data would only be presented in an anonymous and/or aggregated way and only after their consent.

Another important aspect of collaborative work is commitment. It was clear that to guarantee everyone's commitment every part must be available for exchange of ideas, troubleshooting and explanatory questions throughout the whole project. Regular meetings must be scheduled throughout the project, and those should include training or explanatory sessions.

## 5.6 References

Jefferson, T.A., S. Leatherwood, M.A. Webber 1993. FAO species identification guide. Marine mammals of the world. Rome, FAO. 320 p. 587 figs.

Bordalo-Machado, P., I. Figueiredo 2009. The fishery for black scabbardfish (*Aphanopus carbo* Lowe, 1839) in the Portuguese continental slope. Rev Fish Biol Fisheries 19: 49–67.

## 5.7 Project team meetings

During the project, several meetings were held between the partners and the subcontractors, including the participation of the vessels' skippers. Briefly, the most important were:

- September 2008

Participation: 10 people – 6 subcontractors + 4 scientists
Subject: Introduction of project

Summary: The aims of the project were presented to the skippers of some of the vessels. Fishermen were instructed on how to fill the forms and on the importance of all information asked. Unfortunately, less than half the people that were expected participated in this meeting, which prejudiced the explanatory session.

- May 2009

Participation: 12 people – 10 subcontractors + 2 scientists
Subject: Present status and preliminary results

Summary: This intermediate meeting preceded the presentation of the project in an international scientific meeting and was very important to discuss the preliminary results of the project. Fishermen were able to actually see the application of each type of information they had collected. The preliminary results were discussed and some improvements in the self-sampling scheme were proposed. Furthermore, a new vessel entered the project.

- November 2009

Participation: 20 people – 17 subcontractors + 3 scientists
Subject: Discussion of results

Summary: In this last meeting, the results were discussed with the fishermen and members of AP. They agreed that some of the data they had given had to be incorrect (e.g., landings *vs.* number of hooks lost; soaking time). Furthermore, they recognized the importance of supplying correct and precise data and of keeping a periodic sampling scheme. They were reassured that all data was confidential and that it would not be used without their permission. This meeting was followed by an explanatory session about fishery certification and seafood ecolabelling.

## 5.8 Data dissemination and other project outputs

*Oral communications*

CCR.S South Western Waters Regional Advisory Council.
Location: Gran Canaria, Spain Date: 5 March 2009

ICES WGDEEP.
Location: Copenhagen, Denmark
Date: 9 March 2009

ICES Deep-sea Symposium: Issues Confronting the Deep Oceans – The Economic, Scientific, and Governance Challenges and Opportunities of Working in the Deep Sea
Location: Horta, Faial, Portugal
Date: 27-30 April 2009

*Posters*

International Meeting on Marine Resources '09
Location: Peniche, Portugal
Date: 16-18 November 2009

## 5.9 Portuguese artisanal deep-water longline fishery: Self-sampling data collection forms

**Travel registration form (Portuguese version)**

# Registo de viagens

| | Partida | Chegada |
|---|---|---|
| Data | | |
| Hora | | |
| Porto | | |

**Porto de venda**: ____________________

*Informações sobre a operação de pesca, supondo que numa viagem é feita a alagem do aparelho largado na viagem anterior.*

| Fase | Hora (início) | Hora (final) | Latitude | Longitude | Prof. (em braças) | Nº de Anzóis | Nº de Anzóis perdidos |
|---|---|---|---|---|---|---|---|
| Alagem | | | | | | | |
| Largada | | | | | | | |

**Tipo de fundo (lodo, areia, rocha, coral...):** ____________________________________________

*Guardar amostra de sedimento se vier agarrado ao aparelho. Assinalar se for guardado* ☐

**Quantidades capturadas de espécies comerciais, por lance.**
*Nos espaços em branco escrever o nome de outras espécies que tenham sido capturadas e não constem na lista.*

| Espécie | Quantidade (em Kg) |
|---|---|
| Peixe-espada | |
| Carocho | |
| Lixa | |
| Arreganhada | |
| Sapata | |
| Tubarão lusitano | |
| Sapata preta | |
| Tintureira | |
| | |
| | |

**Rejeições.**
*Nome de espécies rejeitadas que não foram guardadas.*

| Espécie | Nº indivíduos |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| | Sim | Não |
|---|---|---|
| Foram avistados mamíferos marinhos? *(se sim, preencher o questionário de mamíferos marinhos – no final)* | ☐ | ☐ |
| As rejeições foram guardadas? | ☐ | ☐ |
| As cabeças de peixe-espada preto foram guardadas? *Se não, qual o número aproximado?* _________ | ☐ | ☐ |

***Observações***:

**Travel registration form (English version)**

# Travel form

| | Departure | Arrival |
|---|---|---|
| Date | | |
| Time | | |
| Port | | |

**Sales port**: ____________________

*Information about the fishing operation assuming that in a single trip one gear is deployed and the gear deployed the previous trip is hauled.*

| Operation | Time (start) | Time (end) | Latitude | Longitude | Depth (fathom) | No. hooks | No. hooks lost |
|---|---|---|---|---|---|---|---|
| Hauling | | | | | | | |
| Deployment | | | | | | | |

**Type of bottom (silt, sand, rock, coral,...):** ______________________________________________

*Collect sediment sample when it is attached to the gear. Mark if sample is collected* ☐

| **Quantity of commercial species caught.** *Write in the blanks the name of other species that have been captured and are not on the list.* | |
|---|---|
| **Species** | **Quantity (kg)** |
| Black scabbardfish | |
| Portuguese dogfish | |
| Leafscale gulper shark | |
| Knifetooth dogfish | |
| Birdbeak dogfish | |
| Lusitanian leafscale gulper shark | |
| Longnose velvet dogfish | |
| Blue shark | |
| | |
| | |

| **Discards.** *Name of discarded species that were not collected.* | |
|---|---|
| **Species** | **No. specimens** |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| | Yes | No |
|---|---|---|
| Did you see any marine mammals? *(if so, fill the marine mammals form, at the end)* | ☐ | ☐ |
| Did you collect the discards? | ☐ | ☐ |
| Did you collect the heads of black scabbardfish? *If not, what's the approx. number?* ________ | ☐ | ☐ |

***Observations***:

**Marine mammals registration form (Portuguese version)**

## Formulário para uso de pingers

Data______/__________/___________ Nº de pingers em simultâneo:_______

**1- Posição dos pingers**

| Hora (entrada na água) | |
|---|---|

| Hora (saída da água) | |
|---|---|

| | | | |
|---|---|---|---|
| Largado a Estibordo | Largado à popa | | |
| Lagardo a Bombordo | Largado à proa | | |

| | |
|---|---|
| Distância da embarcação a que foi largado (braças) | |
| Profundidade a que foi largado (braças) | |

| Hora (entrada na água) | |
|---|---|

| Hora (saída da água) | |
|---|---|

| | | | |
|---|---|---|---|
| Largado a Estibordo | Largado à popa | | |
| Lagardo a Bombordo | Largado à proa | | |

| | |
|---|---|
| Distância da embarcação a que foi largado (braças) | |
| Profundidade a que foi largado (braças) | |

**2- Operação de pesca**

Largada ☐ Alagem ☐

Outras embarcações de pesca (assinalar quantas):

a menos de 100m ☐ a menos de 200m ☐ a menos de 500m ☐ a mais de 500m ☐

embarcações identificadas:________________________________________________

**3- Mamíferos marinhos**

Apareceram? Não ☐ Sim ☐ Hora _________ Fotografaram? Não ☐ Sim ☐

Espécie: Roaz ☐ Golfinho comum/toninha mansa ☐ Orca ☐ Falsa Orca/ negro ☐

Outro?________________________ Nº de indivíduos __________ Nº de crias: ________

**4- Comportamento dos mamíferos avistados**

Atacaram o aparelho de pesca ☐ Quantidade perdida após ataque (kg) ____

Aproximaram-se da embarcação e afastaram-se, sem atacar ☐

Mudaram de rumo/ Afastaram-se ☐

| **Notas importantes:** |
|---|
| |

**Marine mammals registration form (English version)**

## Pingers form

Date_____/_________/__________ No. pingers simultaneously:_______

**1- Pingers positioning**

| | |
|---|---|
| Time (entrance in water) | |

| | |
|---|---|
| Time (exit water) | |

| | | | |
|---|---|---|---|
| Release to starboard | | Release to stern | |
| Release to larboard | | Release to bow | |

| | |
|---|---|
| Distance from vessel (fathom) | |
| Depth (fathom) | |

| | |
|---|---|
| Time (entrance in water) | |

| | |
|---|---|
| Time (exit water) | |

| | | | |
|---|---|---|---|
| Release to starboard | | Release to stern | |
| Release to larboard | | Release to bow | |

| | |
|---|---|
| Distance from vessel (fathom) | |
| Depth (fathom) | |

**2- Fishing operation**

Deployment ☐ Hauling ☐

Neraby fishing vessels (mark the number):

less than 100 m ☐ less than 200 m ☐ less than 50 0m ☐ over 500 m ☐

Identified vessels:____________________________________________

**3- Marine mammals**

Did they show up? No☐ Yes☐ Time ________ Photographed? No ☐ Yes ☐

Species: Bottlenose dolphin☐ Birdbeak common dolphin☐ Killer whale☐ False killer whale☐

Other?_____________________ No. individuals _________ No. calves: ________

**4- Behaviour of sighted mammals**

Attacked the gear ☐ Quantity lost after attack (kg) ________

Approached the vessel and turned away without attacking ☐

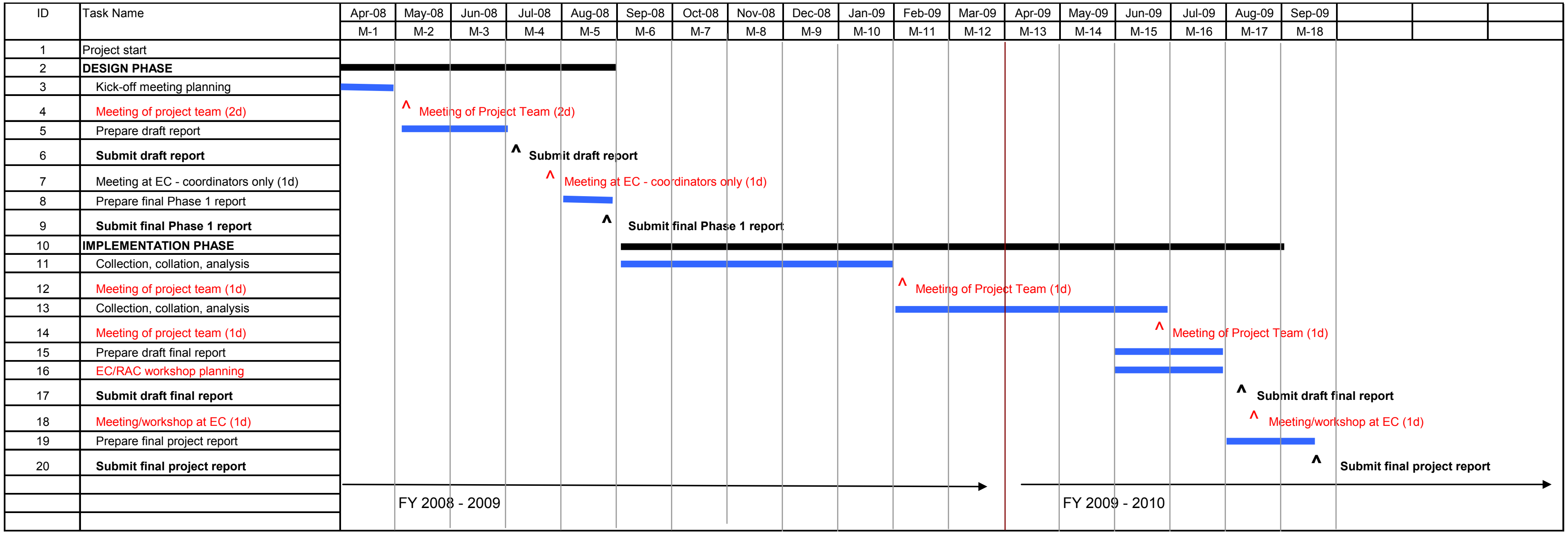
Turned away from vessel ☐

| |
|---|
| **Important notes:** |

## Acknowledgements

The FISH 2007/03 Lot 1 project team would like to thank all members of the fishing industry and scientific colleagues who contributed to the collection and analysis of data and who participated in very fruitful and informative discussions during the course of the project. We would also like to thank the anonymous reviewer from the European Commission who provided constructive comments which have helped to improve the report.

## Appendix 1. GANT Chart for Lot 1 project




Notes: Project extended to March 31 2010. February 2010 meeting of whole project team altered to meetings of individual pilot project teams where deemed necessary. June 2009 meeting delayed to December 15-16$^{th}$ 2010.

## Appendix 2. Project participants

| | Country | Name | Organisation | Role |
|---|---|---|---|---|
| **Industry** | | | | |
| | England | Paul Trebilcock | CFPO (NFFO) | Subcontractor |
| | England | Nathan de Rozarieux | Cornish Seafood | Subcontractor |
| | England | Chris Venmore | SDCSA | Subcontractor |
| | Scotland | Duncan MacInnes | WIF | Subcontractor |
| | Scotland | Alan Coghill | OFA | Subcontractor |
| | France | André Le Berre | CNPMEM | Subcontractor |
| | France | Jean Jacques Tanguy | CNPMEM | Subcontractor |
| | Ireland | Nora Parke | KFO | Subcontractor |
| | Ireland | Charles O Donnell | MHFC | Subcontractor |
| | Ireland | Sean O Donoghue | FIF | Subcontractor |
| | Belgium | Emiel Brouckaert | Rederscentrale | Subcontractor |
| | Belgium | Ben Desmyter | Rederscentrale | Subcontractor |
| | Belgium | Tom Craeynest | Rederscentrale | Subcontractor |
| | Spain | Victor Badiola | OPPAO & SWWRAC | Subcontractor |
| | Portugal | Manuel J. G. P. Santos | AP | Subcontractor |
| | Portugal | Carlos A. P. De O. Macedo | AP | Subcontractor |
| | Portugal | Joana Barosa | AP | Subcontractor |
| **Science** | | | | |
| | England | Mike Armstrong | Cefas | Lead |
| | England | Mike Smith | Cefas | Partner |
| | England | Andrew Lawler | Cefas | Partner |
| | Ireland | Norman Graham | Marine institute | Partner |
| | Ireland | Eoghan Kelley | Marine institute | Partner |
| | Ireland | Oliver Tulley | BIM&Marine Institute | Partner |
| | France | Martial Laurens | Ifremer | Partner |
| | Spain | Jon Ruiz Gondra | AZTI | Partner |
| | Spain | Iñaki Artetxe | AZTI | Partner |
| | Spain | Estanis Mugerza | AZTI | Partner |
| | Portugal | Ivone Figueiredo | IPIMAR | Partner |
| | Portugal | Pedro Bordalo-Machado | IPIMAR | Partner |
| | Portugal | Teresa Moura | IPIMAR | Partner |
| | Portugal | Inês Farias | IPIMAR | Partner |
| | Portugal | Olga Moura | IPIMAR | Partner |
| | Belgium | Sophie Vandemaele | ILVO | Partner |
| | Belgium | Sophie Nimmegeers | ILVO | Partner |
| | Belgium | Hans Polet | ILVO | Partner |
| | Belgium | Wim Demaré | ILVO | Partner |
| | Scotland | Aileen Mill / Susan Lusseau | FRS | Partner |

# Joint data collection between the fishing sector and the scientific community in Western Waters

**FINAL REPORT to the European Commission Directorate-General for the Fisheries and Maritime Affairs**

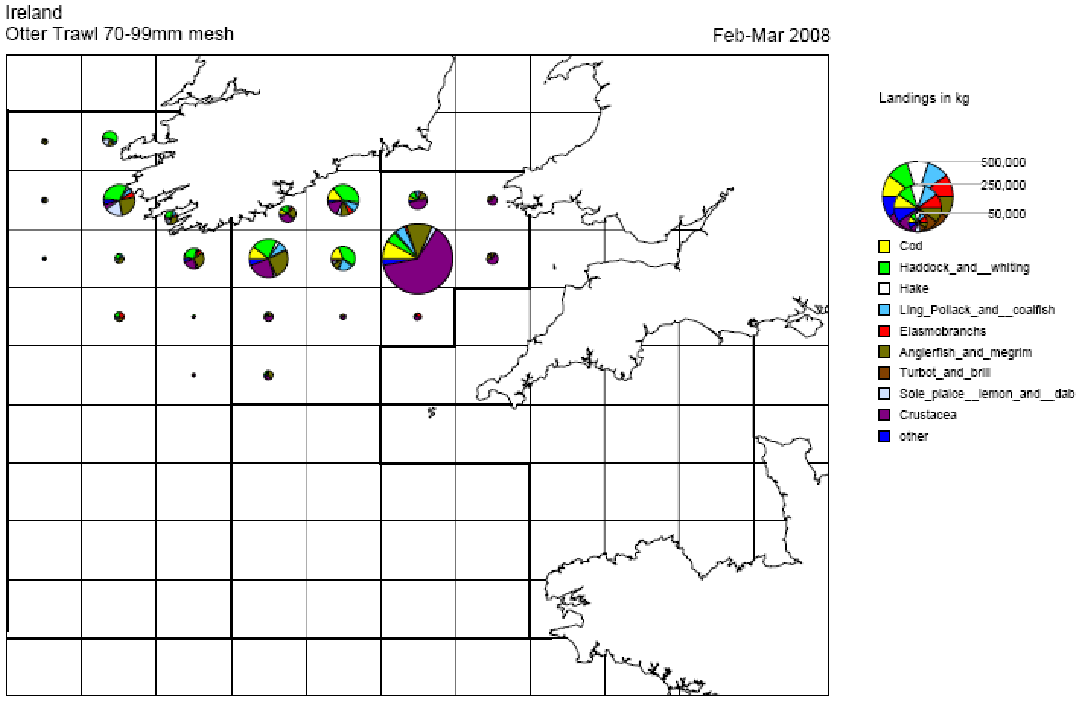
Contract SI2.491885, Ref. FISH/2007/03 Lot 1.

## *Appendix 3.*

### *Species composition plots by season, fleet sector and ICES rectangle for Pilot Project 2: Development of a fishery information report for demersal fisheries in the Celtic Sea and western Channel (Section 3).*

The following maps, which should be viewed in colour, present the species compositions of reported landings by ICES rectangle during four periods in 2008, for a range of different gear types and mesh size bands used by otter trawlers, beam trawlers and fixed-netters targeting demersal species in the Celtic Sea area. The pie diagram centered on each ICES rectangle is scaled so that the radius of the circle is proportional to the landed weight of all species. Note that the scaling is the same for all periods and mesh bands in each national gear type, but varies between countries and gear types. The pie diagrams are centred over each ICES rectangle and therefore do not reflect the distribution of landings within a rectangle.

Note that data for BELGIUM cover only VIIf,g & h; data for IRELAND covers VIIf,g,h&j whilst data for the UK and FRANCE cover VIIe,f,g,h &j.



