Studies and Pilot projects for carrying out the common fisheries policy

Cooperation to Develop Fisheries Information from the North Sea

for
The European Commission
Directorate-General for the Fisheries and Maritime Affairs

SWFPA
The Scottish White Fish Producers Association Ltd

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Coopératives Maritimes Etaploises
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Directorate-General for Fisheries and Maritime Affairs

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CoDFINS – Cooperation to Develop Fisheries Information from the North Sea

Executive summary

The studies conducted within the Cooperation to Develop Fisheries Information from the North Sea (CoDFINS) project have been undertaken within the European Commission studies and Pilot projects for carrying out the common fisheries policy Lot 7: *Joint data collection between the fishing sector and the scientific community in the North Sea* specified in the Call for Tenders FISH/2006/15 "*Studies and Pilot projects for carrying out the common fisheries policy*".

The programme has successfully facilitated collaboration between representatives from fishers' organisations and scientific fisheries institutes in the resolution of fisheries issues of importance to the North Sea Regional Advisory Council (NSRAC).

A series studies which covered the themes of the Lot 7 Studies and Pilot projects for carrying out the common fisheries policy Terms of Reference were outlined by the project team, discussed and agreed with the NSRAC Executive Committee and its Demersal Working Group. Meetings were then organised within the project framework and at NSRAC meetings to refine the studies and carry out and present and discuss the analyses. The group has:

- Reviewed the published information, listed studies that can be used as examples and provided suggestions for self sampling data gathering programmes that can be applied by fishers.

- Reviewed the information that can be gathered from collaborative industry - science surveys currently taking place in the North Sea. Data collected from a series of coordinated commercial surveys, designed by fishers, could provide the information required to improve stock assessments, especially at the oldest ages where catch rates in surveys are low. The basis for such a coordinated survey is already in place because several countries are already conducting surveys that could, over time, and with minor modifications to sampling protocols and design be combined to provide an industry survey series. The expertise and experience is already available, but setting up of such a survey will require input from more countries to give greater coverage and could be encouraged by EU funding of industry projects. The study group has helped to begin this process already, by collaborating to provide input into the design of a new North Sea wide gadoid survey that has been funded and incorporated within the UK Fisheries Science Partnership programme; the first fishing survey was conducted in 2009. The survey results can be used to link together indices from surveys conducted in other areas in a combined analysis.

- Analysed catch rates from commercial surveys being conducted currently in the North Sea to address fishers concerns about the quality of research survey catch rates. Two studies have demonstrated that indices derived from soft and hard substrate have similar dynamics and that there is coherence between commercial data and research surveys at young ages. However, the studies both raised concerns about low catch rates at older ages in research surveys resulting in noise

in stock assessments. Information from the collaborative surveys described previously would resolve this.

- Within studies examining the utility of VMS data the study group reviewed the methods applied by analysts from each member state to process satellite monitoring data and extract fishing information. The team complied a common protocol for the standardisation of approaches for use in common projects, the first time this has been carried out. The analysis methods were applied to VMS data on fishers' spatial movements and gear use within an area of the North Sea that may be designated as a potential Natura 2000 conservation area by the UK. A report was prepared at the request of the North Sea RAC and presented to its Demersal Working Group, providing them with information on usage of the area by gear country and also the species catches by weight and value. The NSRAC highlighted the value of the information provided by the group to its future advice and discussions with managers as to the use of the area of seabed.

Study results were presented to and have been used by: the NSRAC Executive Committee and the NSRAC Demersal Working Group at its tri-annual meetings; directly to the industry to highlight the information contained within data and to provide guidance on alternative sources and ways in which it can be collected; the ICES North Sea Working Group.

The study has been challenging in two respects: first, in the requirement for targeting of data gathering and analysis at areas that are current to the NSRAC in a rapidly changing system, biologically and politically. Second the process of working within the temporal frame work of the NSRAC which has only a few meetings each year at which work plans can be proposed, revised and results discussed. Such logistical difficulties have resulted in important lessons being learned by the Project Team whom consider that the project has been successful in achieving its aim of facilitating collaboration between representatives from fishers' organisations and scientific fisheries institutes in the resolution of fisheries issues of importance to the North Sea Regional Advisory Council (NSRAC), albeit at a slower pace than originally envisaged possible.

1. INTRODUCTION

1.1 Provenance

CoDFINS was established by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) in response to the open call for tenders, Reference No FISH/2006/15 "*Studies and Pilot projects for carrying out the common fisheries policy, Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea*" from Directorate-General for Fisheries and Maritime Affairs on 5 August 2006.