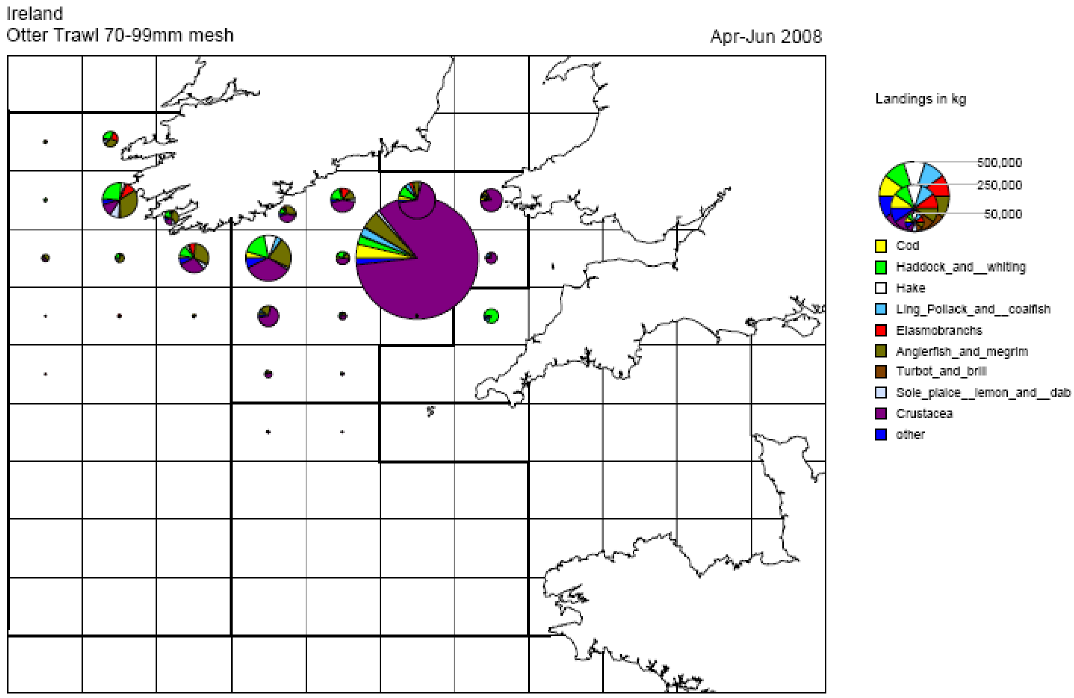
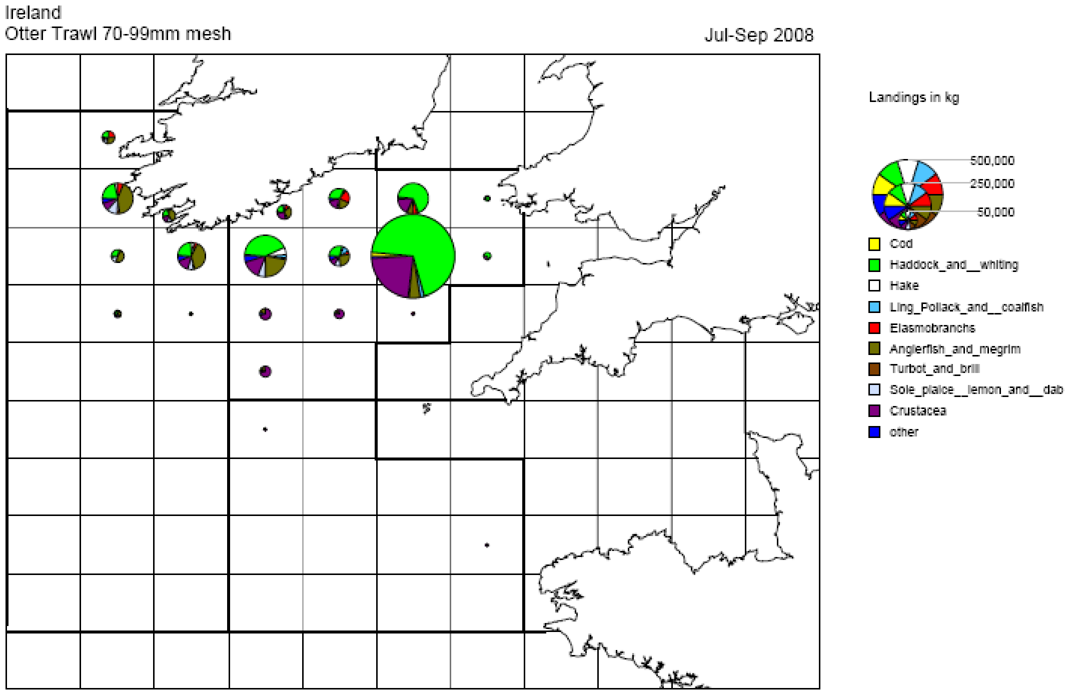




**Fig A-3.1a**. Ireland: demersal otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



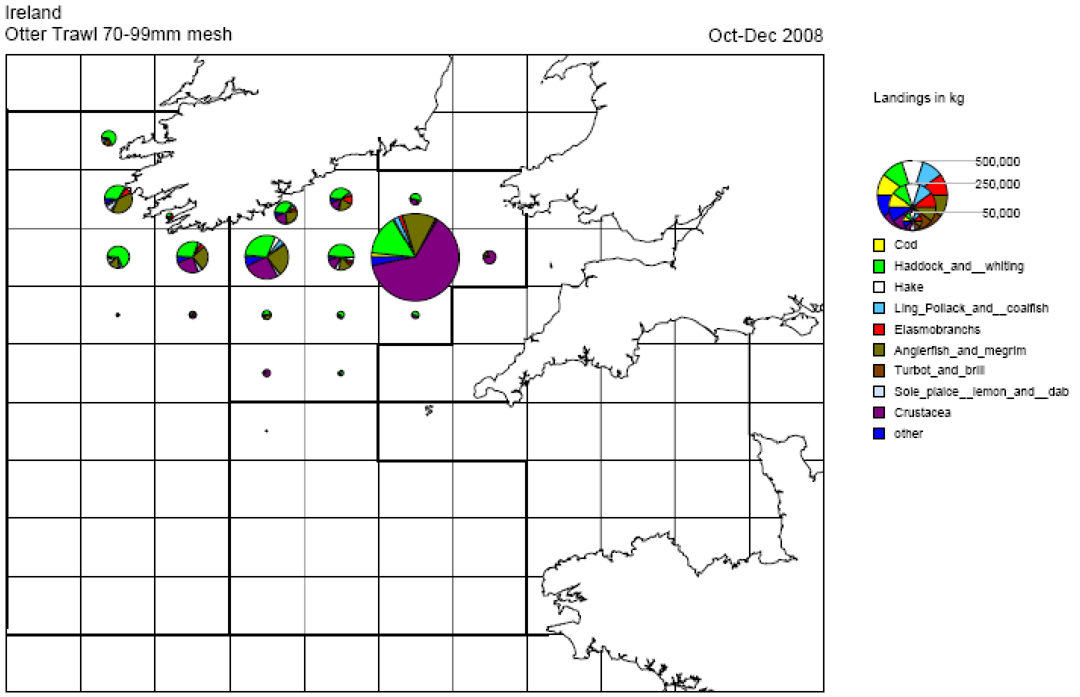
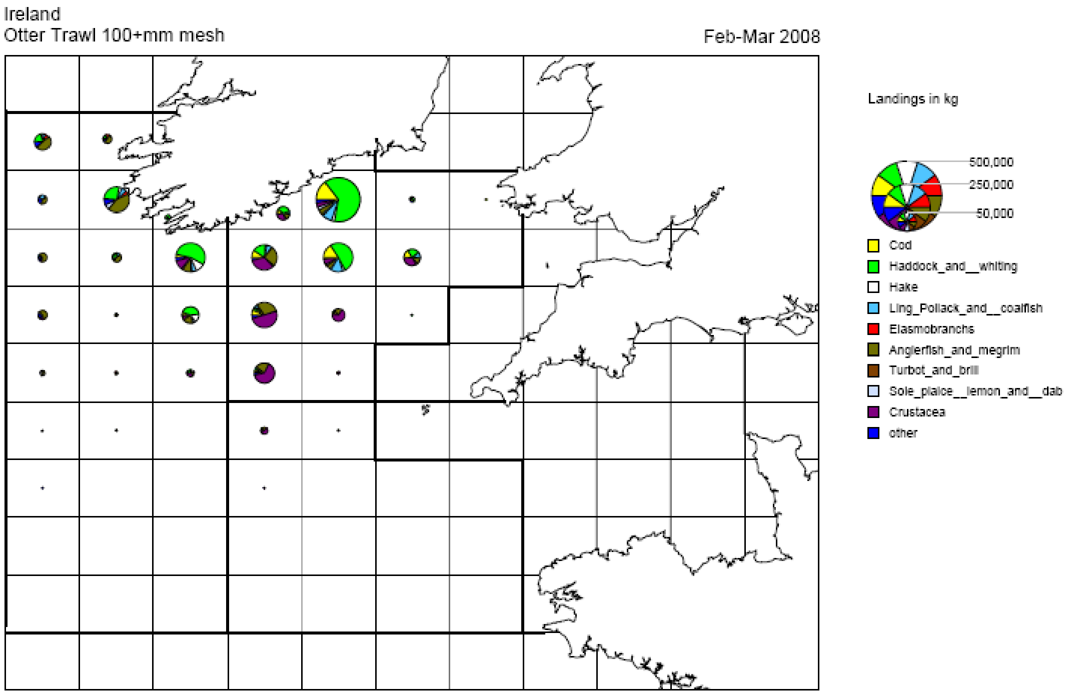




**Fig A-3.1b**. Ireland: demersal otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for July-September and October - December 2008



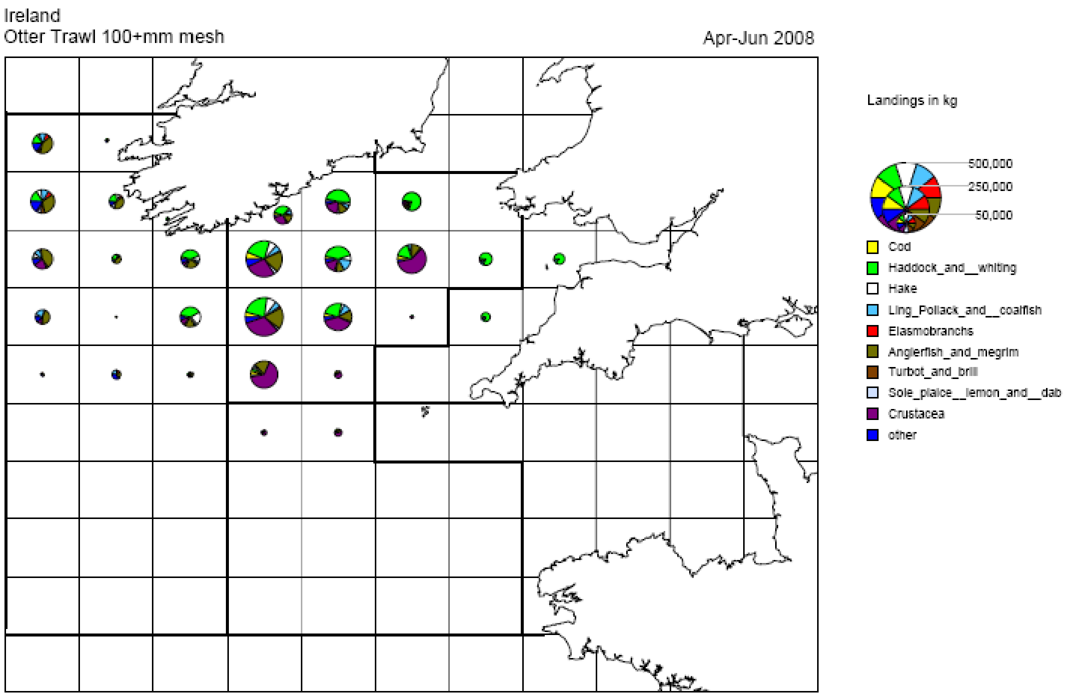
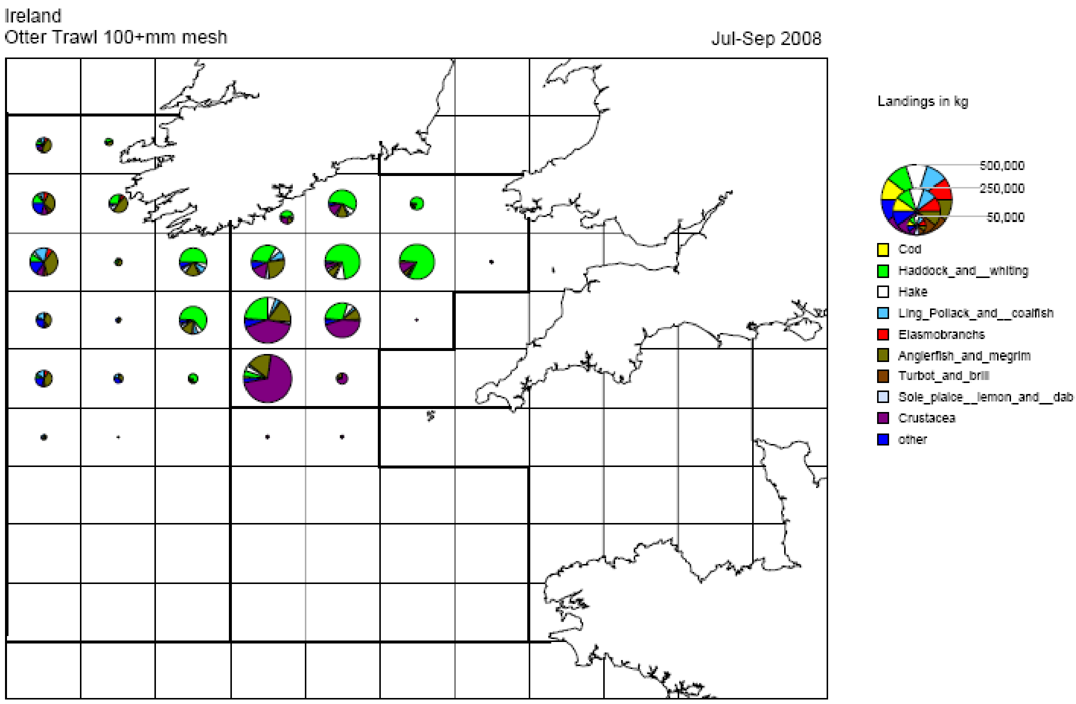




**Fig A-3.2a**. Ireland: demersal otter trawlers (all LOA) using 100mm and over mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



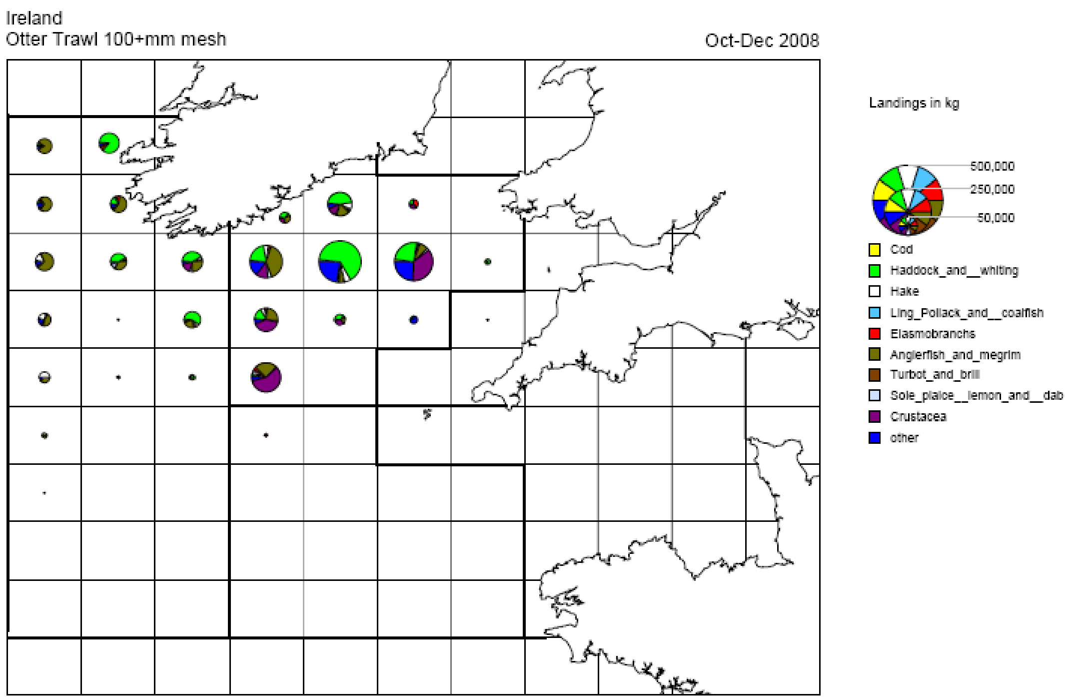
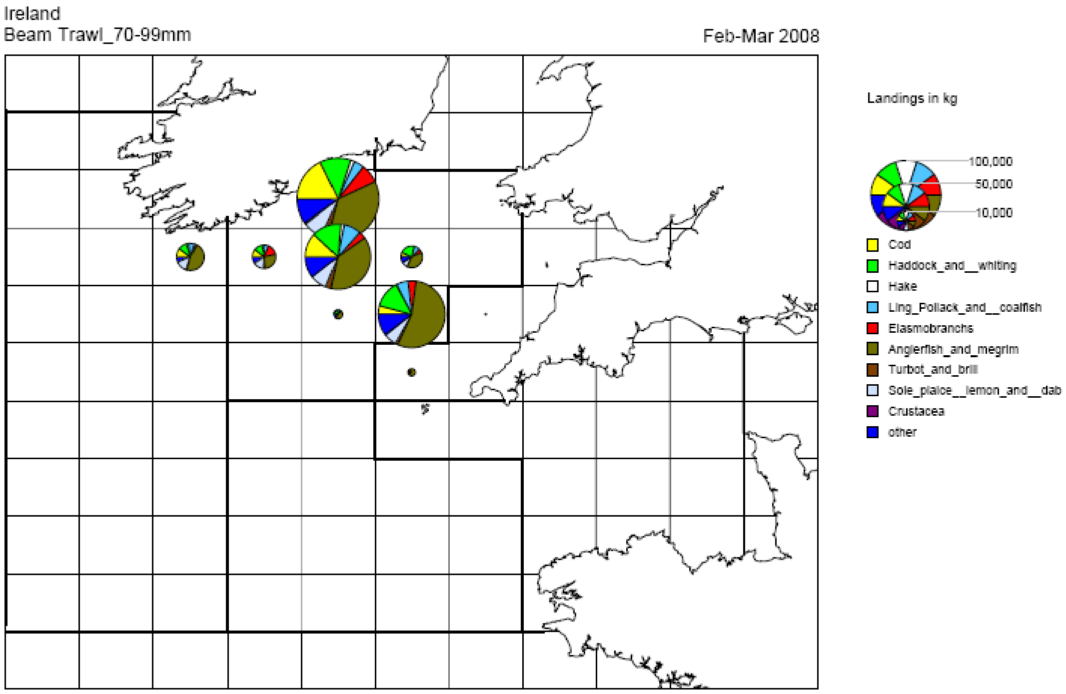




**Fig A-3.2b**. Ireland: demersal otter trawlers (all LOA) using 100mm and over mesh: Species composition by ICES rectangle for July-September and October - December 2008



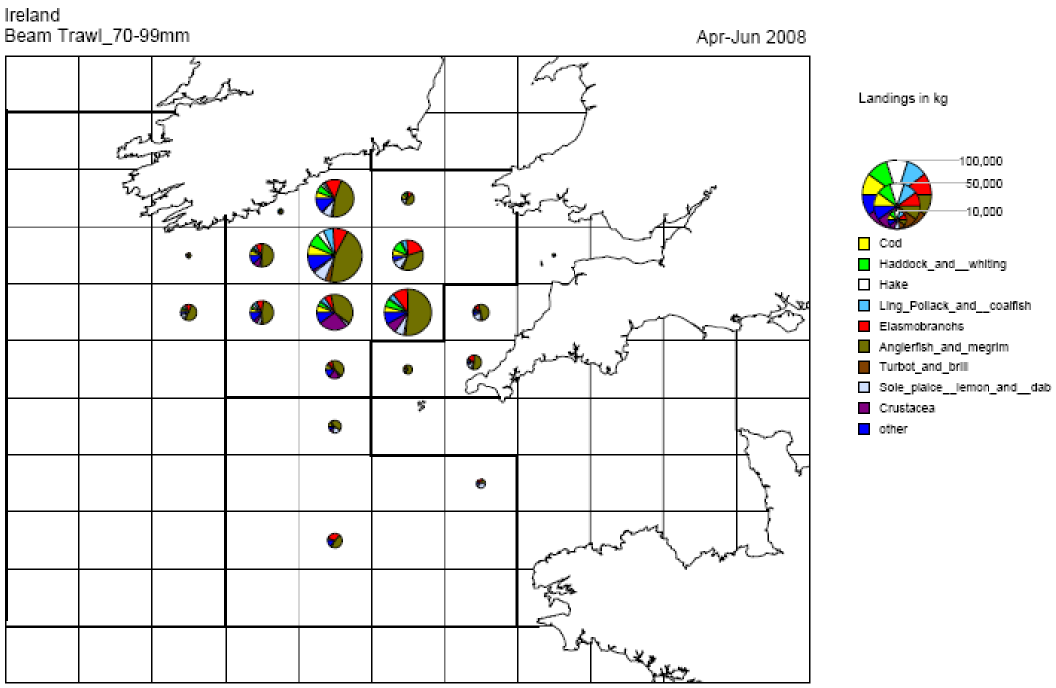
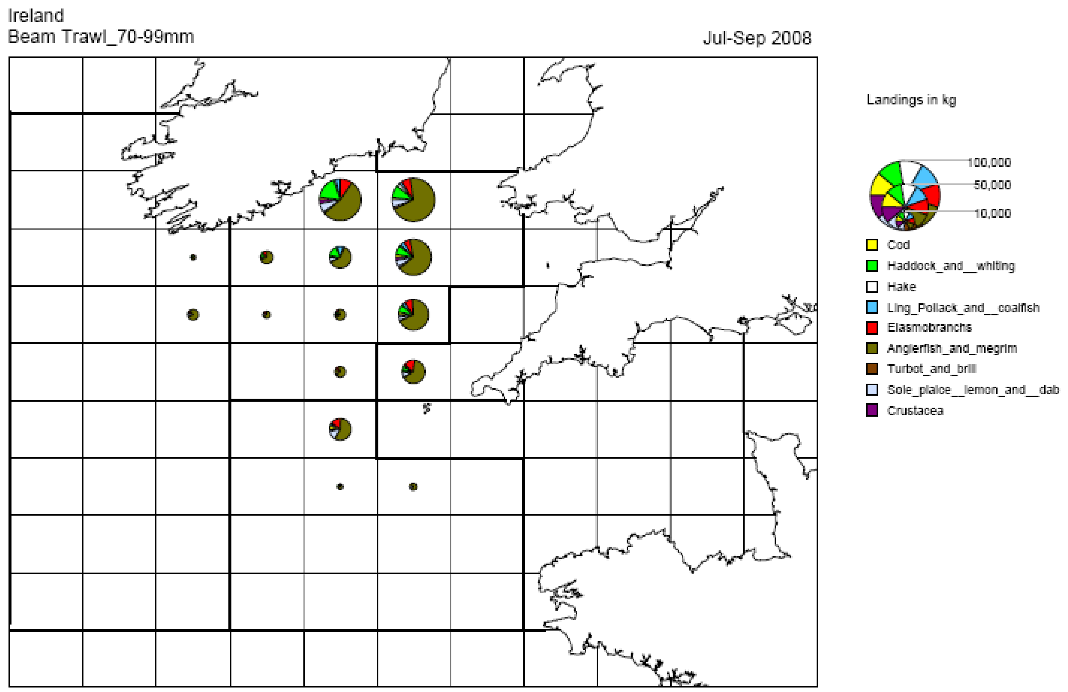