1.2 Background

Fishers' knowledge of the current dynamics of the stocks they exploit is based upon many years of experience of the catch rates available to them within the areas they fish. In recent years there has been a substantial reduction in the level of information, used within assessments, that has been collected directly from fleets exploiting a fishery. Deterioration in the reliability of reported effort, lack of trust in the quality of reported catches and landings data etc. have all resulted in the data being omitted from assessments. Consequently, management advice from working and study groups has a greater degree of uncertainty and has lost credibility with the fishing industry.

In response to the requirement for a source of information that is based on fishers' knowledge, the North Sea Commission Fisheries Partnership (NSCFP) and its successor the North Sea Regional Advisory Council (NSRAC) have examined ways of bringing fishers' knowledge into the management process. When funding became available from the Directorate-General for Fisheries and Maritime Affairs the study proposal was instigated to bring together fishers' and scientists from 5 North Sea countries participating the NSRAC - Scotland, England, France, the Netherlands, and Denmark - to form a group that can provide the expertise to collate, analyse and provide interpretation of information gathered by fishers. The overall aim of the programme being to develop the framework for a study group able to present fisheries information, based on fishers' knowledge, derived from their own data. Fisheries management and advisory bodies such as the North Sea Regional Advisory Council (NSRAC), European Commission, STECF, and ICES would then use the collated information as a basis for the formulation of management advice.

1.3 Organization

The requirements of the project specification were for two phases in the work programme, a design phase and an implementation phase.

Design Phase

During the first part of the study (Design Phase), the Project Team met to discuss and to select a series of case study stocks (fleets and fisheries) from within the North Sea. Data availability, methods of analysis and associated costs were considered and a work programme for the subsequent 12-month period developed (Implementation Phase). The work programme includes a breakdown of time frames, objectives defined to ensure tasks specified in the Implementation Phase were delivered. A draft

report of the work programme was presented to the NSRAC and submitted to the Commission.

Following discussions with the NSRAC and the Commission and, unfortunately, due to unforeseen changes to the project team participants described later, the work programme was modified and the project proceeded to the implementation phase.

Implementation Phase

Within the projects two meetings were scheduled, a first to co-ordinate and carry out the supporting studies and a second meeting to present and discuss the report with the Commission and North Sea RAC. The development of each project is outlined below within report sections describing each task and its related work programme. Completion of the project was reported to the NSRAC Executive Committee meeting in Stockholm in June 2009 at which it was agreed that presentations would be made at the July 2009 meeting of the NSRAC Demersal Working Group, which was undertaken.

1.4 Project development

A series of studies which covered the themes of the Terms of Reference were outlined by the project team during the design phase, discussed and agreed with the NSRAC Executive Committee and its Demersal Working Group. During the implementation phase, a series of meetings were then conducted within the project framework and at NSRAC meetings to refine the studies and carry out and present and discuss the analyses.

1.4 Output

CoDFINS studies covered four of the five Task areas (study themes) raised within the project specification. The project group has:

- Reviewed the published information and provided suggestions for self sampling data gathering programmes that can be applied by fishers (Task 2, Section 2.2) .

- Addressed fishers concerns about the quality of research survey catch rates, by collating and analysing information from commercial fishing surveys, conducted in collaboration between fishers and scientific institutes. The study has demonstrated coherence between commercial data and research surveys at young ages but raises concerns about low catch rates at older ages and highlighted that collaborative surveys conducted using commercial gear with scientific observers, provide indices of abundance that can be aggregated across areas (Task 3, Section 2.3).

- Collaborated in providing direct input into the design of a new North Sea fishers gadoid survey that has been funded and incorporated within the UK Fisheries Science Partnership programme. The first fishing survey was conducted in 2009 (Task 3 and Task 5, Section 2.5).

- Reviewed the methods applied by analysts from each member state to process satellite monitoring data and extract fishing information, complied a suggested common protocol for the standardisation of approaches for use in common projects (Task 4, Section 2.4).

- Applied the common protocol in the analysis of Interpreted and reported to the NSRAC on fishers' spatial movements and gear use within an area of the North Sea that may be designated as a potential Natura 2000 conservation area by the UK. The NSDRACX highlighted the value of the information provided by the group enabling further discussions as to the use of the area of sea (Task 4 and Task 5, Section 2.5).

- In addition, an output from the project that was considered equally as important as the analysis and reviews conducted by the group was the development of dialogue between fishers and scientists.