**Fig A-3.3a**. Ireland: beam trawlers (all LOA) using 70-99 mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



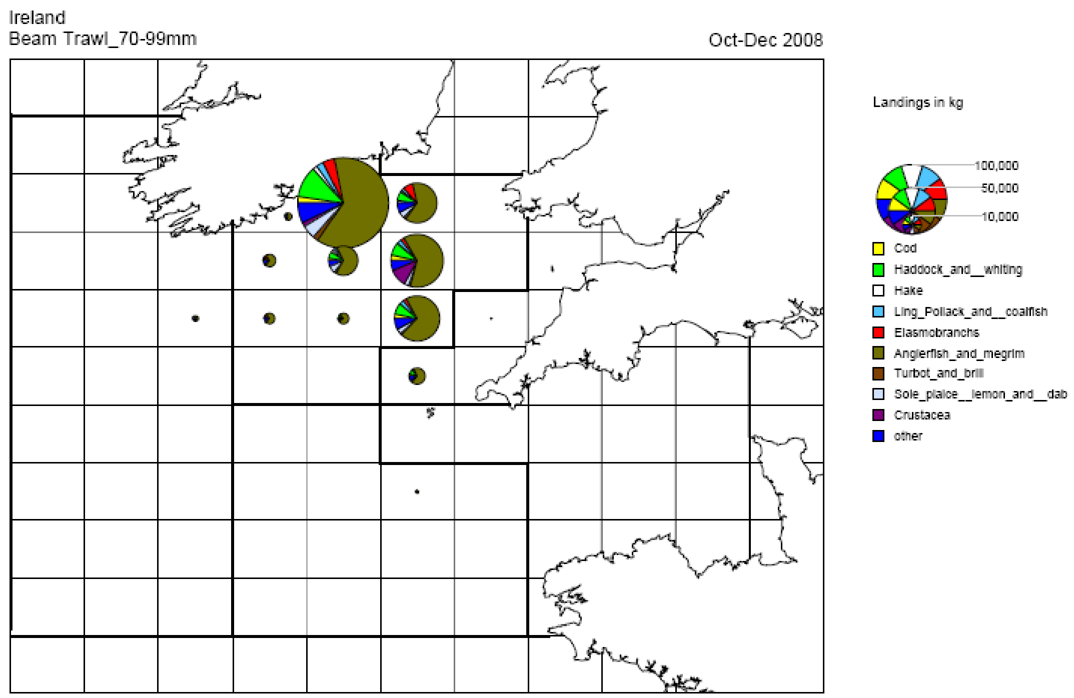
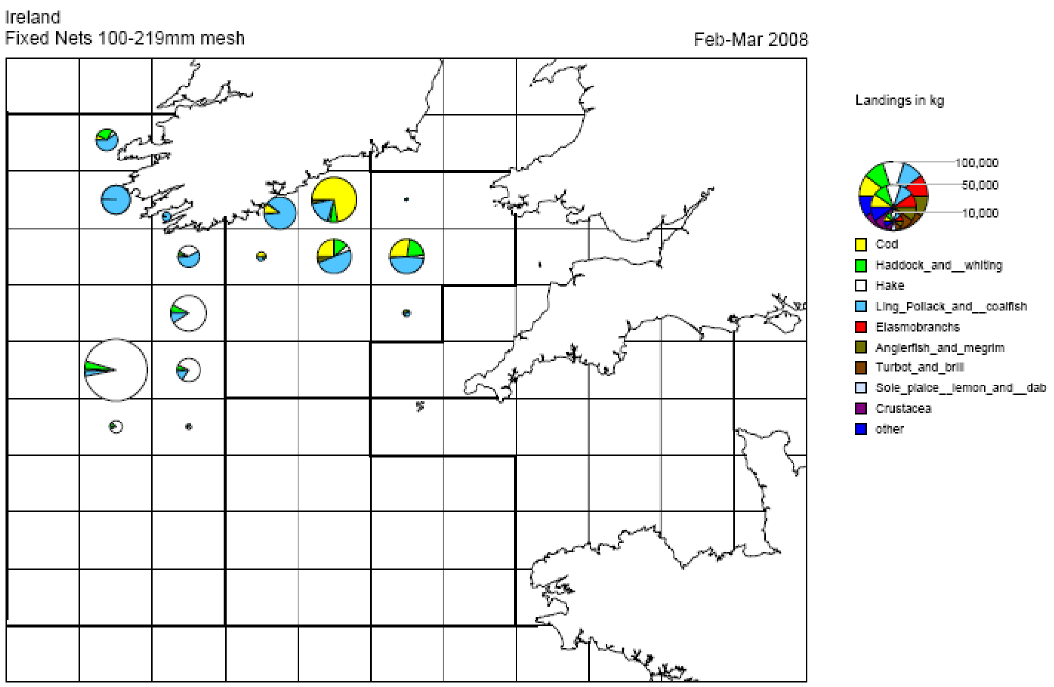




**Fig A-3.3b**. Ireland: beam trawlers (all LOA) using 70-99 mm mesh: Species composition by ICES rectangle for July-September and October - December 2008



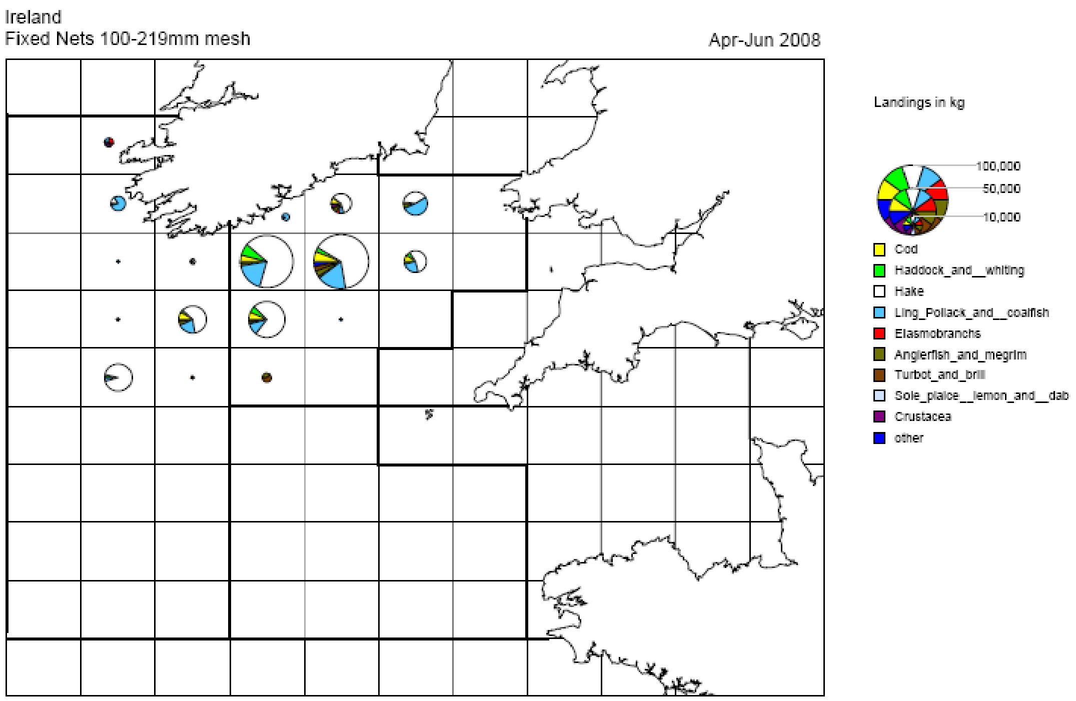
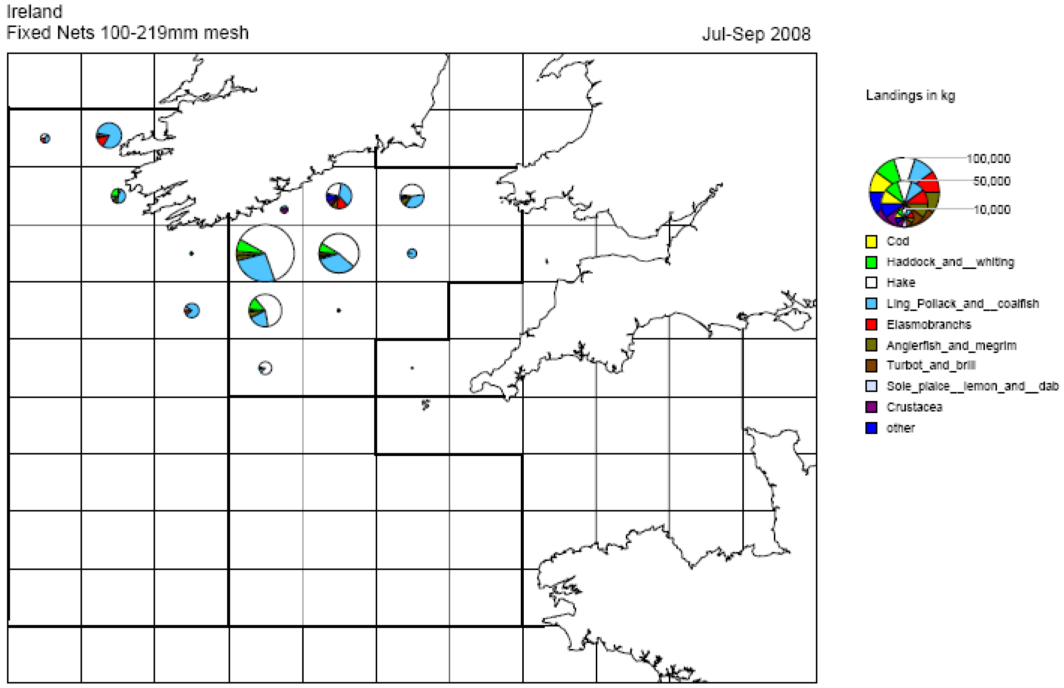




**Fig. A-3.4a**. Ireland: Fixed netters (all LOA) using 100 - 219 mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



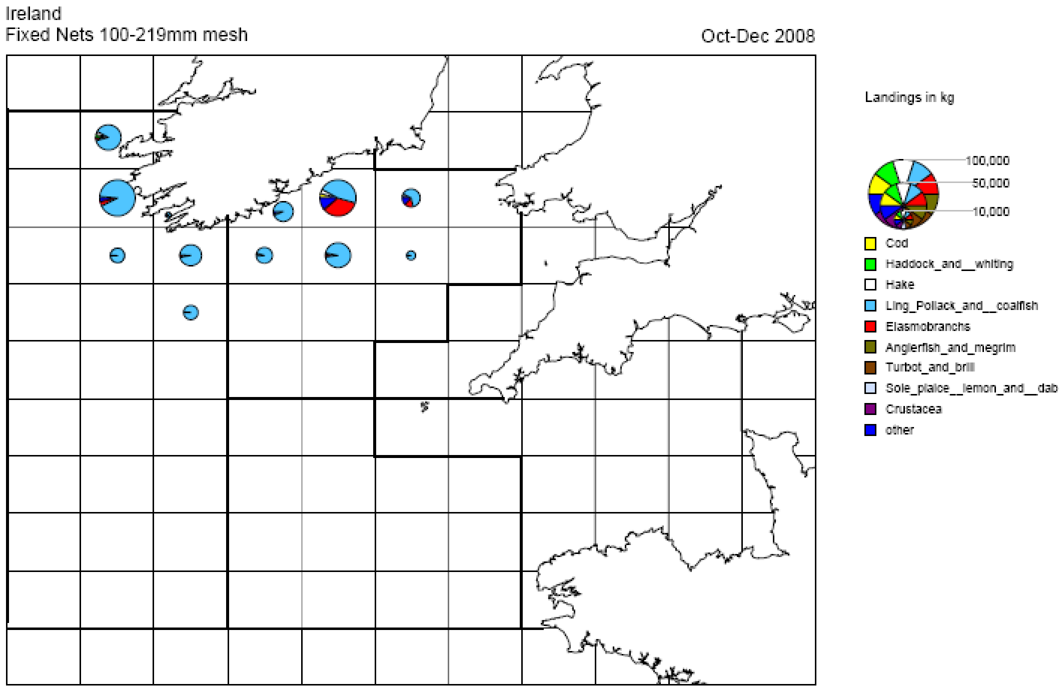
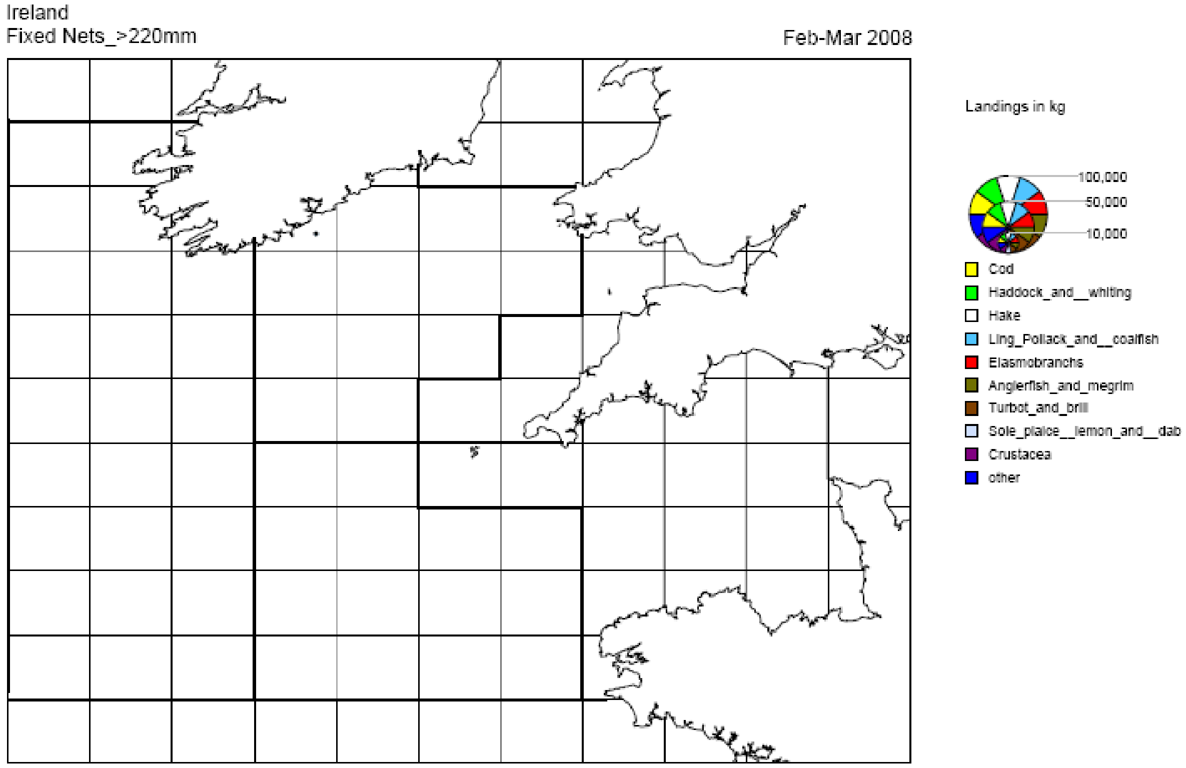




**Fig A-3.4b**. Ireland: fixed netters (all LOA) using 100-219 mm mesh: Species composition by ICES rectangle for July-September and October - December 2008



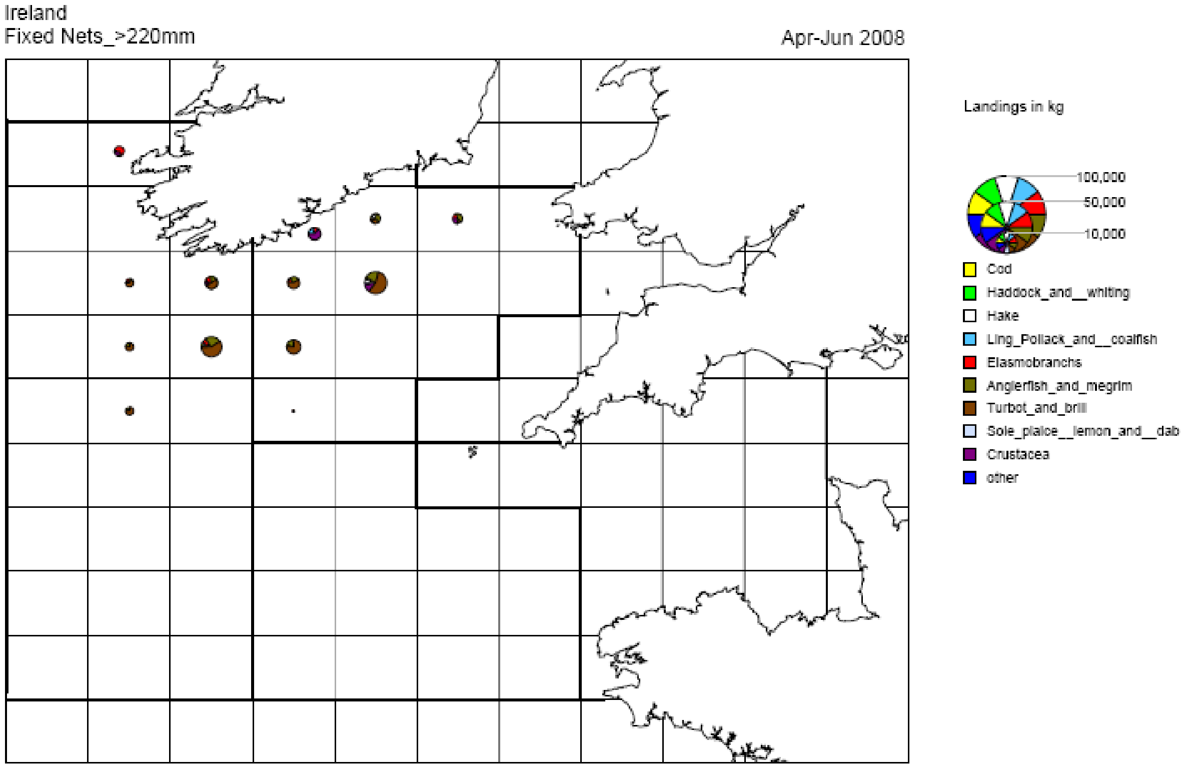
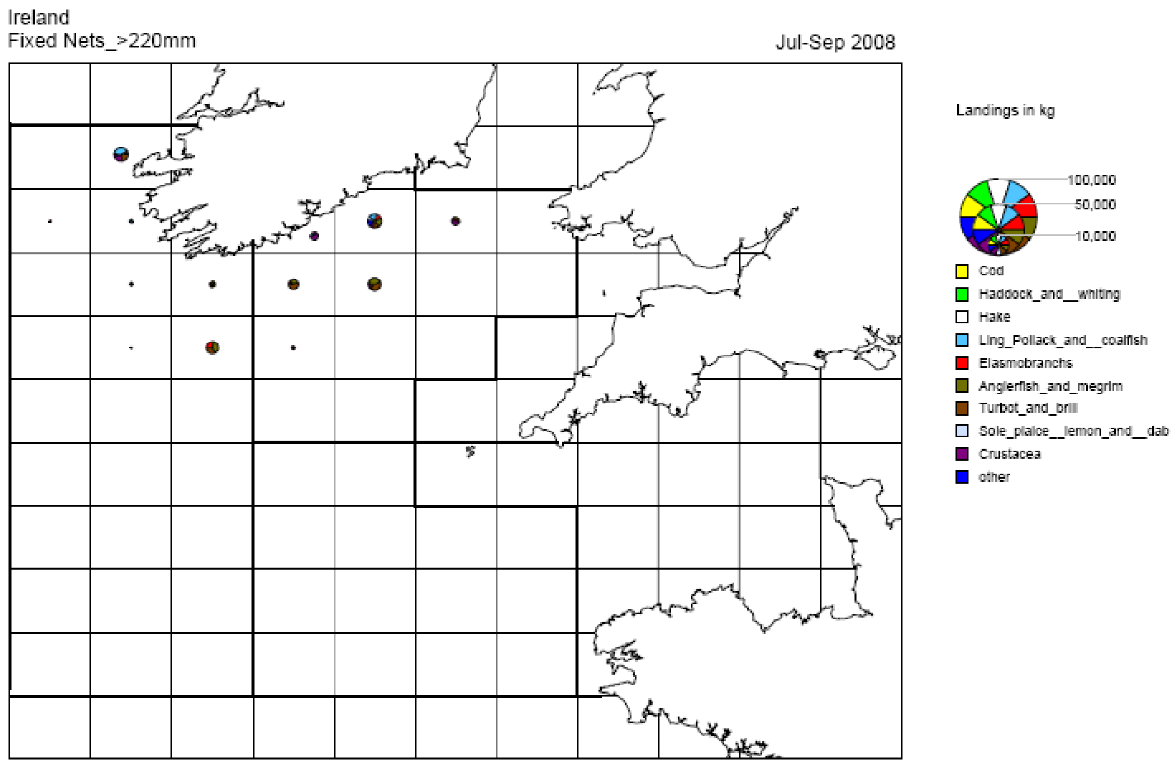




**Fig. A-3.5a**. Ireland: Fixed netters (all LOA) using 220 mm and over mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



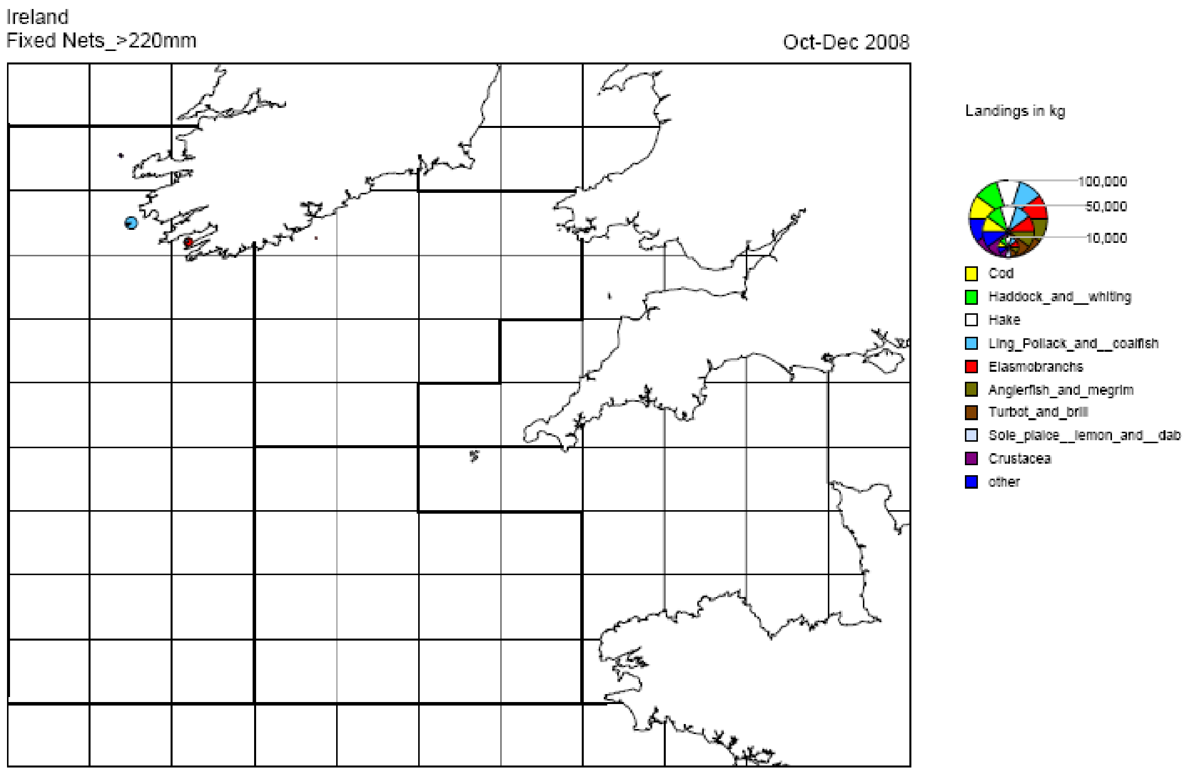
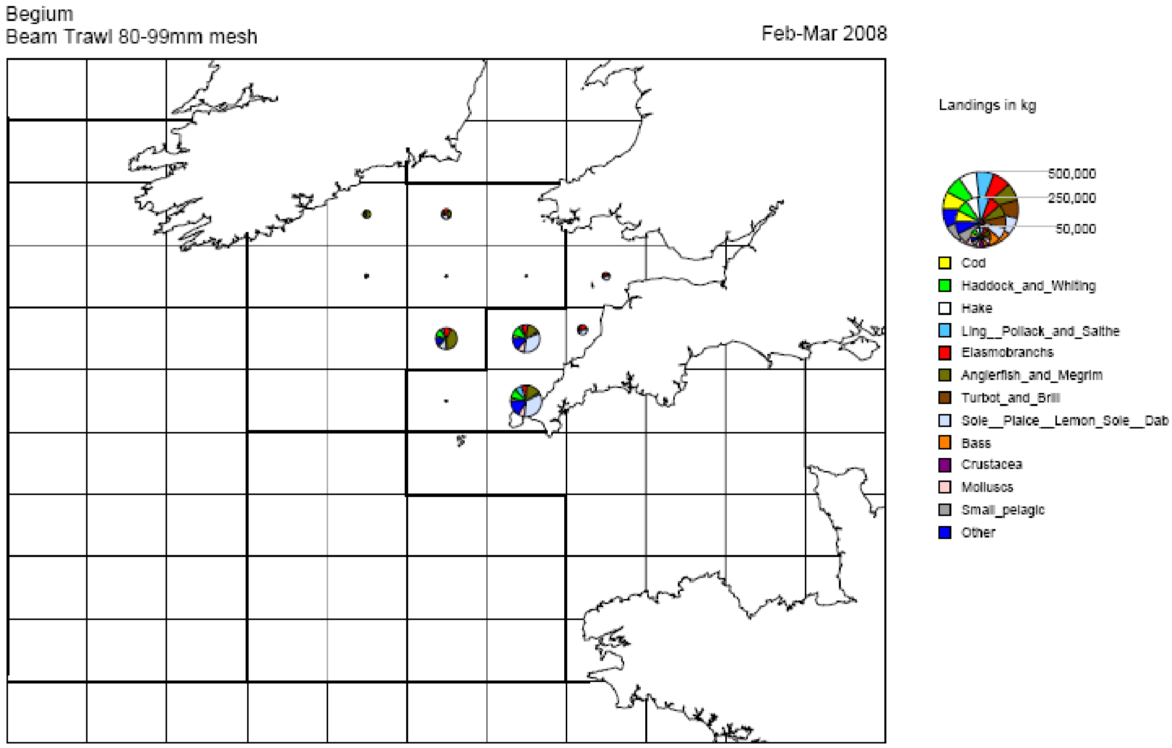




**Fig A-3.5b**. Ireland: fixed netters (all LOA) using 220mm and over mesh: Species composition by ICES rectangle for July-September and October - December 2008



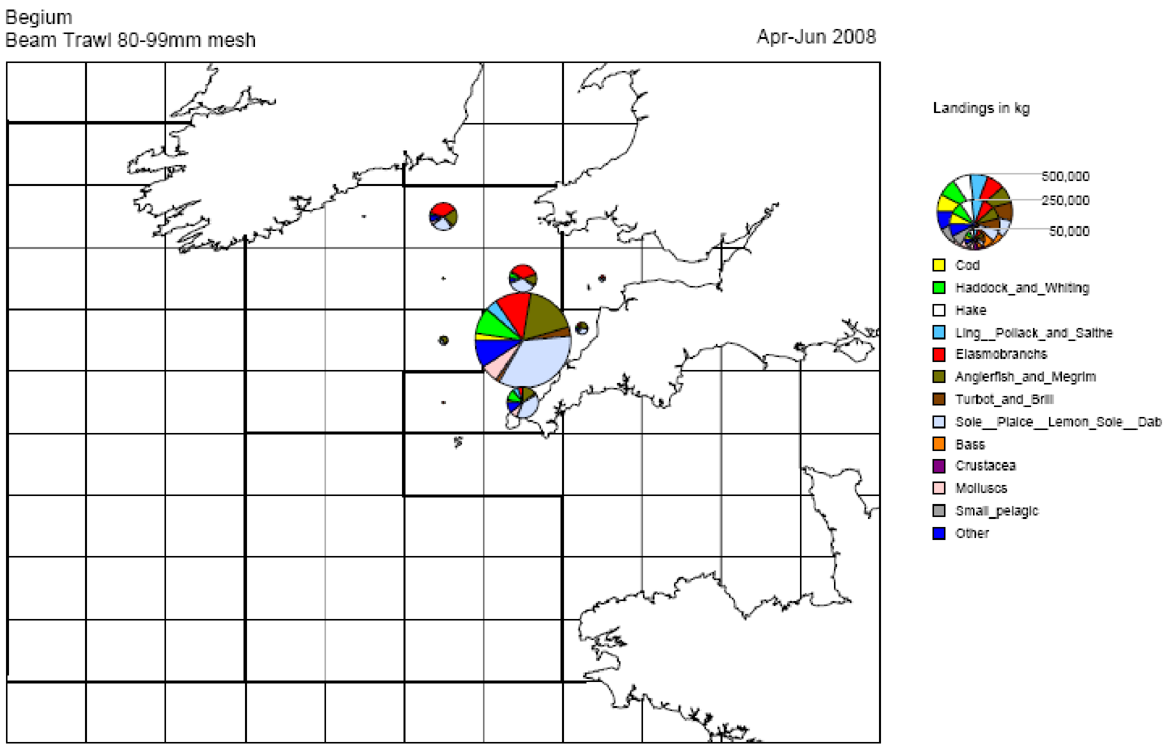
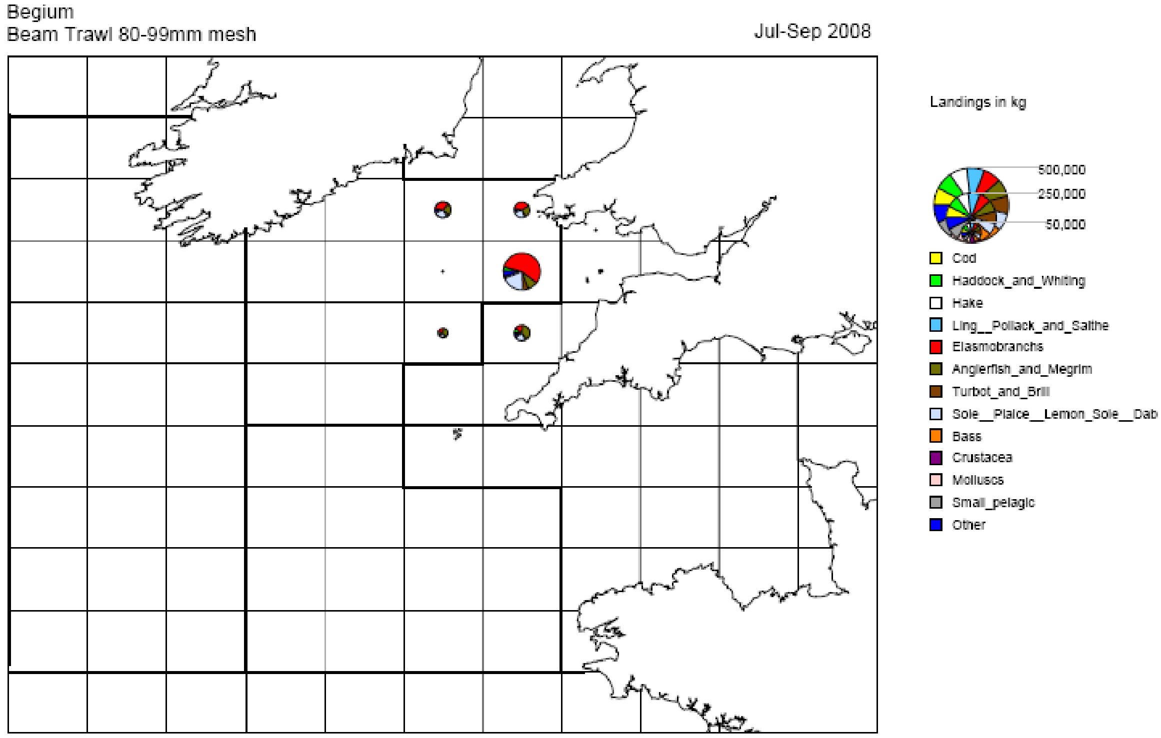




**Fig A-3.6a**. Beam: beam trawlers (all LOA) using 80-99 mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008. *Please take into account that the data are based on the auction date instead of the fishing date, which results in a minor temporal shift.* Source: 'national database'



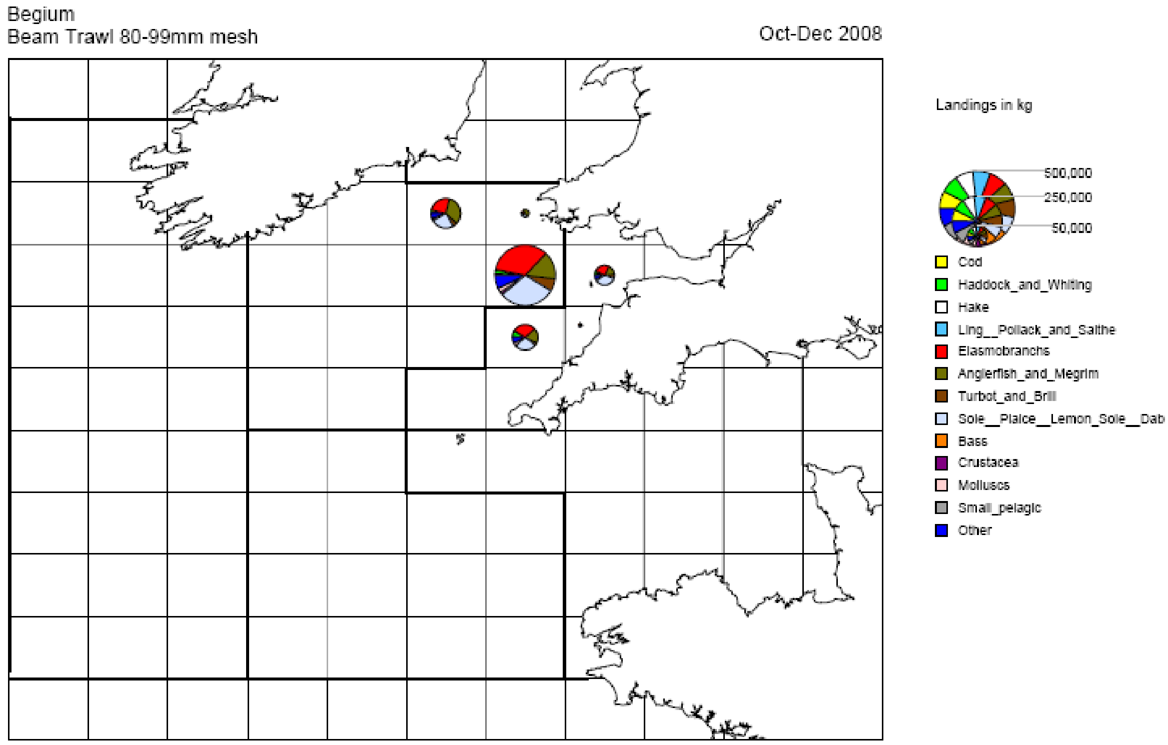
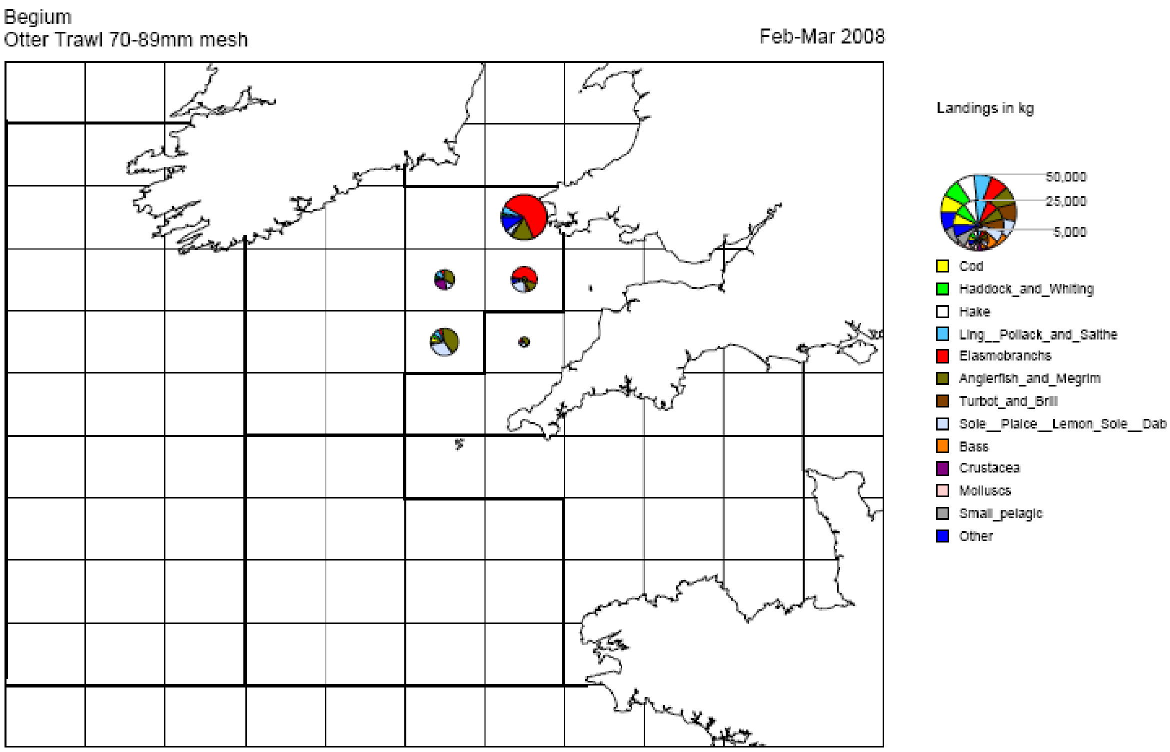




**Fig A-3.6b**. Belgium: beam trawlers (all LOA) using 80-99 mm mesh: Species composition by ICES rectangle for July-September and October - December 2008. *Please take into account that the data are based on the auction date instead of the fishing date, which results in a minor temporal shift.* Source: 'national database'



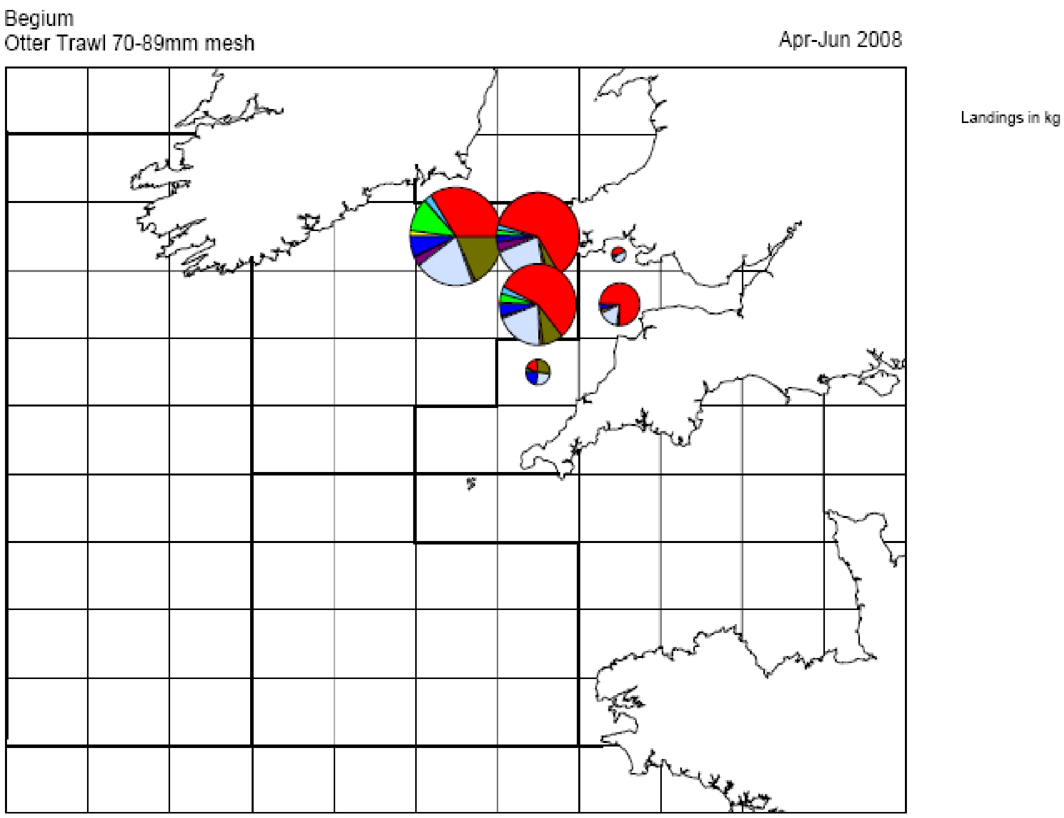




**Fig A-3.7a**. Belgium: demersal otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008. *Please take into account that the data are based on the auction date instead of the fishing date, which results in a minor temporal shift.* Source: 'national database'

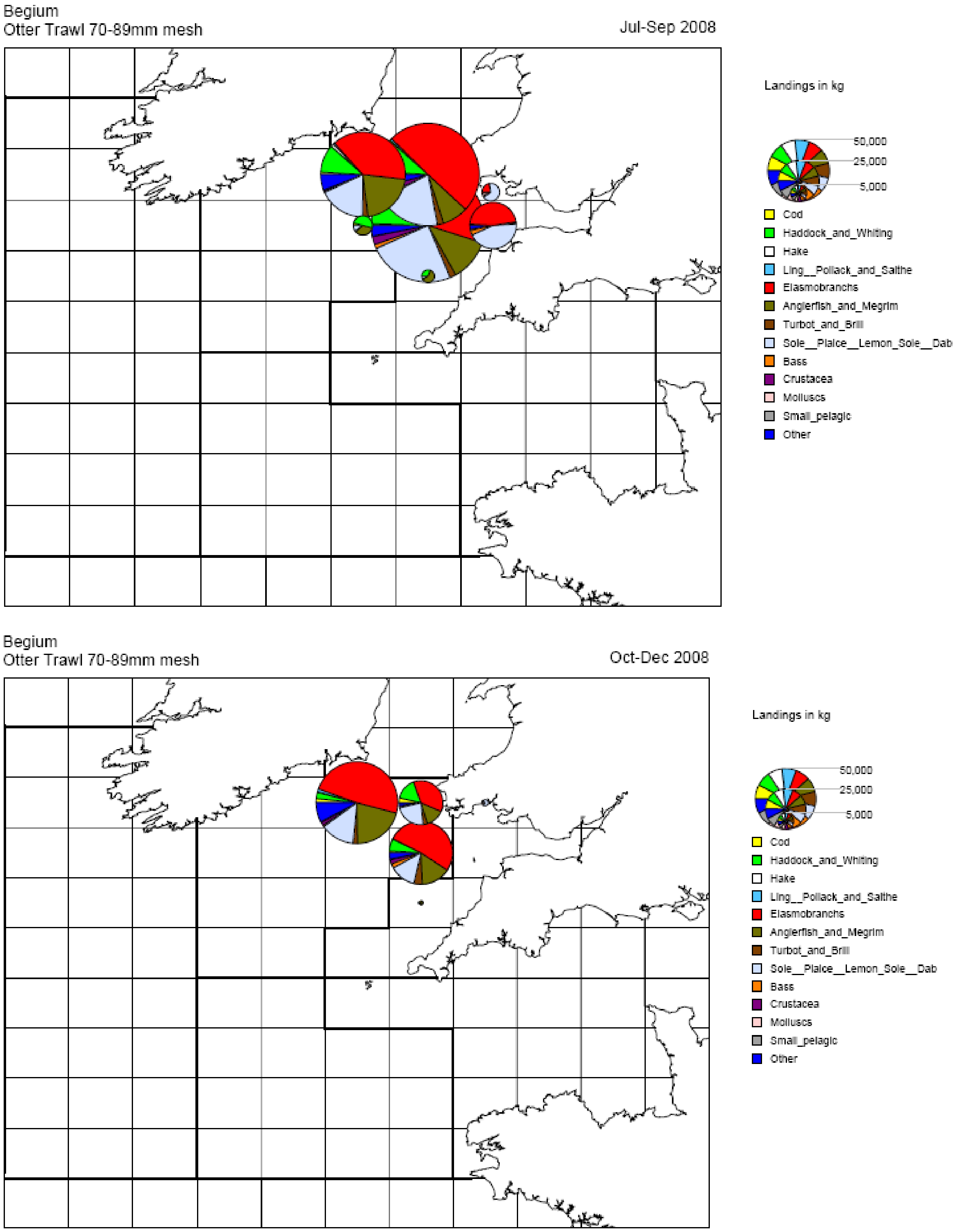



**Fig A-3.7b**. Belgium: demersal otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for July-September and October - December 2008. *Please take into account that the data are based on the auction date instead of the fishing date, which results in a minor temporal shift.* Source: 'national database'