The study results were presented directly to the industry as well as: a) the NSRAC Executive Committee and the NSRAC Demersal Working Group; b) the ICES North Sea Working Group and Benchmark Assessment Group WKROUND; d) ICES Annual Science Meeting

2. WORK PACKAGES

2.1 Task 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).

2.1.1 Information on Commercial Fishing Gear and its Use

Project specification

There is a basic lack of fishery information on what gears are being used to catch fish and the configuration in which they are being applied, which is a major factor in determining the gear's selectivity. Gear uptake and frequency of use are affected by management measures. However, the level of compliance is unknown and consequently it is more difficult to predict what the effect of technical measures will be on stocks.

FRS Marine Laboratory Aberdeen has carried out a long-standing and ongoing survey of the types of codend in use in the demersal fisheries, and this has been extended to other details of the gear deployed. The survey work is initially based on approaches for a short questionnaire presented by on-board observers. This is followed up at the skipper's convenience with a more detailed series of questions on gear and other salient information. The intention is to coordinate the information from several Member States to obtain more comprehensive view of the gear use and compliance for several key international North Sea fisheries. Knowledge of gear variations across regions and gear development over time – technology creep - and how these impact on fleet effort, effective fishing power and selection properties would be a valuable resource for the RAC and fishery scientists and managers.

Aims

a) To provide data to identify changes in fleet operations and technology (such as developments in gear designs) which may affect the effort exerted by fleets using a range of mobile gears and hence the effort balance between fleets.
b) To provide data to identify the level of compliance with minimum legislation requirements and the changes in the design of a range of mobile fishing gears which may affect size (and species?) selectivity of specific fleets.

The fleets in question are those using otter and beam trawls, pair trawls and seines, multi-rig trawls and Scottish and Danish seines in mesh size ranges from 80mm upwards.

Methods

An initial assessment using information on national databases will be undertaken to determine the significant fleets in the area and the number of vessels involved. A significant fleet can be defined as one taking more than a certain value of catch where the criterion is based on an absolute value or a proportion of the total value of the relevant international fishery. Having identified these fleets the partners participating in this work package will meet to choose the fleets, common to as many participants as possible, which will be targeted to conduct the pilot surveys. The chosen fleets should use different mesh size ranges and/or target species. Each partner will survey at least 2 fleets.

The aim should be to sample 25% of the vessels in these fleets and this sample should attempt to represent the whole range of vessels in terms of size, power, design and gear handling.

The data will be collected by means of forms which will be completed by skippers and researchers in one-to-one meetings which should not take more than 15 minutes. A separate form will be used for the effort and selectivity objectives. The researcher will need to be familiar with the technical aspects of fishing gear and fishing operations. Example forms are given in appendices X and Y but may need to be redesigned specifically for each fleet and the gear types they use.

The surveys for each fleet should be completed within a specified period (e.g. within one / two months) and each form will cover the fishing operation on the most recent trip. Analytical methods to collate the data for each fleet will be developed to obtain potential variables to describe the aggregated characteristics of fleet effort and selectivity. Consideration will be given to methods of assessing the suitability of the variables for characterizing effort and selectivity.

Project summary

Following an initial presentation to the North Sea RAC at its Executive Committee Meeting on the 20th February 2008 in Peterhead, Scotland, the NSRAC Executive Committee agreed that in principal the project met with its aims and objectives at that the detailed proposals should be forwarded to the NSRAC Demersal Working Group for consideration. The next meeting of that group identified the North Sea whiting as a suitable stock that could be considered for application of this project; given the problems of low stock size and high discard rates which some fisheries for this species induce.

Unfortunately during the time between project specification and agreement by the NSRAC, the projects leading expert in the field of gear selectivity surveys and the translation of the results to advice, retired from the Marine Scotland Laboratory. Task leadership was passed to a replacement expert at Cefas who agreed to take on management of the project but due to commitments during the project period he was not able to commit time to the project and this proposal had to be shelved. The time allocated to the project was diverted to a review of fisher self sampling for Task 2.

2.2 Task 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.).

2.2.1 Fisher's Self-Sampling

Project specification

To assess a fishery it is necessary to determine the biological characteristics, such as age and length distributions, of the commercial catch. In addition, estimates of the amount of discards will lead to more accurate assessments, as will information about effort, fishing efficiency and fleet behaviour. Using scientists to collect information on commercial catches is usually not cost effective. Currently there is ongoing effort worldwide to develop programmes to use fishers to self-sample their catches.

A major difficulty with studies to date has been the problem of providing information that is considered scientifically valid. While more information is being provided there is still a mismatch in what industry can offer at the local scale and what is being used in the assessment and management of the stock as a whole. Care needs to be taken at this critical time in order to avoid disenchantment with the process of providing information and a perceived lack of improvement in the quality and relevance of the resulting scientific and management advice.