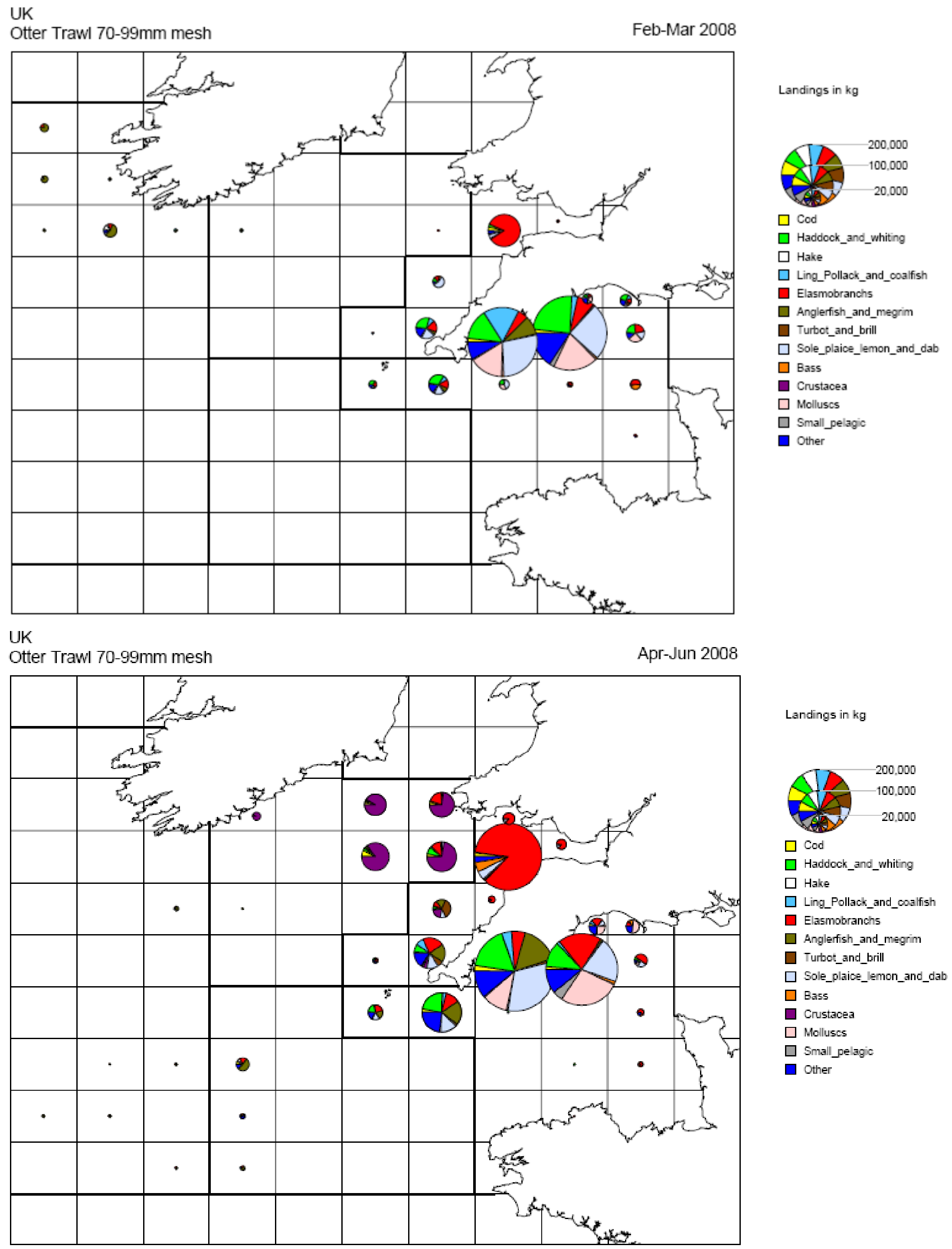
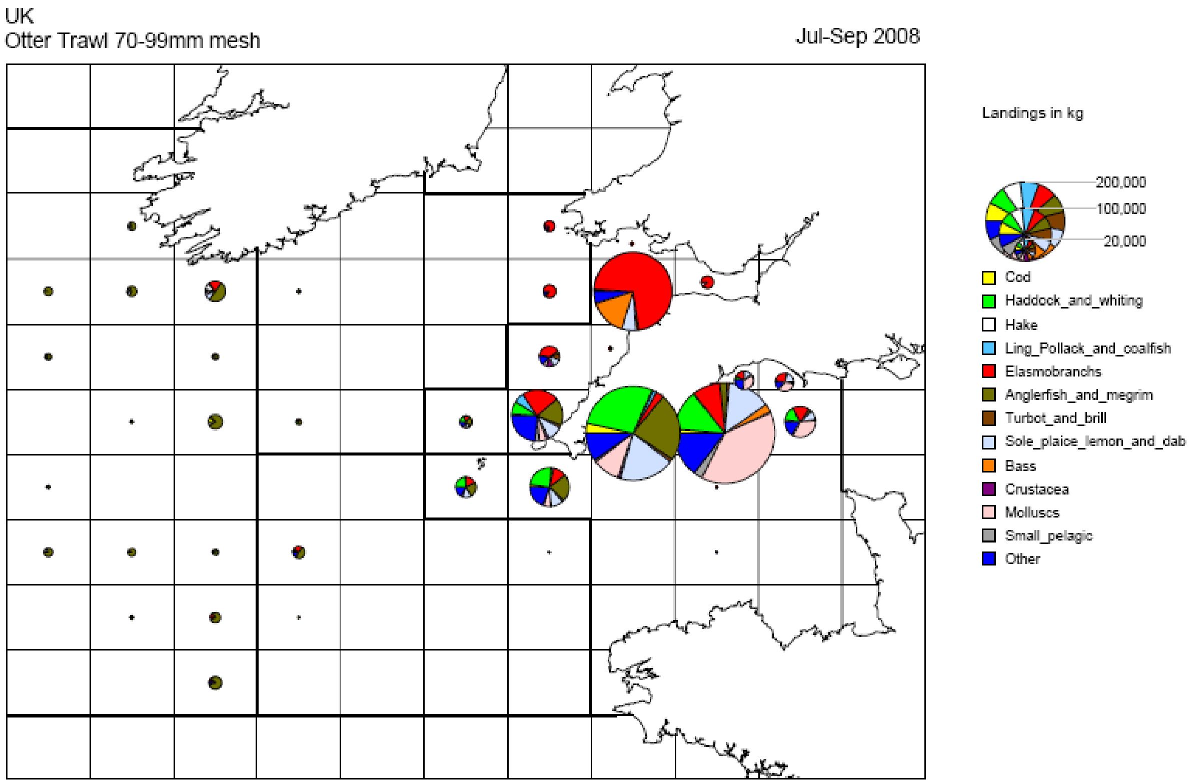



**Fig. A-3.8a**. UK demersal otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



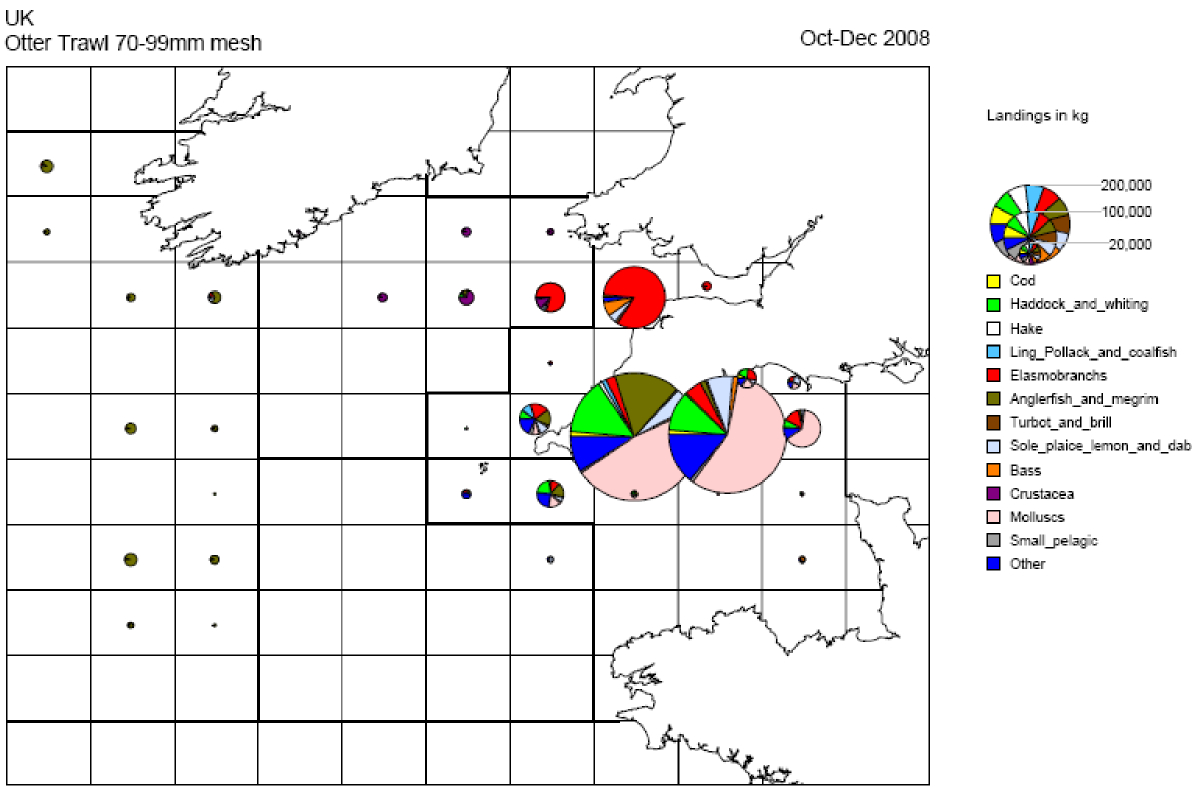
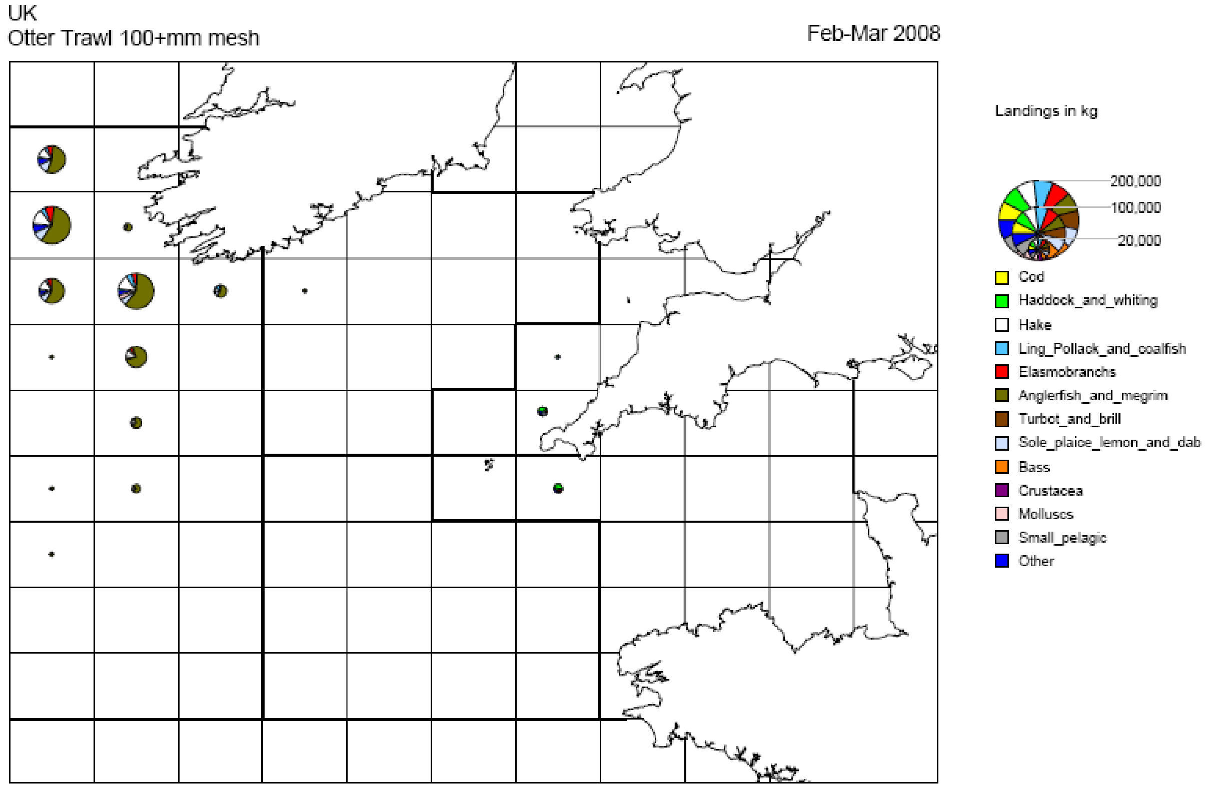




**Fig. A-3.8b**. UK demersal otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for July – September and October-December 2008



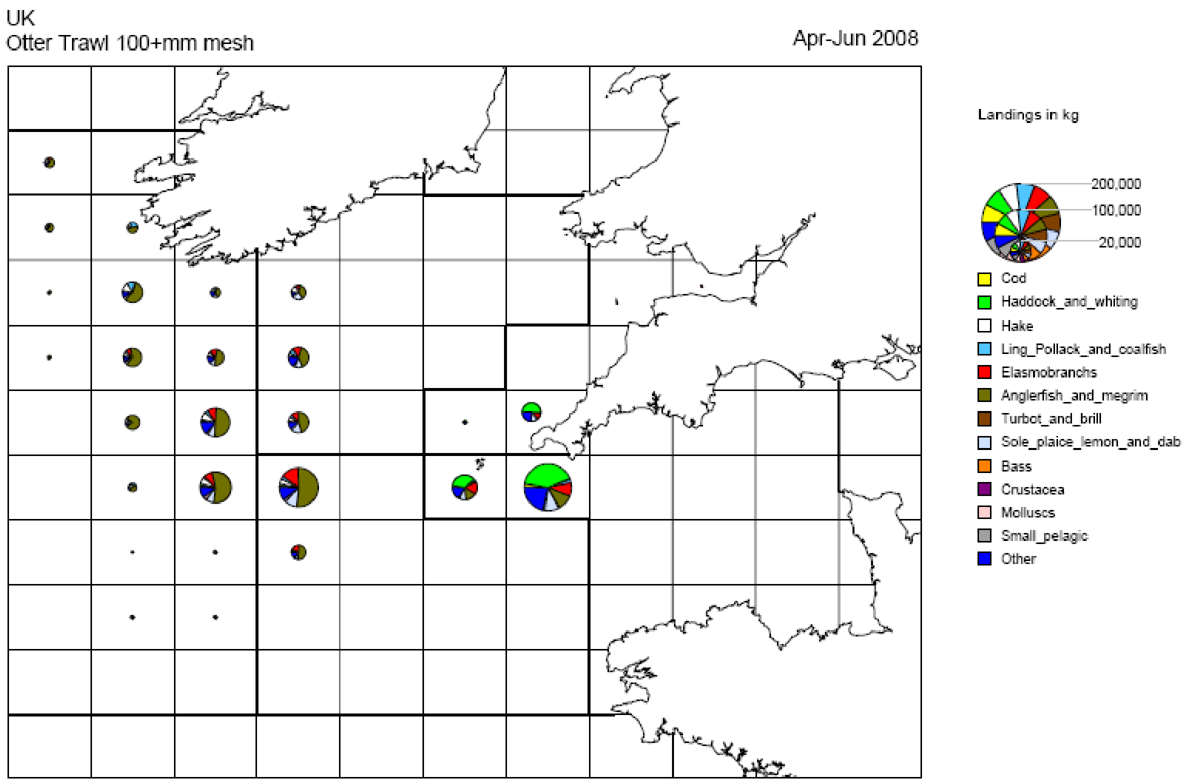
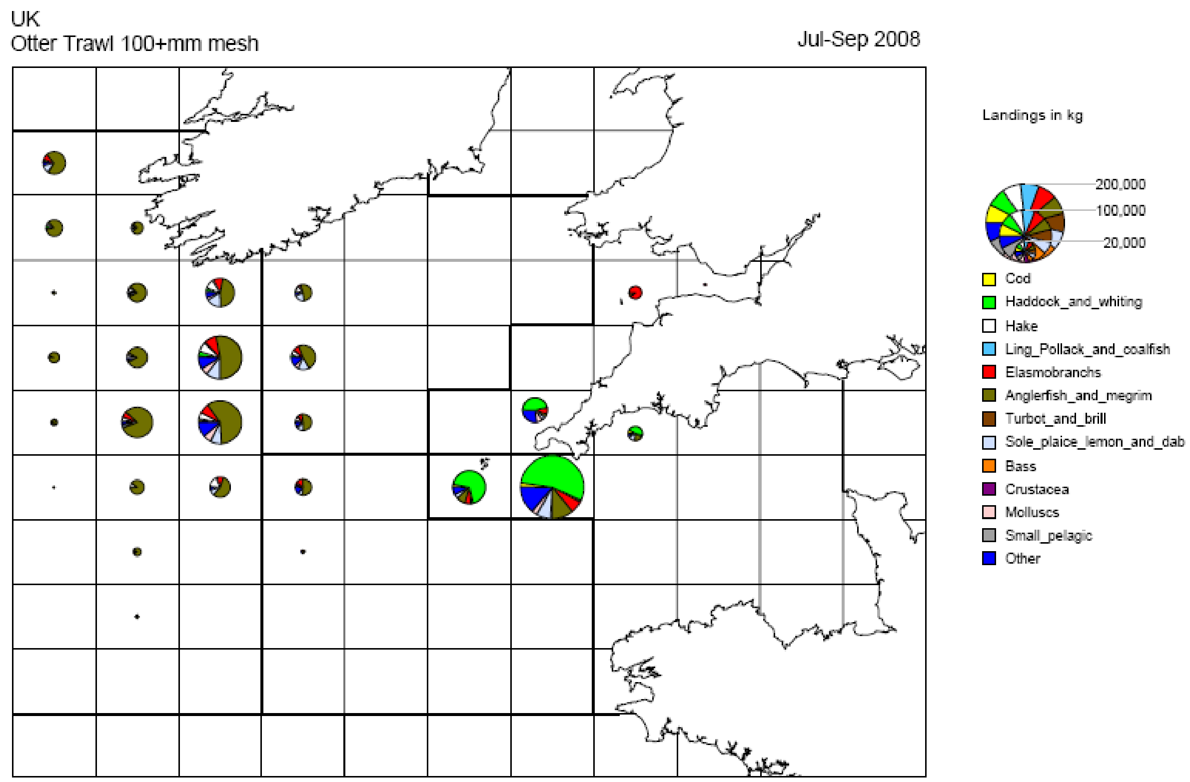




**Fig. A-3.9a**. UK demersal otter trawlers (all LOA) using 100mm+ mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008



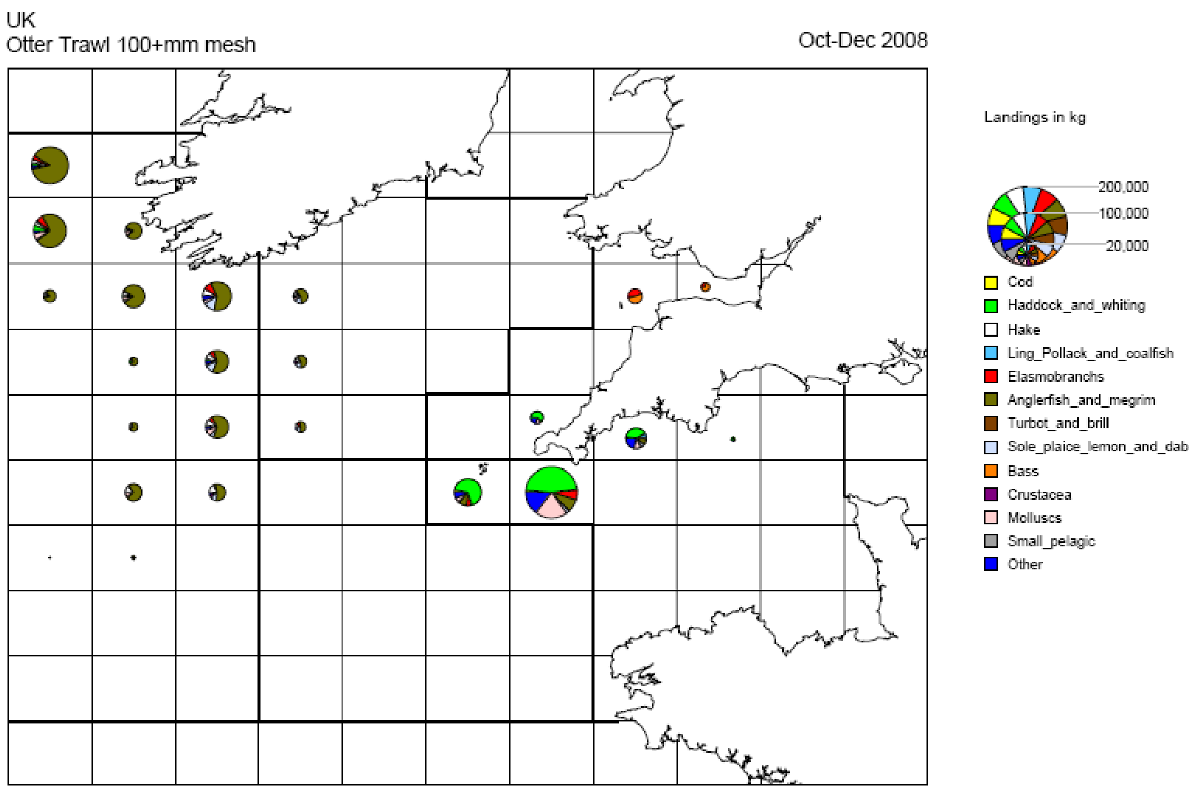




**Fig. A-3.9b**. UK demersal otter trawlers (all LOA) using 100mm+ mesh: Species composition by ICES rectangle for July – September and October-December 2008

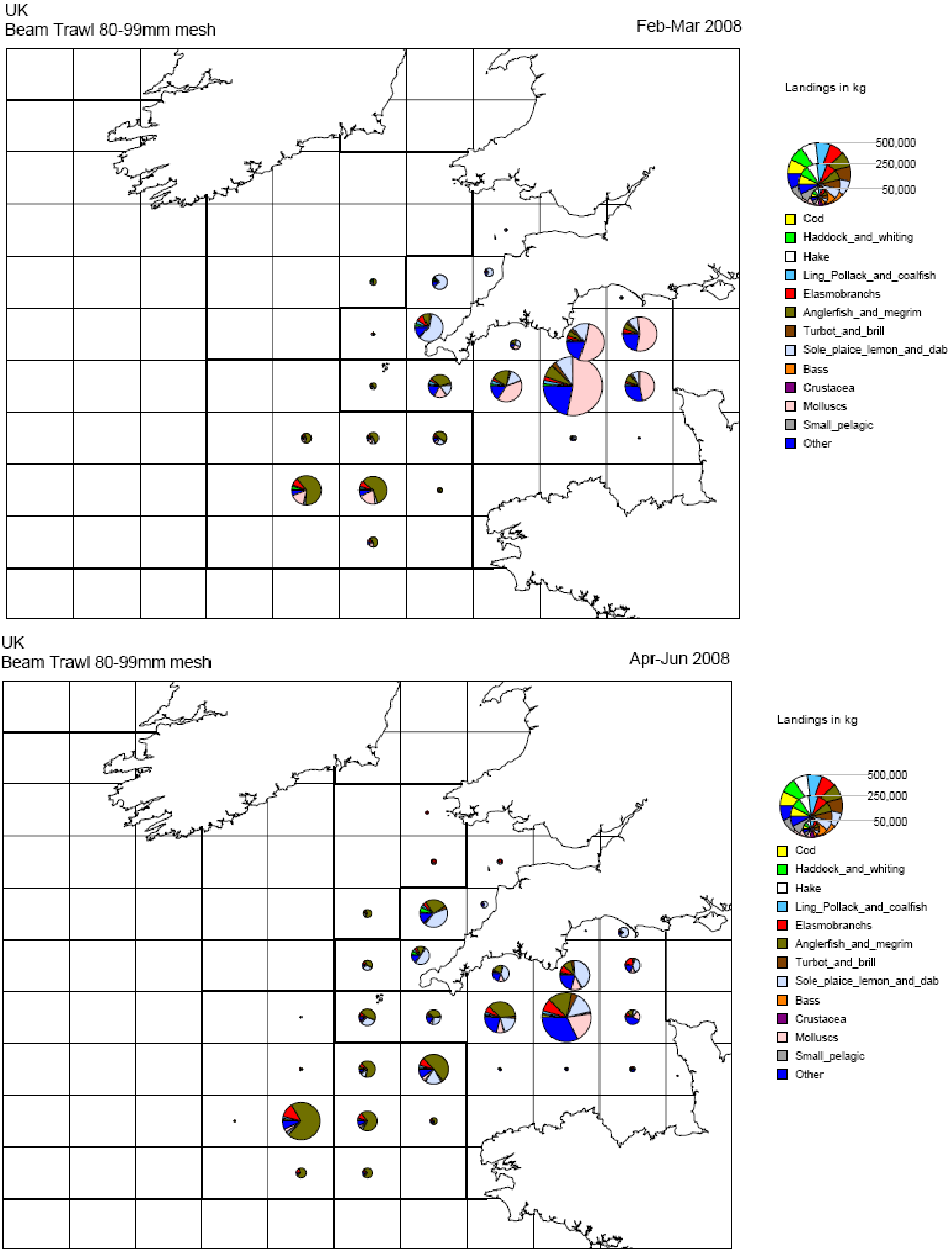
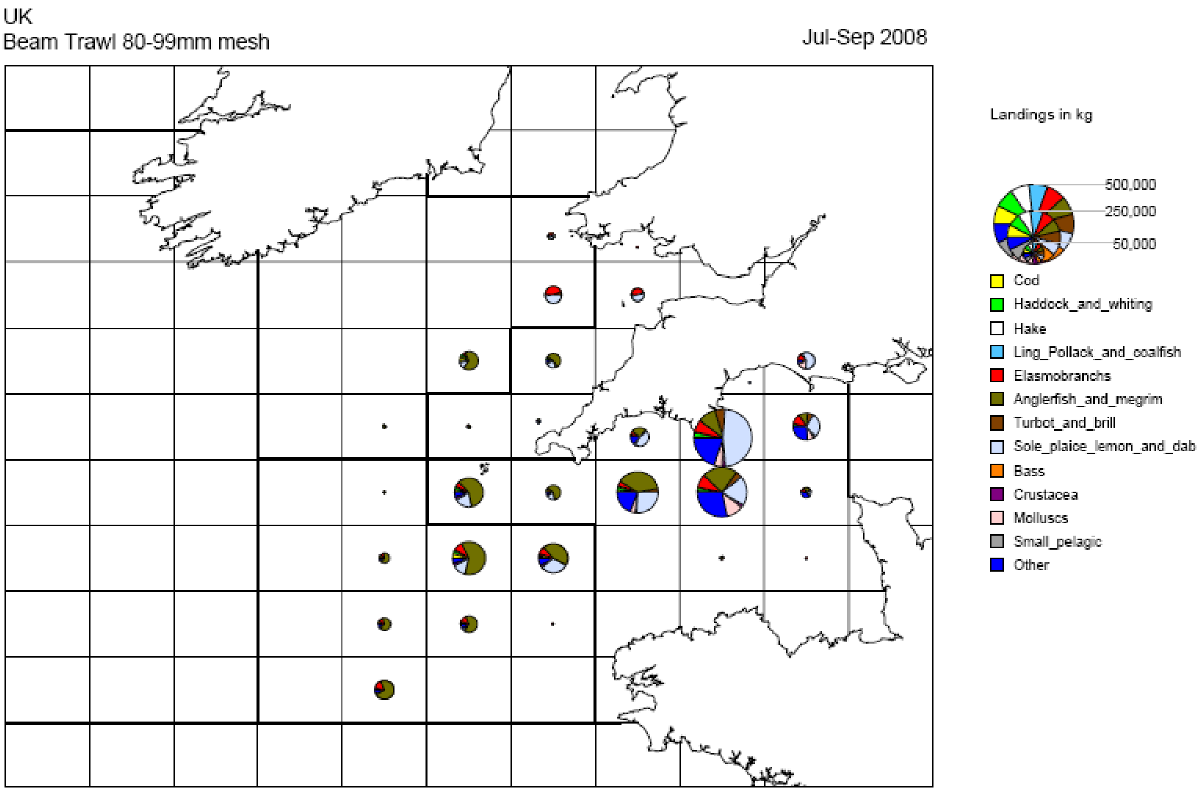



**Fig. A-3.10a**. UK beam trawlers (all LOA) using 80mm+ mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.



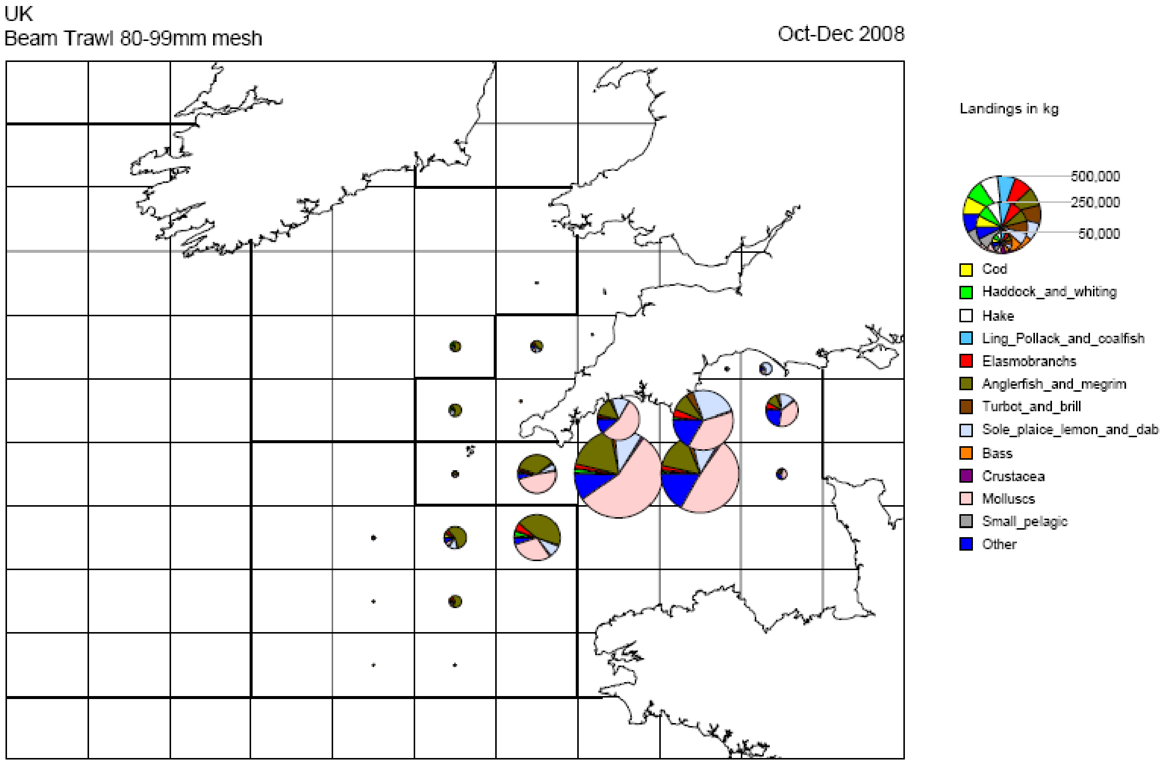
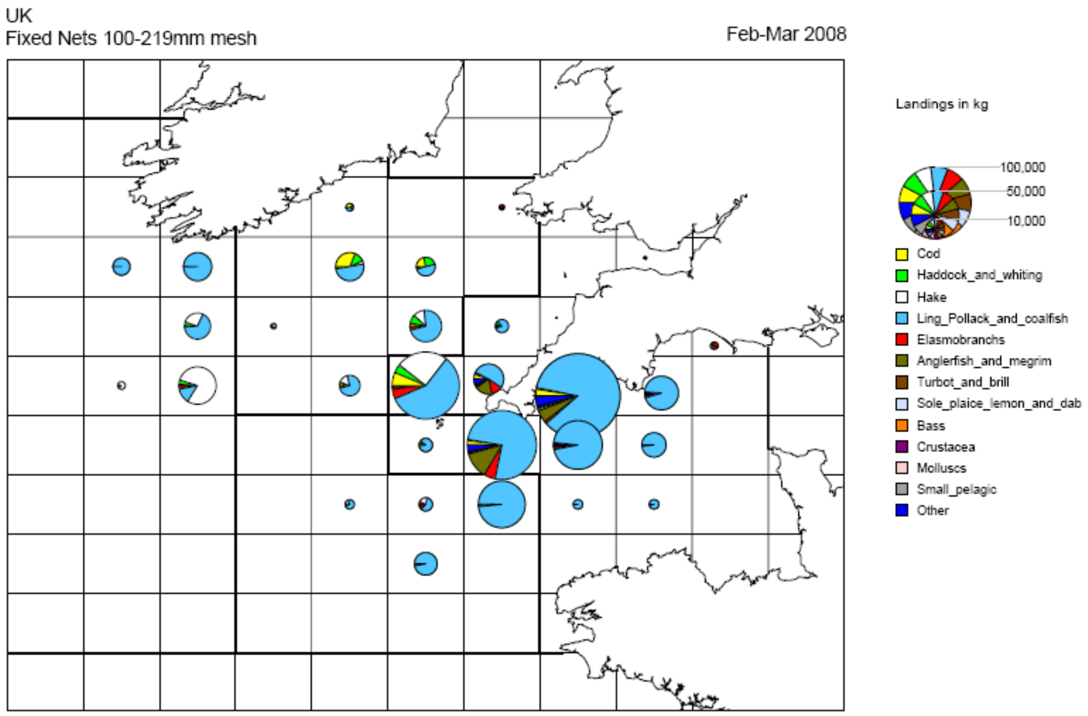




**Fig. A-3.10b**. UK beam trawlers (all LOA) using 80mm+ mesh: Species composition by ICES rectangle for July – September and October-December 2008



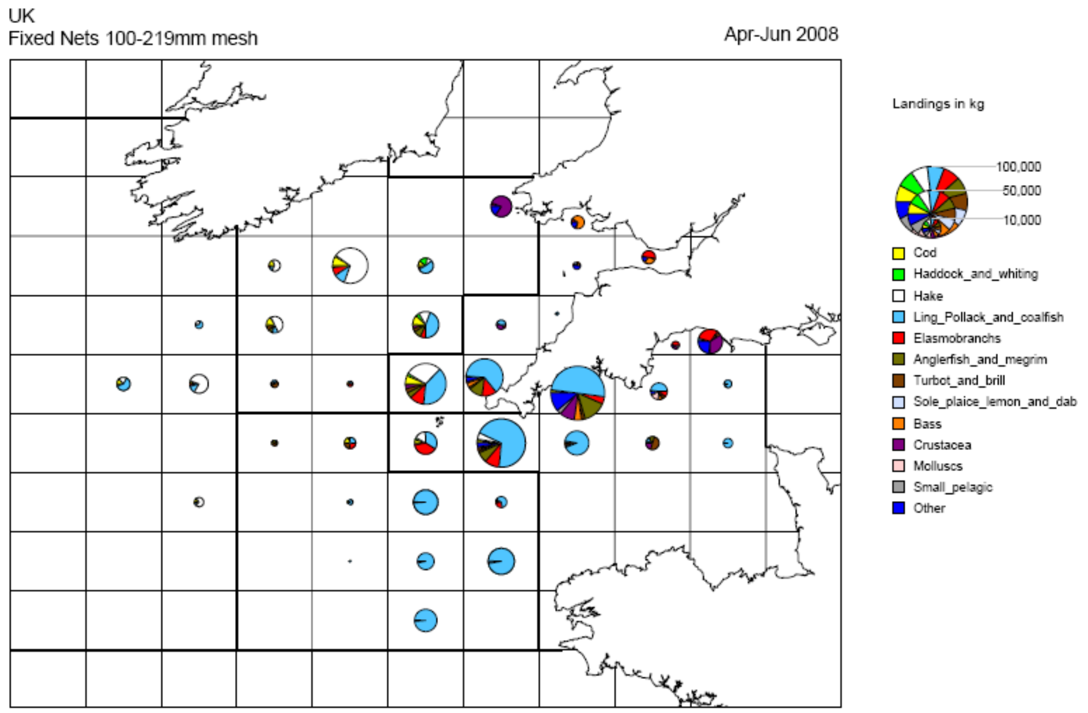
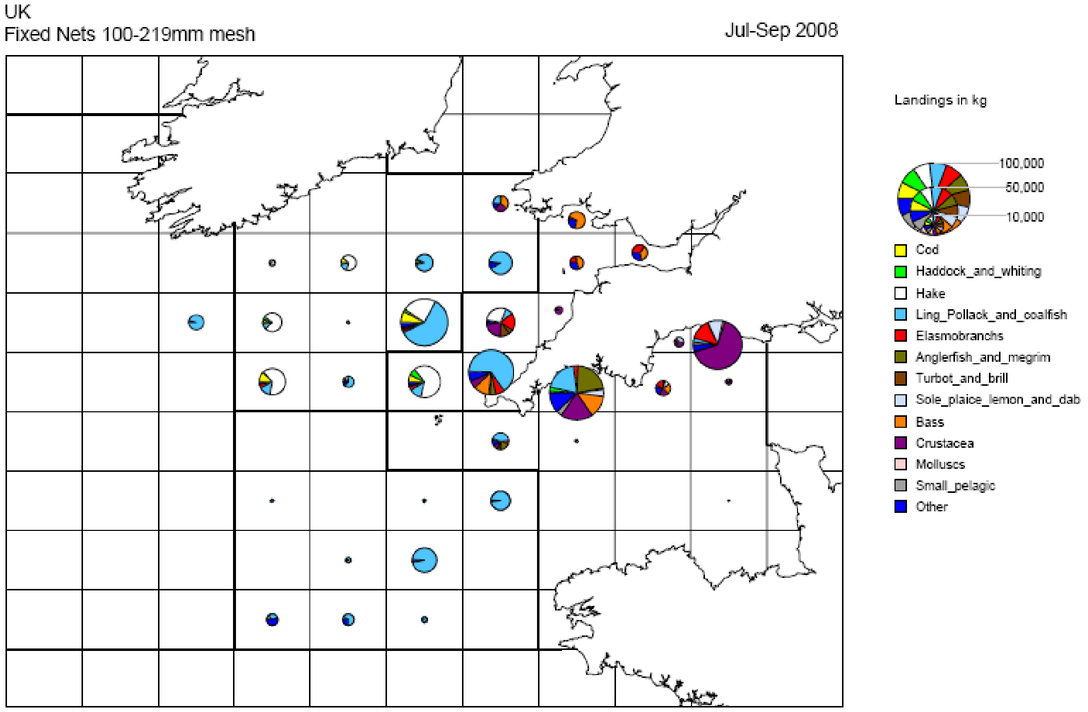




**Fig. A-3.11a**. UK fixed netters (all LOA) using 100 – 219mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.



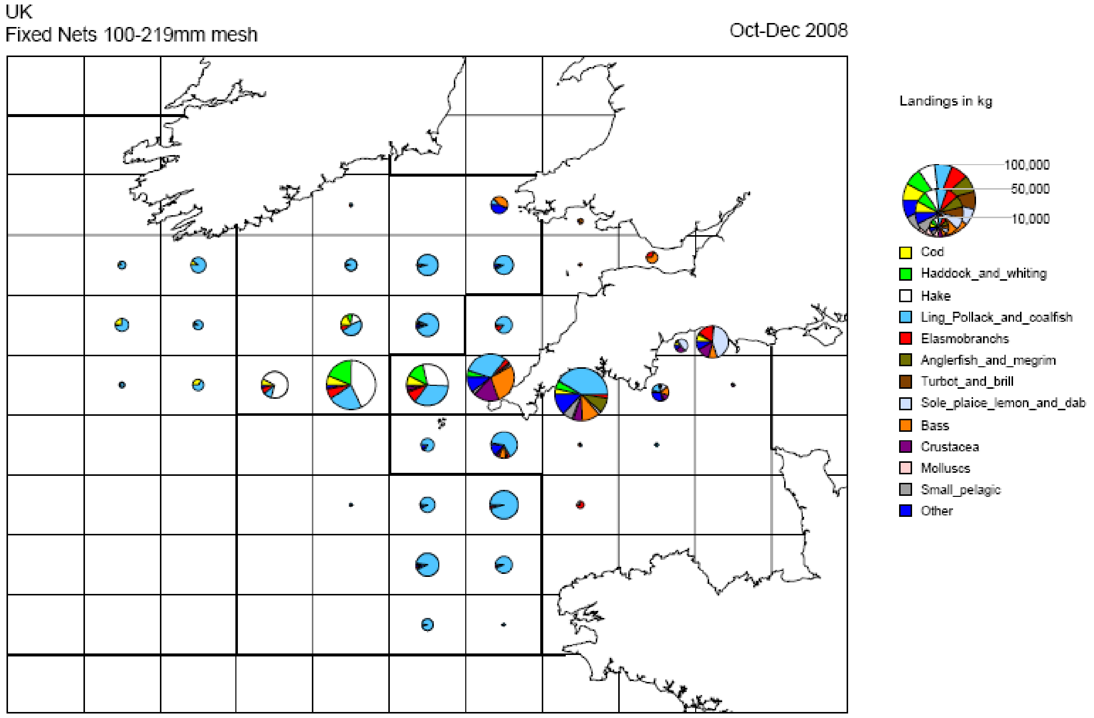
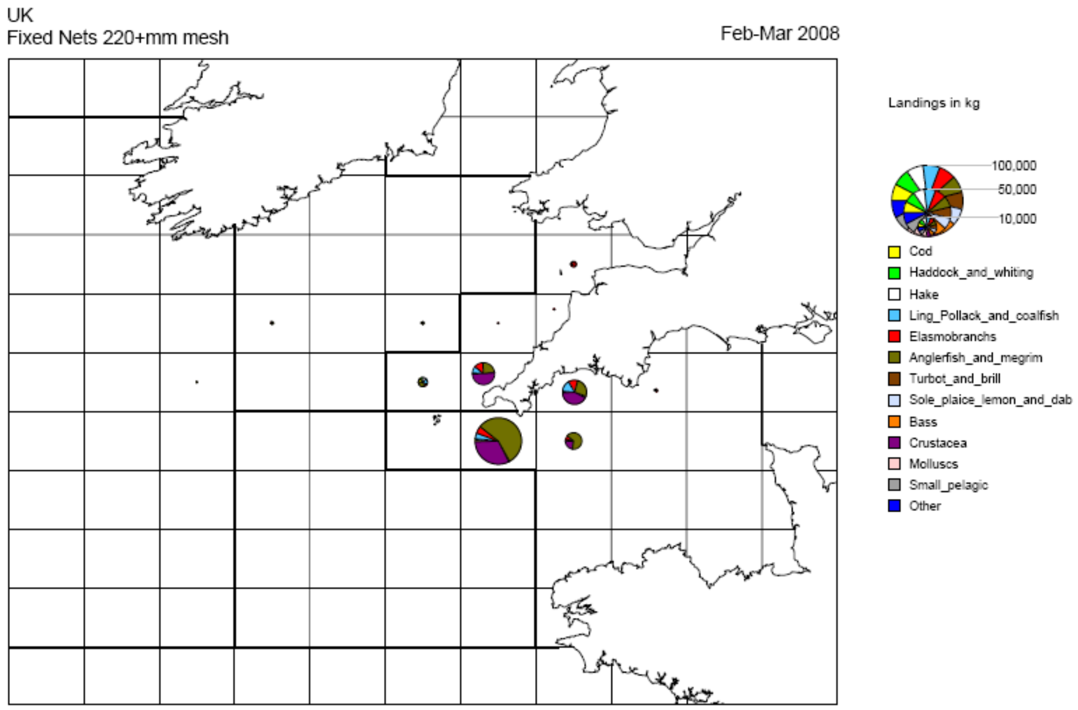




**Fig. A-3.11b**. UK fixed netters (all LOA) using 100 – 219mm mesh: Species composition by ICES rectangle for July - September and October - December 2008.