Aims

The aim of this study is a desk based review of the initiation, execution and reporting of self-sampling and self-reporting programmes in order to identify areas in which they have been successful and where they have weaknesses. The study will provide a protocol that will help fishers organisations identify information that can be readily gathered from their fisheries and which will enhance the assessment process and management process.

Summary

The project was initiated as a desk-based study of current literature, projects and assessment analyses. The report is timely in that the ICES Benchmark Assessment meetings have recently highlighted the importance of industry data noting that: "Collaborative programmes that forge closer links between assessment scientists and the industry could improve assessments through more complete, or complementary, data, however, care needs to be taken to avoid a mismatch in what industry can offer and what scientists are able to incorporate into assessments." The study has identified a number of research and collaborative projects that have been undertaken which form the basis for a reference library of examples that can be used when developing new projects; guidance protocols are presented.

2.2.2 A Review of Fishers Self-Sampling Programmes

Report 1 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea. Reference: SI2.464218

Fishers Self-Sampling Programmes

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Introduction

To assess a fishery it is necessary to determine the biological characteristics, such as age and length distributions, of the commercial catch. In addition, estimates of the amount of discards will lead to more accurate assessments, as will information about effort, fishing efficiency and fleet behaviour. Using scientists to collect information on commercial catches is usually not cost effective. Currently there is ongoing effort worldwide to develop programmes to use fishers to self-sample their catches (ICES 2007).

As highlighted in two recent workshops on using fishers to sampling catches (Workshop on Using Fishers to Sample Catches (WKUFS), Workshop on Fishers Sampling of Catches (WKSC), there are two broad objectives for self-sampling programmes. One is to efficiently collect commercial fishery data; the other is to involve fishing industry in the assessment process by having them work closely with the scientists. The overall purpose of the programmes is to improve stock assessments.

One of the major recognised problems with industry self-sampling is that some scientists do not see the data as fully scientific or valid. A shift in this attitude is required and then it is felt that the industry would be more willing to participate in self-sampling schemes. A basis for this paradigm shift is a proper verification of usability and high quality of data (ICES 2008).

This study adds to the work of the WKUFS and WKSC and other studies (see Appendix 1 for examples) to develop guidelines of best practice and general recommendations to assist in the initiation and execution of self-sampling and self-reporting programmes. Successful projects rely on collaboration between scientists and fishers to define clear aims and generate quality data.

Guidelines of good practice

Seven themes have been identified for designing and implementing a self-sampling programme:

- Creating incentives for fishermen
- Aims
- Communication
- Confidentiality
- Financing self-sampling programmes
- Training
- Survey Design
- Survey Assessment

Creating incentives for fishermen

The most important issue is the need for incentives for fishers to participate in a self-sampling scheme. If there are no incentives, motivation will be lost and fishermen will stop cooperating (Catchpole 2007; ICES 2007). There are two forms of incentive and both are present in the most successful projects. The first is the knowledge that the data will be used to improve stock assessments; the second is direct remuneration:

- **The knowledge that participation is necessary and/or useful for the management of a stock, for example:**

The utility of the Danish sand eel programme was clearly demonstrated when data from fishers supported their claims that 0–group strength of sand eel could be predicted from larvae observations at the end of the previous fishing season (ICES 2007).

Following the Dutch self-sampling of North Sea plaice catches, fishers carried out a mesh size experiment to provide information to discussions on the reduction of plaice discards. This joint fishers and researchers project (IMRES) has resulted in reliable data that were used directly in fishery management discussions (Quirijns 2009).

FRS (Scotland) presented data on the low catch of cod in the Clyde Nephrops fishery provided by the Clyde Fisheries Development Plan at the EU negotiations in December 2006. Similarly, at the request of English fishers, data from Codwatch was presented to the EC Fisheries Council meeting in December 2007. Fishers considered that this provided empirical evidence to support their view that the status of the cod stock was not the same as that described in the assessments.

There was initially a good response by Scottish fishers to providing data on monkfish but following a new assessment, which was still data deficient and could not justify an increase in TAC the number of vessels taking part reduced. Many fishers had become disillusioned with the project and no longer recorded their information. This highlights the need for project participants to understand how the data are used and what can be achieved with it.

Similarly, the data collected in this Irish Sea ISDEP was intended to feed into the ICES stock assessments, however, this now looks unlikely. To achieve this a time series of several years is required, and this project ran for only a short period.

- **Compensation, for example an increased TAC, days-at-sea, or direct payment for their work.**

Several fisheries in the US use a Research Set-Aside programme to allocate quota to vessels willing to provide scientific data. The New England monkfish fishery management plan sets aside a portion of the days-at-sea allocated for fishing to establish an annual pool of research days. This Research Set-Aside program sets aside 500 monkfish days-at-sea from the directed monkfish fishery to be used for monkfish related research endeavours, thereby providing a mechanism to fund such research activities (Anon. 2006).

Danish fishers providing data on total catches via video-cameras have been awarded additional quota (Anon. 2008a).

English inshore <10m vessels providing information on all aspects of their fishing activity are exempt from quota restrictions.

For each day that data were provided in the English Codwatch project, the skipper received £50 (75 Euro).

The additional permitted days offered to those vessels taking part in the Irish Sea Data Enhancement Programme (ISDEP) did not provide adequate incentive because days-at-sea were not a limiting factor in this fishery. Consequently, there was low uptake of the programme and much less data collected than was expected.

Aims

- Clearly define the aim
- Have agreement on the aims among the participants
- Communicate the aims to the participants
- It is important to manage the expectations of the programmes by making clear what can and cannot be achieved with the data

Communication

Good communication is essential for the success of a project in which fishers and researchers cooperate. Good cooperation is based on trust and transparency among the different parties. Having a contact person for the programme who can act as communicator between fishers and scientists is useful (ICES 2008). Frequent

communications, quick reporting of results to fishers and the development of steering committees, have shown to improve the success of projects (Catchpole 2007).

For example, the Clyde Fisheries Development Plan engaged the entire fishing fleet via a steering committee. This helped to change the emphasis from doing scientific work to collecting the fishers' own data. The engagement of the whole fleet was considered the strength of this project. However, involving so many made it difficult to achieve consensus at all times and there was some disengagement from the project by some fishers for short periods in the project. It was important to keep the objectives of the project high in people's agendas and keep them making decisions about the project so that they remained involved.

Meetings with all participating fishers should be held at least annually to exchange experiences. Such meetings should include:

- Showing data from individuals to compare among participants;
- Show data from different years (do the quality of data improve)
- Show the assessment with and without the improved data Successful projects have been those that have been forged by both fishers and researchers. The use of steering committees that are representative of all project participants is one way to create the necessary social networks.

Confidentiality

It should be assured that data are confidential and can only be presented in an anonymous and/or aggregated way. It should be noted that some data might be "interesting" for enforcement services etc., which might endanger trust between parties.

Projects such as the Clyde Fisheries Development Plan have ownership over their data. However, when government research institutes and agencies are involved it is important to ascertain the availability of data to enforcement agencies.

Financing

The industry, authorities and researchers should decide how to finance a programme. For example, the Norwegians finance their self-sampling programme with a research TAC for participants: the money that is earned from selling the fish is used to finance the project.

Sufficient finances should be available to fund quality control methods, scientific analysis and project management. Large data collection projects have also benefited from having a single dedicated person to manage the project.

Training

Depending on the objectives of a self-sampling programme, the training should be adapted to each particular situation. Some general remarks are (ICES 2007)(ICES 2008):

1. Training/Instruction of a group of participants can be achieved through a plenary meeting. The timing of this meeting is important: make sure that fishermen are available;

2. An individual approach is important to increase understanding and commitment, which can be achieved by onboard training;
3. The goal should be to instruct fishermen how to sample, not to educate them to be fisheries scientists;
4. It should be clear what kind of data are required (and why) and what kind of format is required in order to make data processing more efficient;
5. Short feedback loops from researchers to fishers are required;
6. It should be easy for fishermen to contact the relevant researcher (ICES 2007).
7. It is important that all participants are properly trained, not only the ship owners (as it is the men on deck that take the samples).
8. Scientists should go to sea with fishers to quality control data collection techniques.

Survey design

There are many different self-sampling programmes. Therefore, it is impossible to give general details on the required sampling scheme, the number of samples, gear used, etc.

Examples of relevant questions for designing a survey (ICES 2007):

- Why is the information needed?
- What measurements should be taken?
- Short-term versus long-term?
- What strata are within the fishery under investigation (gear, target species, spatial units, and temporal units)?
- Voluntary or paid?
- How to select vessels and when does your sample of vessels represent the total fleet?
- To what extent should differences in gear/rigging be taken into account?
- What is the number of samples required (statistical power analyses)?
- Are samples taken and processed onboard the vessels or do we use port sampling?
- How can the results from samples be scaled up to the total fleet?
- How are data registered and processed (software onboard and in fishing laboratories)?
- How to deal with legal issues: e.g. keeping undersized fish onboard?
- How to arrange these kinds of issues with the authorities?