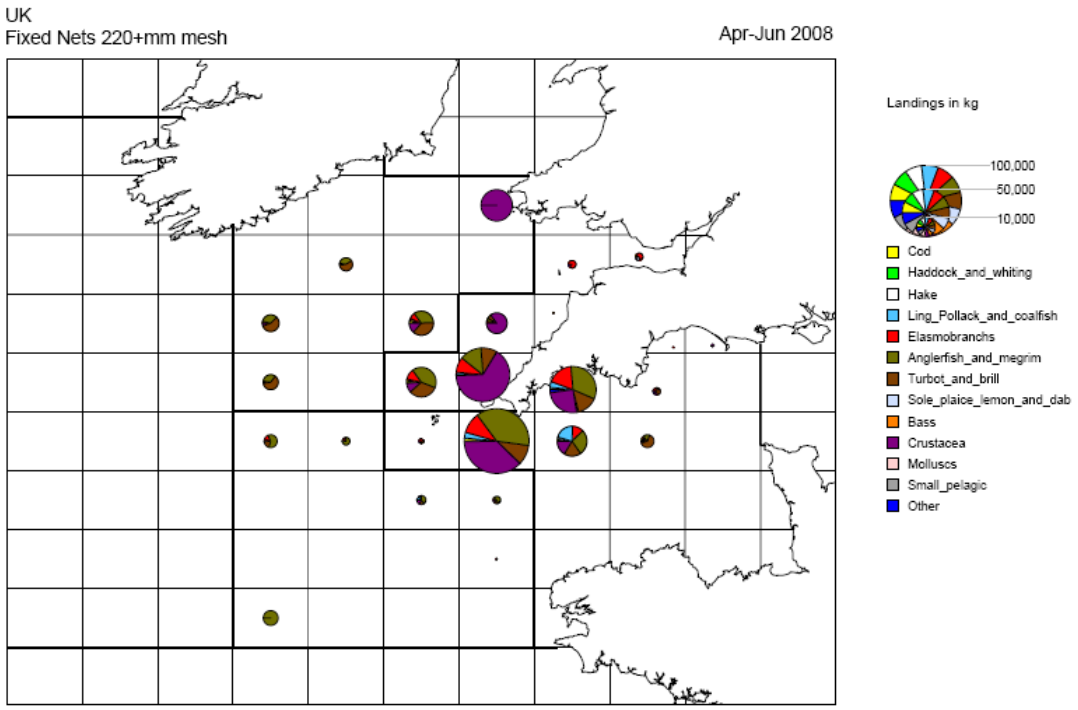
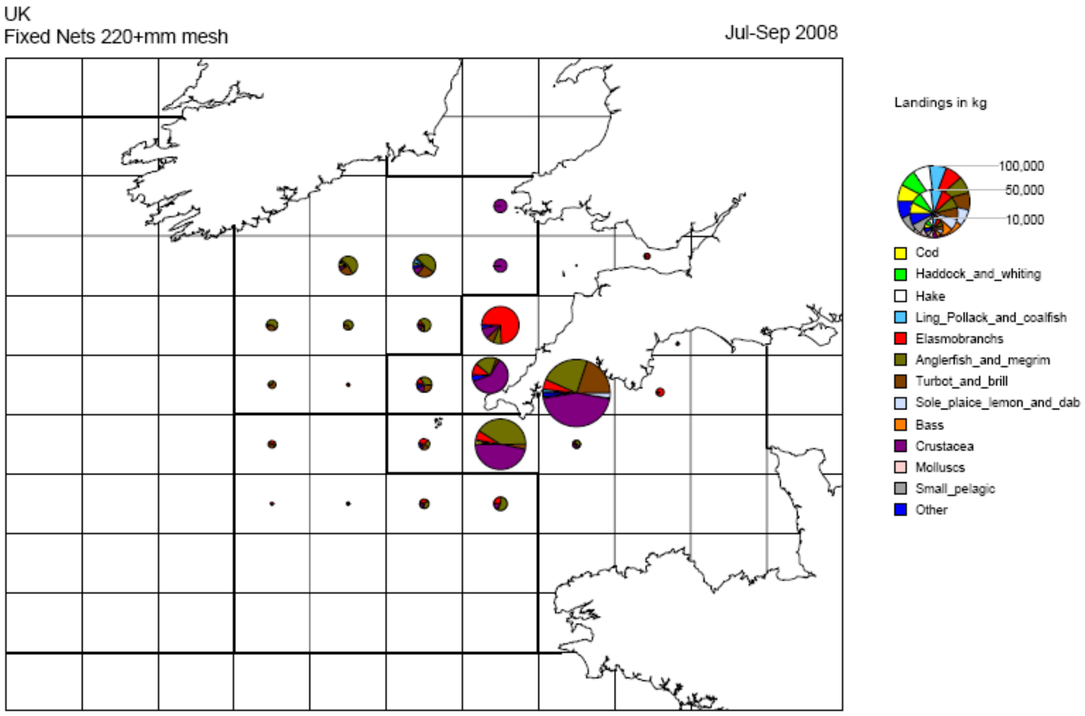




**Fig. A-3.12a**. UK fixed netters (all LOA) using 220mm+ mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.



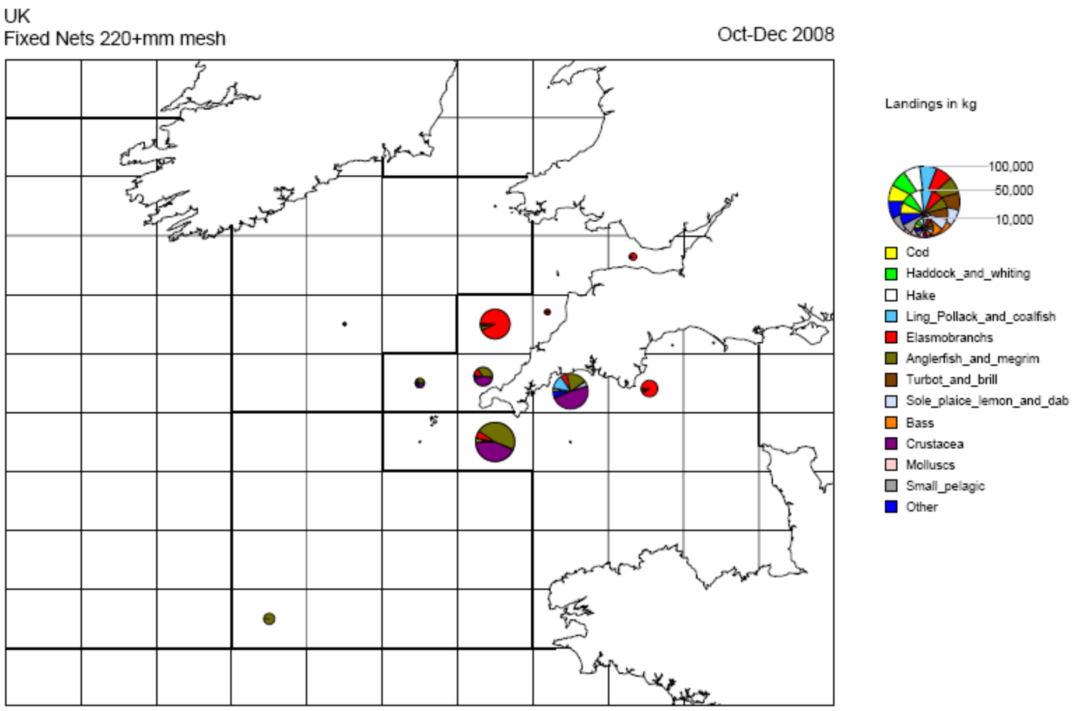




**Fig. A-3.12b**. UK fixed netters (all LOA) using 220mm+ mesh: Species composition by ICES rectangle for July – September and October - December 2008.

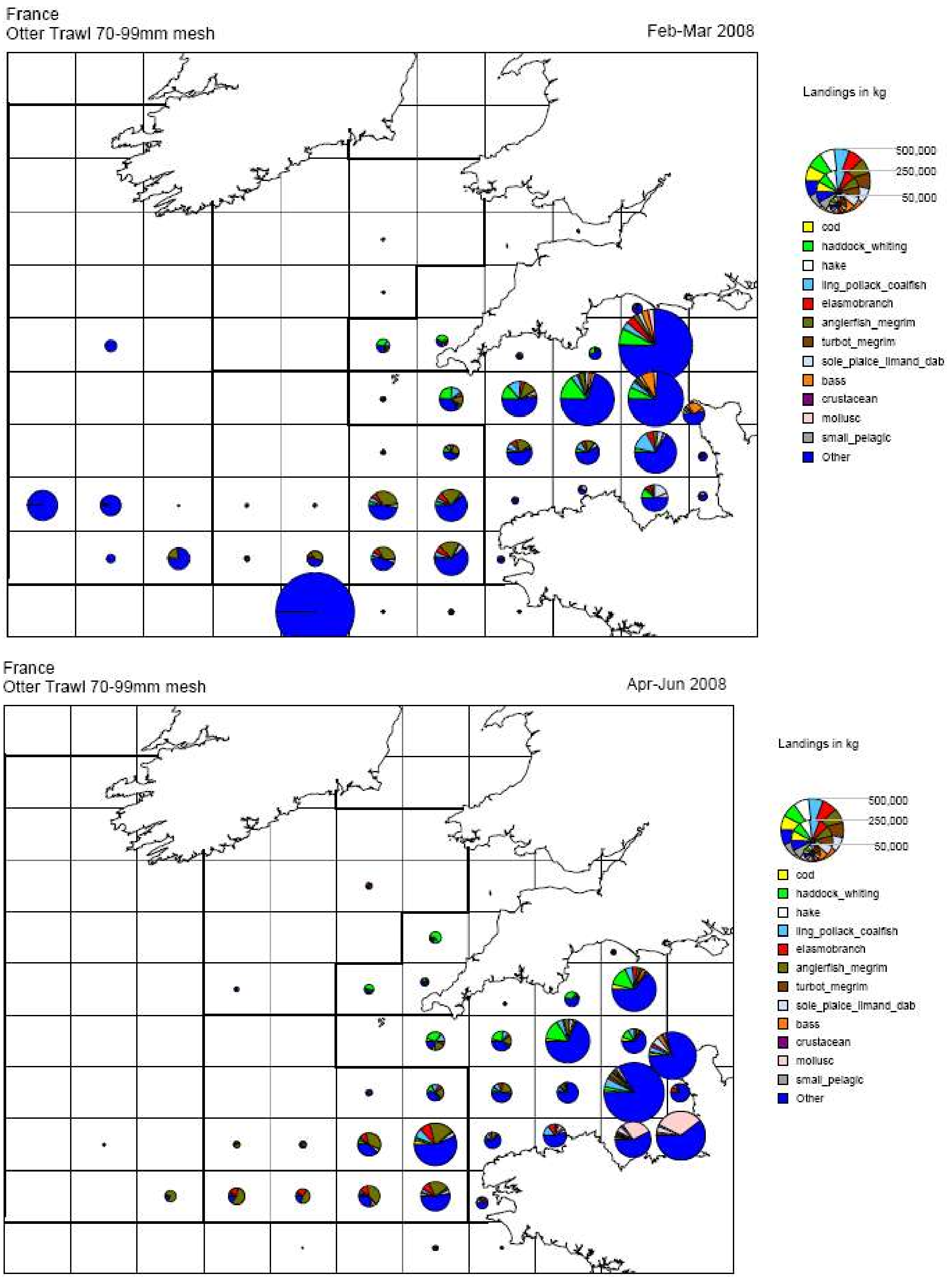
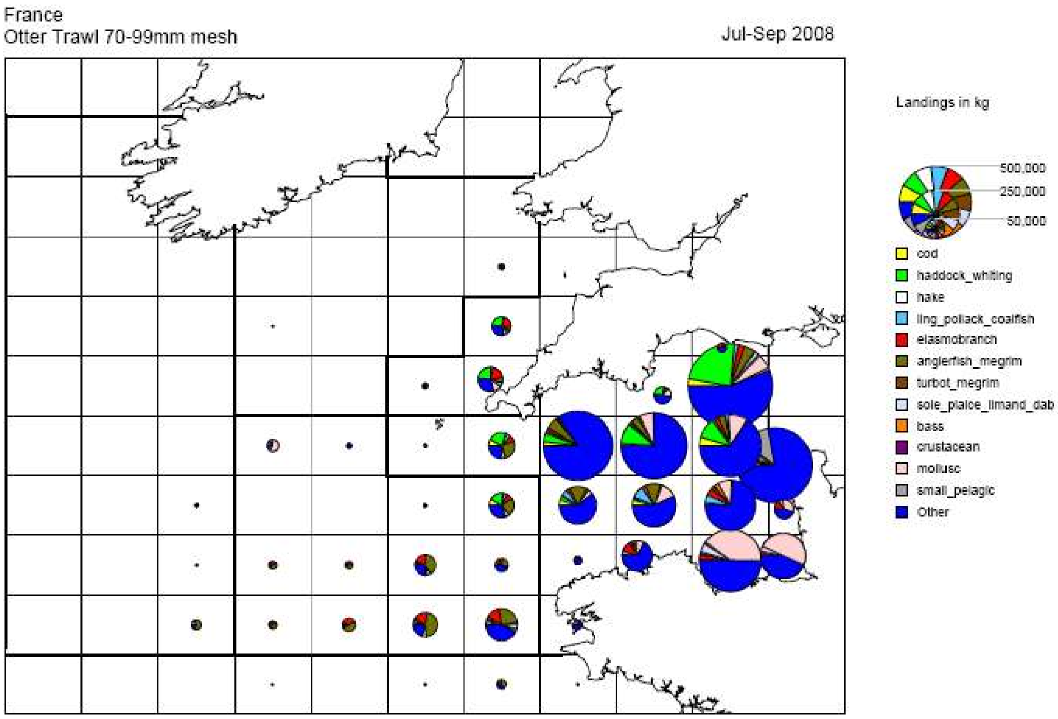



**Fig. A-3.13a**. French otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.



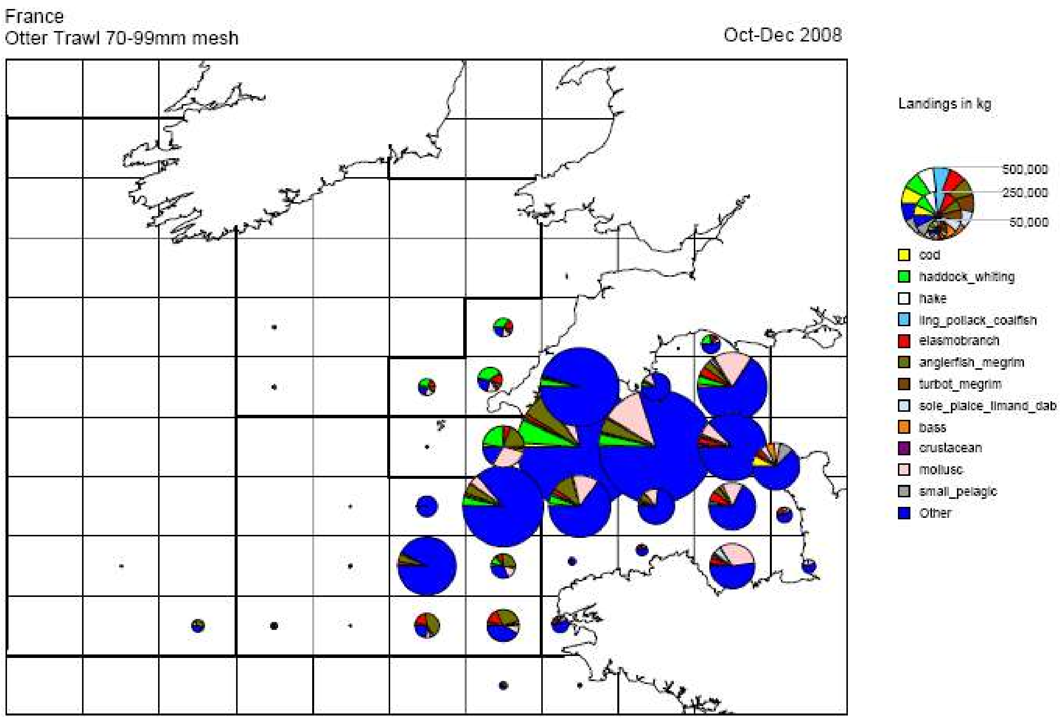
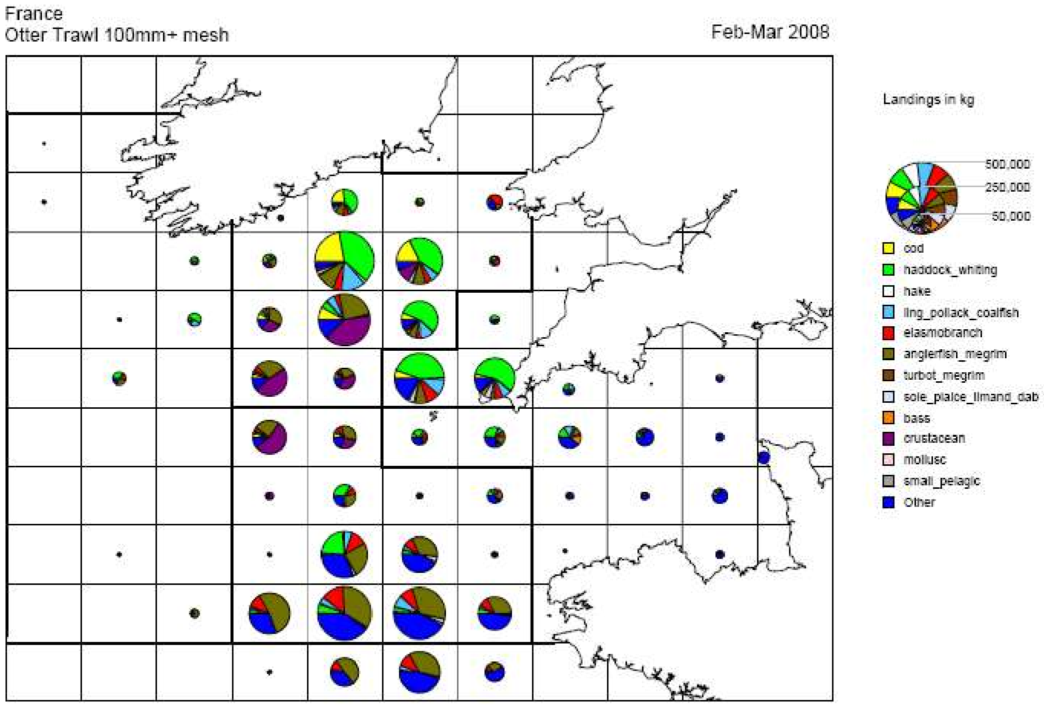




**Fig. A-3.13b**. French otter trawlers (all LOA) using 70-99mm mesh: Species composition by ICES rectangle for July-September and October-December 2008.



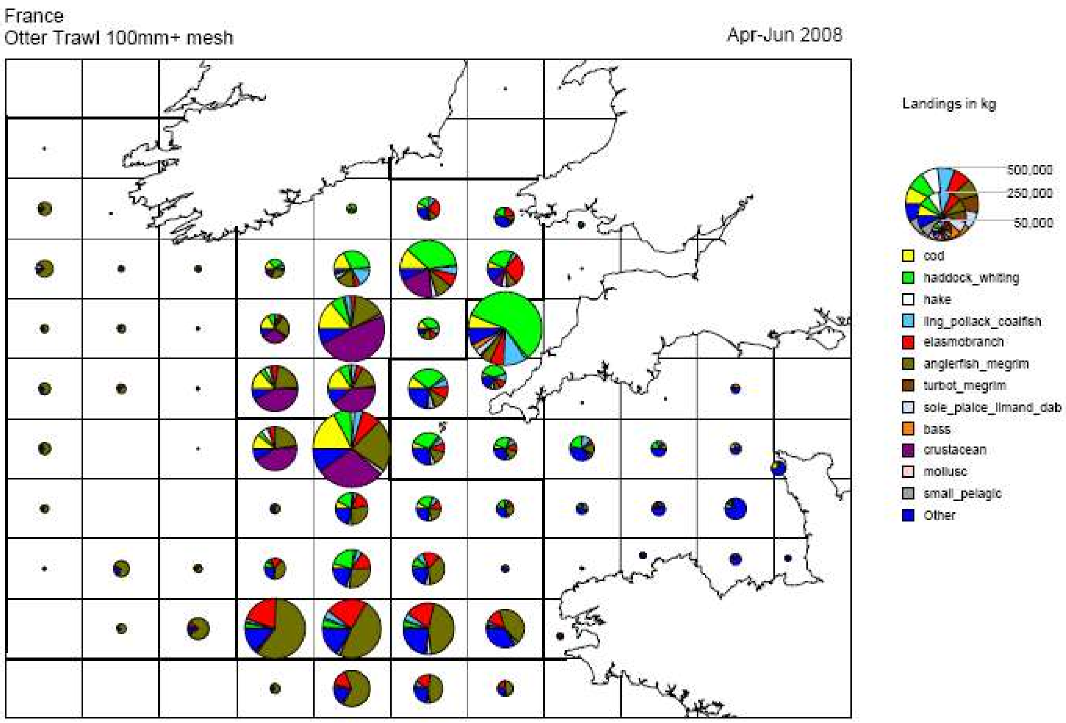
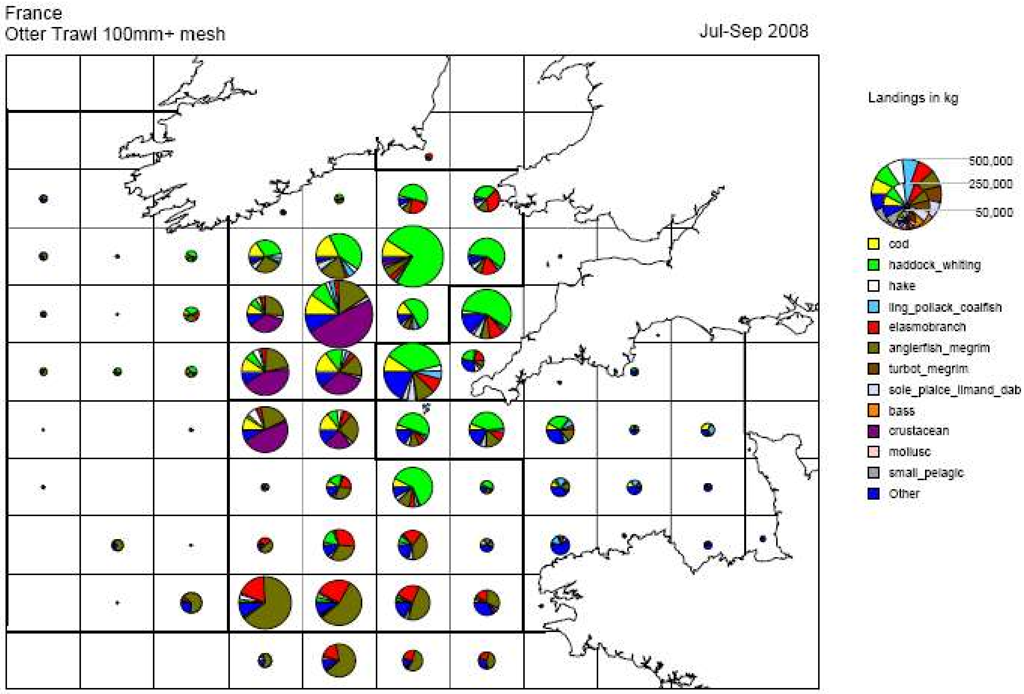