Several institutions are now employing selected fishers (often called a ‘reference fleet’, ‘study fleet’ or ‘sampling fleet’) to measure a sub-sample of their catches, extract otoliths, record the amount of discards, etc. This may be a cost efficient way to collect such data but care is needed to assure that is known how representative these data are of other vessels. Similarly, other programmes may also have bias in vessel selection, whereby those willing to collect information may have different fishing patterns to those who are not.

Survey assessment

Once data are available, the sampling scheme should be optimized. The effective sample sizes and variance analysis should be used to get an idea of how much

information the present survey design is giving you and if you could optimize it with the available resources. For example, how much are you gaining in precision by sampling many fish from a tow (ICES 2008).

Methods for analyzing self-sampled data, appropriate estimators and sources of variability are available. Bias in self-sampling may be avoided by routinely checking the coverage by, e.g., area, gear and season using simple ratio-estimators. One rule for sampling in the marine environment appears to be generally true: It is better to sample a few fish from many locations than to sample many fish at each of a few locations (ICES 2007). Samples of fish for length measurements should be collected from as many vessels as possible, while the number of fish measured per vessel, trip, or haul could be adjusted downwards (ICES 2007).

Quality control of self-sampling systems

There are two recognised types of quality control procedures. The first is the cross-checking of data from self- sampling surveys with other sources of information from the same area, fleet, time period, etc (VMS, logbooks, observers, correlation with year class strength, comparison with surveys from other countries, check with fishers) (ICES 2007).

The second procedure is monitoring the internal consistency of data series (for example, compare the coefficient of variation of individual participants fishing in the same period, area and fleet, check if biological measures are within acceptable limits; for example fish length, compare self-sampled data with observer data on the vessels in the same fleet, period and area, fleet characteristics) (ICES 2007).

Electronic data collection

A criticism of some previous projects has been the amount of paperwork required in recording data (some examples of some successfully used recording sheets are in Appendix 2). The use of technology offers one method to improve the efficiency of data capture and transfer. There is an increase in the use of technology in data collection programmes, which make use of video techniques, electronic logbooks, electronic measuring boards and codend and basket weighing equipment. The use of this technology should be evaluated for each programme.

For example, the Cape Cod commercial hook fishermen's association (http://www.ccchfa.org) is testing an Electronic Vessel Trip Reporting system (EVTR). These reports include important information such as how much fish is caught and discarded, fishing date, location, and gear characteristics. The information can be submitted to a centralised database through satellite email. The software developed for this project will automatically check the report for omissions and errors prior to it being sent. It will also allow fishermen to check and verify the reports through an internet portal later on, as well as download the information for their own records.

The next phase of this work is testing the applicability of using video-based electronic monitoring systems to augment existing at-sea observer programs. The CCCHFA are committed to the development of video-based monitoring as a potential future cost

savings when implementing Special Access Programs (SAP). SAP's allow fishing vessels, under certain restrictions, access to locations that are not normally fished in order to harvest healthy stocks. Similar technology is being trialled in the North and Irish Sea.

In the Norwegian reference fleet programme each vessel is equipped with an electronic fish sampling board (Scantrol), scales, otolith sampling device and PC with specialised software. The Institute of Marine Research (IMR) provides training support and updates the scientific equipment on an ongoing basis.

An anglerfish is measured on Norwegian FV "Utflesa".

Recommendations

Ten self-sampling programmes were systematically evaluated using a questionnaire as part of the Workshop on Fishers Sampling of Catches (ICES 2008). Those involved in the projects provided information on all aspects of the programmes. The main problems encountered included having enough resources to visit vessels to quality control the data collection methods. Similarly, there is a need for consistency in the data collection and a protocol that cannot be interpreted in different ways. The benefits of the programmes were an increase in the amount of information available to scientists, improved contact and relations with the fishers and a better understanding of fishing methods, effort and distribution by scientists and of the assessments by fishers.

All the information presented here and in the referenced material has been used to generate nine recommendations on how best to initiate and execute a self-sampling programme:

1. A project steering committee should determine the aims - what data are required and what the data are to be used for.
2. There is a need to manage expectations and identify and communicate what can and cannot be achieved with the data to all participants.
3. There should be a financial incentive for fishers to participate in self-sampling programmes (e.g. improved fishing opportunities or direct payment), but incentives must be agreed with the fishers.
4. The sampling method developed should be feasible as part of the fishers work.

5. The sampling procedure must be scientifically robust.
6. The ownership of the data should be with the project steering committee and should be analysed by a scientific institute with guidance and support from the industry.
7. Scientific institutes must guarantee the availability scientific observers that are required to quality check data and train fishers.
8. One person should oversee the management of the project. In the case of large pilot studies a full time position is required.
9. The data and sampling procedure need to be quality checked and optimized during the course of the programme.
10. The data and its use should be communicated with the fishers as soon as practicable to provide continuous feedback.

Conclusions

Self-sampling allows for continuous, broad area, high-resolution sampling, using large numbers of ships of opportunity. As such the resulting data allow the scientists to focus on "the right place at the right time" (ICES 2007).

The data collected are almost always intended for stock assessments and thus feed into the fishery management process. In this respect, a clear objective is that such data should lead to improve stock assessments. This may be less a question of precision and more that the assessment provides a common perception of what is in the sea (ICES 2007). The increased involvement of fishers in the assessment process is a considerable benefit of self-sampling programmes.

There must be good two-way communication on collecting and recording the data. There is a wealth of information potentially available through fisher self-sampling programmes to aid better management of marine resources. To initiate and maintain support for these programmes there is a need to manage expectations and identify and communicate what can and cannot be achieved with the data. It is best to "keep it simple" by not asking too much of the fishers, but gain enough information to improve the sustainable management of fisheries.

There are two new large self-sampling projects currently underway in the western waters and Baltic Sea. The first is 'Lot 1: Joint data collection between the fishing sector and the scientific community in Western Waters', which aims to design and implement programmes to obtain supplementary information from the fishing industry on the practical fishing operations and the decisions made about the fisheries (Anon. 2008b). The second is 'Lot 8: Joint data collection between the fishing sector and the scientific community in the Baltic Sea' which aims to review, design and test the feasibility of new joint data collection programmes with fishers. As part of the 6th International Fisheries Observer and Monitoring Conference in July 20 – 24, 2009, in USA there is also a session on how self-reported data can be improved for use in assessments and management?

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Appendix 1 Examples of self-sampling programmes

Many self-sampling programmes are now operational. There is a wide range of different programmes, for example:

Norway

In 2000 the IMR began a programme to collect data and biological samples directly from some chosen commercial fishing vessels, the "reference fleet." The fishers, who are paid for their effort, measure a sub-sample of fish at selected stations and less frequently they collect otolith, stomach, genetic and other biological samples, which are then analyzed by the IMR. The reference fleet also provides the IMR with information on fleet behaviour and technical developments influencing efficiency and effort. There are around 16 offshore and 18 coastal fishing vessels in the reference fleet (Anon. 2004).

Denmark

A reference fleet takes samples in the sandeel fishery in the North Sea. Sampling levels are set at one sample per fishing ground fished. The utility of this programme was clearly demonstrated when data from fishers supported their claims that 0–group strength of sand eel could be predicted from larvae observations at the end of the previous fishing season (ICES 2007).

Also in Denmark is the first test of a digital video catch monitoring systems in the EU. The Danish Institute for Fisheries Research (Difres) has started a pilot project on four vessels in a mixed species fishery using the electronic observer systems. Camera monitoring systems from Canada are already being used in New Zealand and North America. The kit includes four cameras, global positioning satellite equipment, plus hydraulic sensors that monitor when the winches are used. The cost is €6,000-7,000 per vessel (Anon. 2008a).

Sweden

Since January 2009 a number of self-sampling programmes have commenced for the cod fisheries using longlines and gillnets in the Baltic, gillnets in the Kattegatt/Skagerrak and grid-trawl fisheries for Pandalus in the Skagerrak/North Sea. Fishers are randomly selected (and get moderately paid and licensed) to bring the whole catch (landings and discards) ashore where it is sample (pers. com. D. Valentinsson).

Iceland

Fishermen are hired to collect cod stomachs for feeding studies. They measure the sampled fish and collect and freeze the stomach. The aim is to collect data from all areas and seasons. Institute staff analyse the stomach contents (ICES 2007).

The Netherlands

The Dutch demersal self-sampling programme is designed to better estimate the amount of discards of North Sea plaice and cod. The fishers sample two hauls at roughly the same time per week from which a sub-sample of one or two boxes is taken. Plaice above and below minimum landing size are selected and volume and length measurements are taken. (Aarts and van Helmond 2007; Dekker and van Keeken 2004; Dekker and van Keeken 2005).

Poland

Self-sampling is conducted by selected experienced fishers who are trained by scientific observers. Data including length and weight measurements, sex and maturity data and also scales, for age reading, are collected form the catches. The amount of remuneration for the work is negotiated annually (ICES 2007).

Scotland

It is recognised by ICES that the data on monkfish (West of Scotland) has been too poor to use in an assessment of the stock, which led to having to work with the precautionary approach and keeping the TACs at the same level. Consequently the industry has been keen to provide additional information to enable a more accurate assessment. Fishers reported the details monkfish catches (collated at FRS) (Catchpole 2007).