**Fig. A-3.14a**. French otter trawlers (all LOA) using 100mm+ mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.



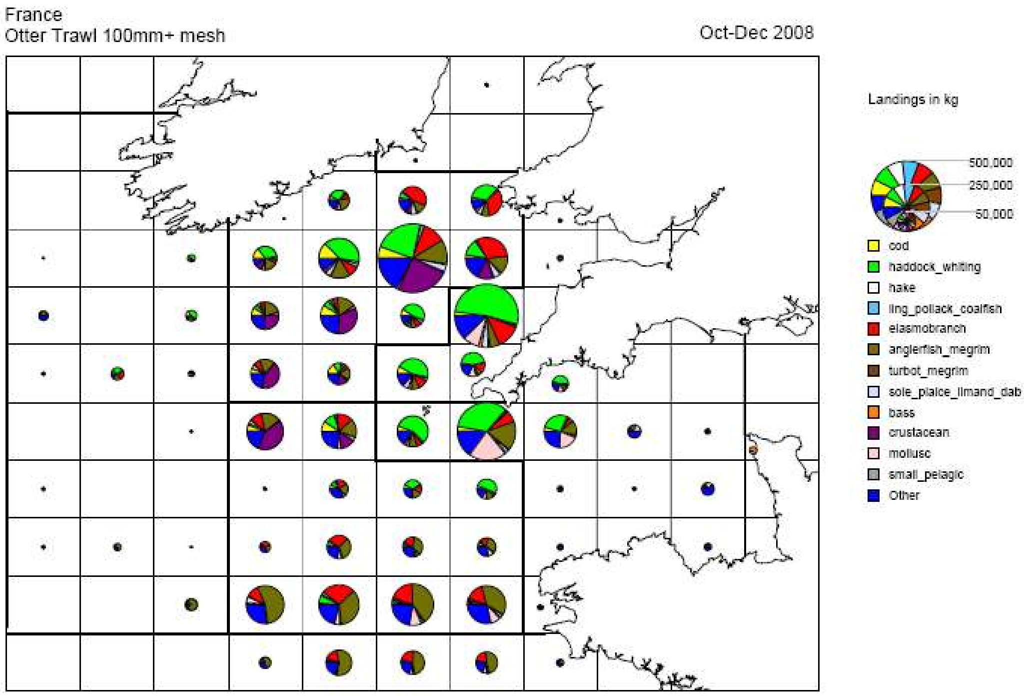
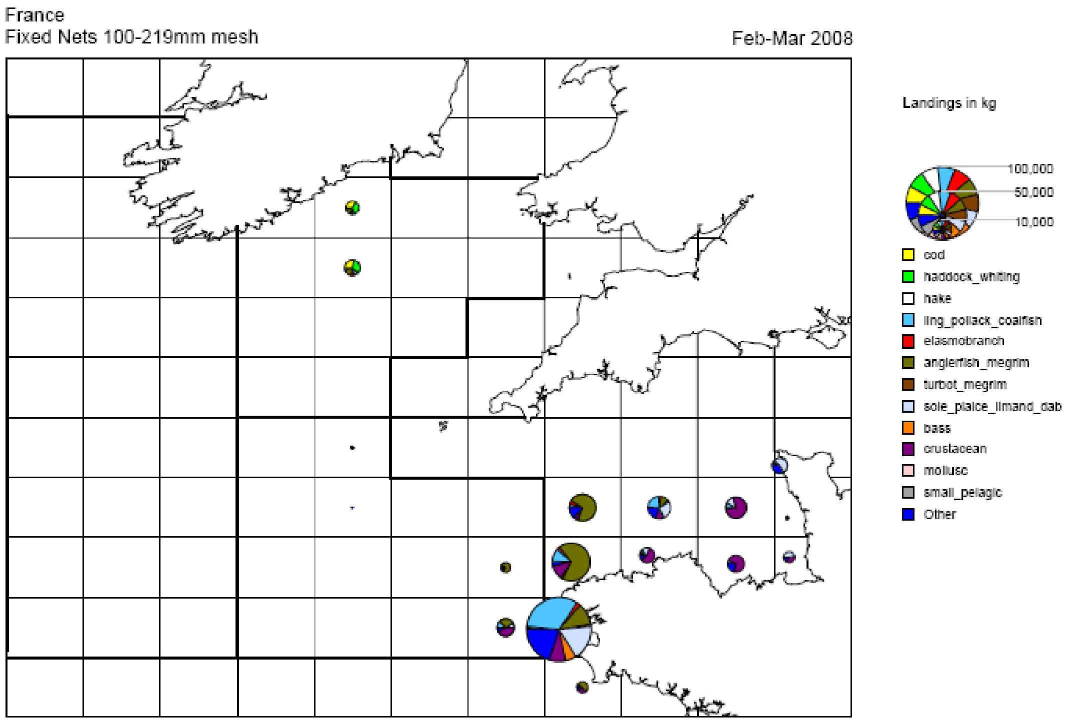




**Fig. A-3.14b**. French otter trawlers (all LOA) using 100mm+ mesh: Species composition by ICES rectangle for July-September and October-December 2008.



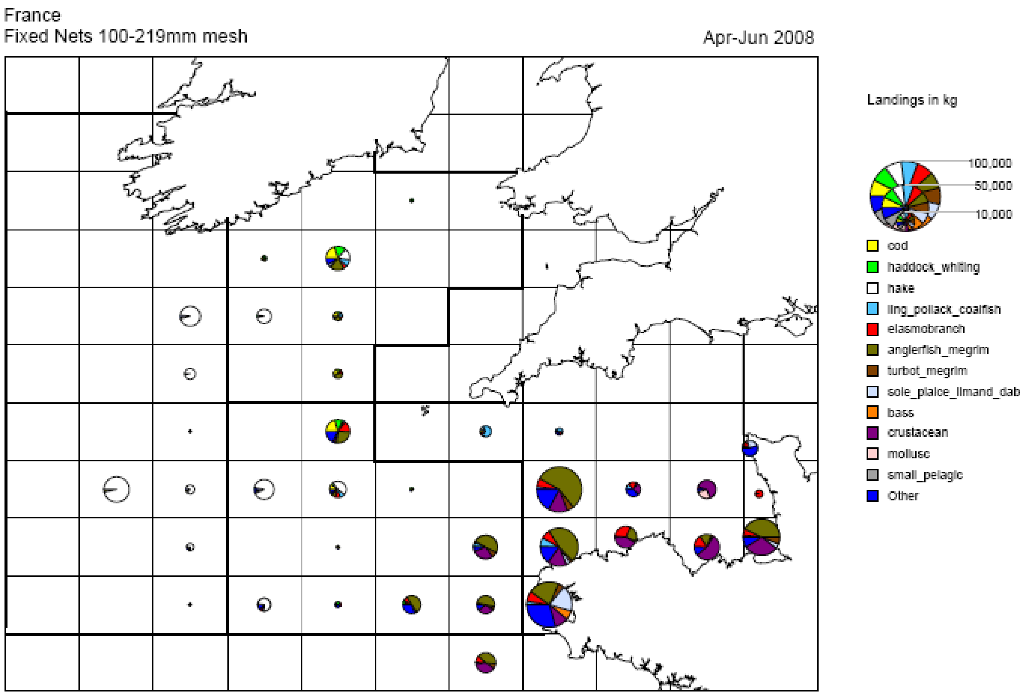
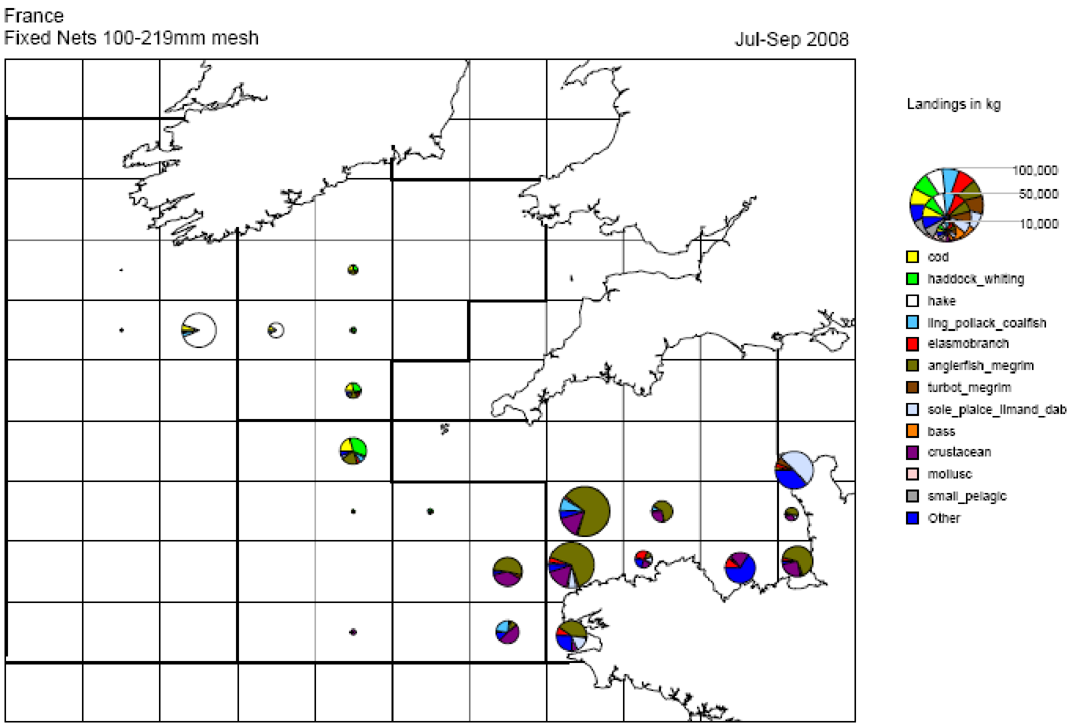




**Fig. A-3.15a**. French fixed netters (all LOA) using 100-219mm mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.



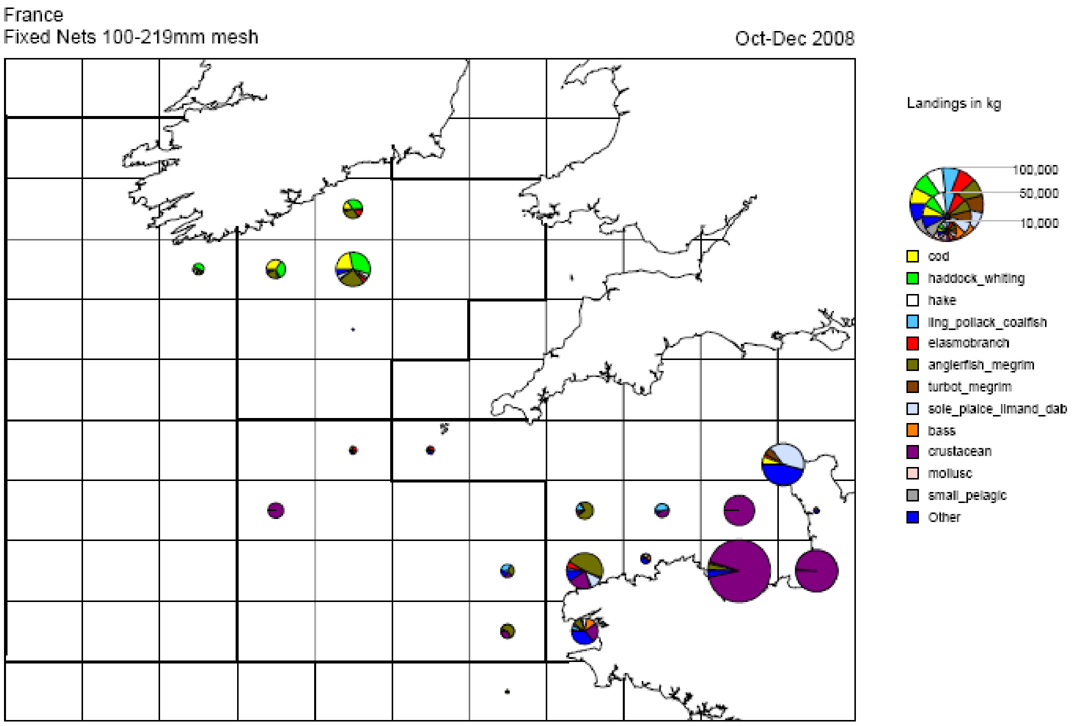
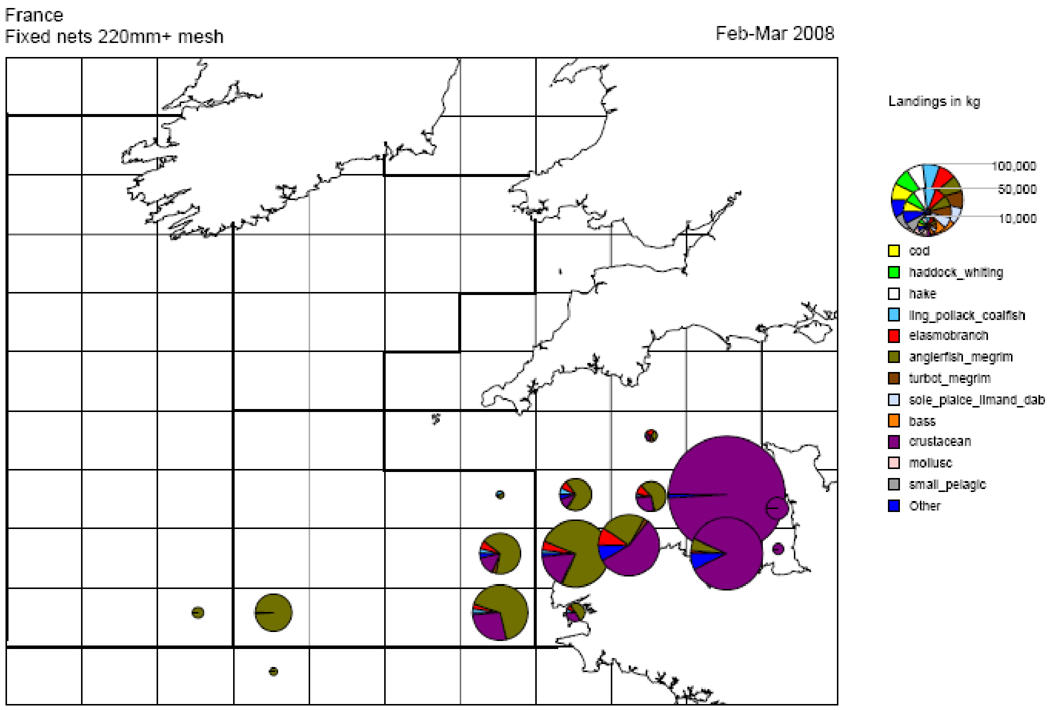




**Fig. A-3.15b**. French fixed netters (all LOA) using 100-119mm mesh: Species composition by ICES rectangle for July-September and October-December 2008.



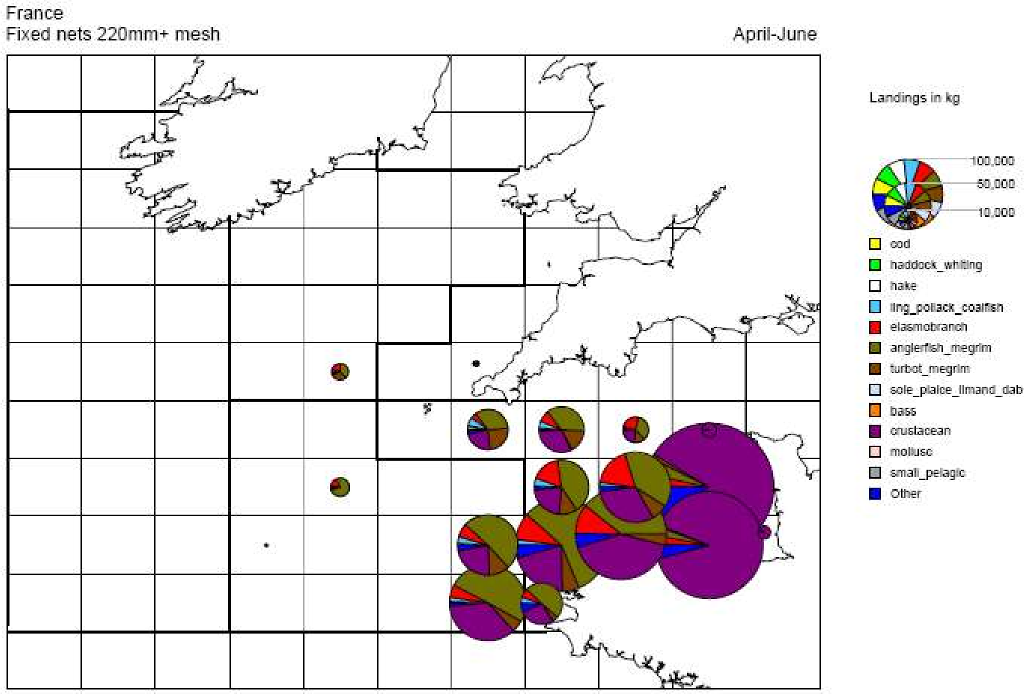




**Fig. A-3.16a**. French fixed netters (all LOA) using 220mm+ mesh: Species composition by ICES rectangle for February -March (Trevose closure period) and April - June 2008.

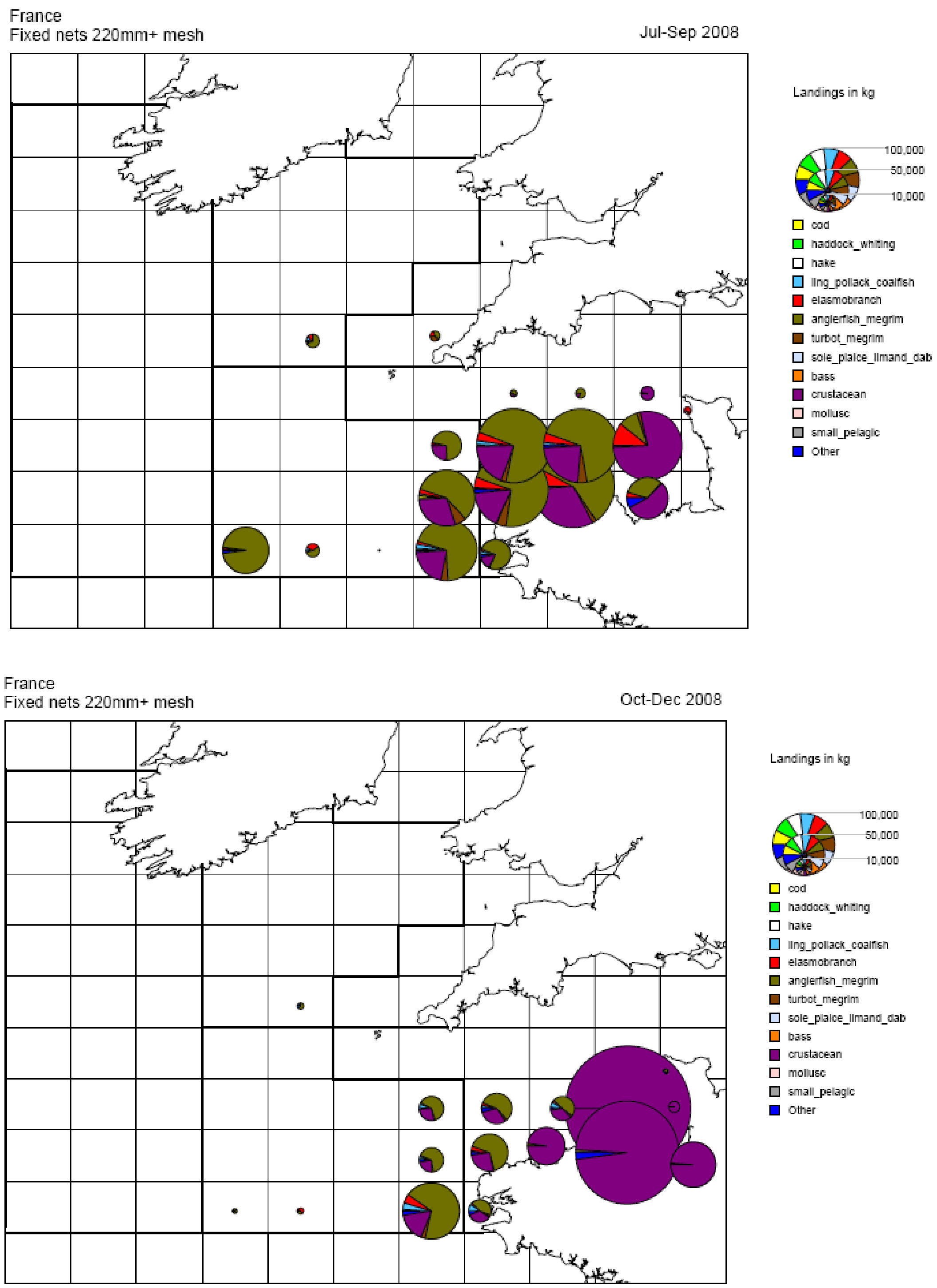



**Fig. A-3.16b**. French fixed netters (all LOA) using 220mm+ mesh: Species composition by ICES rectangle for July-September and October-December 2008.