Also in Scotland, fishers of the Clyde Sea Nephrops fishery formed a steering committee, the Clyde Sea Working Group, because they felt alienated from the management process. The fishery was facing the prospect of Nephrops quota cuts; which were proposed in order to reduce the bycatch of fish caught in Nephrops fisheries, in particular cod. A sampling programme in which all vessels were sampled was conducted to gain improved data on catches in this fishery (Clyde Fisheries Development Plan) (Catchpole 2007).

Portugal

A self-sampling scheme of catches was conducted in a trammel net fishery targeting soles. The scheme was initiated after recognition that shark and ray catches were decreasing in Portugal, indicating that these species could be overexploited (Catchpole 2007).

France

A lack of data to estimate the level of discarding and the amount of discarded fish has meant the assessment of Celtic Sea Cod in Divisions VIIe-k has been in recent years more uncertain. Restrictive quota has led to an increase in high-grading by French fishers. A self-sampling protocol, proposed by Ifremer, has been adopted by four bottom trawlers. Fishers take length and weight measurements of all the cod caught every other haul (Bellail et al. 2008).

England

There have been a number of surveys undertaken on board English fishing vessels as part of the Fisheries Science Partnership (FSP). In some of these, fishers collect most of the data. In the North Sea saithe FSP, the skipper and crew were trained during one trip by a scientific observer. On subsequent trips the fishers provided estimates on the weight and number of retained and discarded cod and saithe of each size grade for every haul. All cod were measured every haul and a minimum of 100 saithe per size grade were measured on a trip basis.

Another FSP project is Codwatch. The 2005 year-class of North Sea cod is estimated by ICES to be one of the most abundant of recent below-average year classes. Industry indications, however, are that the 2005 year class is much stronger than the long-term historical average. The industry requested that fishers collect their own information on cod catches (landings and discards). The project is being administered by Cefas. Fishers on 12 vessels are observing and recording, quantitatively where possible, the incidence, distribution and abundance of the 2005 and 2006 year classes, and of cod (data recording sheet Appendix).

Also in England, there is a project to collect data on the fishing activity of inshore under 10m vessels targeting finfish off the east coast. The Environmentally Responsible Fishing Project requires fishers to collect data on all aspects of their fishing activities and runs concurrently with an observer programme. The vessels taking part are exempt from quota restrictions (data recording sheet Appendix).

Ireland

When there is an incentive for fishers to misreport it becomes increasingly difficult to establish the real stock situation and to advise on catches that can be taken sustainably. Recognising this situation existed in the Irish Sea and that opinion of the state of the stocks differed widely between scientists and industry, the North Western Waters Regional Advisory Council, with support from both the UK and Irish fisheries administrations and scientific laboratories, commenced an Irish Sea data enhancement programme (ISDEP) during the summer of 2007 including fisher self sampling programme for Irish Sea demersal trawl and seine fisheries (Catchpole 2007).

United States

The Northeast Fisheries Science Center used fishers in a “study fleet” in a study of the accuracy of the reported fishery-based data from off the northeast coast of the USA. A total of 32 vessels participated in the study. In the same area off the northeast coast of the USA, the School for Marine Science and Technology (SMAST), which is part of the University of Massachusetts/ Dartmouth, used a study fleet to assess the commercial fishery. Approximately 20 commercial vessels were in the fleet (ICES 2007; Roman 2009).

A number of Research Set-Aside (RSA) programs have been implemented in accordance with individual fishery management plans. Some of these set aside a portion of the annual quota to be harvested for the purpose of funding research. Fishery management plans such as those for scallops and herring in New England,

and summer flounder, black sea bass, spiny dogfish, Illex squid, Loligo squid and Atlantic mackerel in the Mid-Atlantic reserve up to 3% of the TAC, depending on the fishery, for research funding. A vessel that participates in an approved research project may apply for research quota to participate in cooperative research. Currently, RSA programs have been implemented for Atlantic Sea Scallops, Mid-Atlantic multi-species, Monkfish, and Atlantic Herring (Anon. 2009b).

Canada

The British Columbia Groundfish Trawl Fishery is the largest fishery by volume of catch on the Canadian west coast. Further to the ITQ system in this fishery, strict guidelines are in place to minimize resource wastage. All vessels fishing bottom trawls must have a certified observer on board. All groundfish landings are monitored dockside by certified validators. The industry finances the observers and validators which costs more than Can $2.5 million (1.7 million Euro) annually (Catchpole 2007).

Also in Canada, a Dungeness crab fishery on the north coast of British Columbia has taken a lead role in involving industry in fishery data collection and management. There has been an increase in the amount of data required to effectively manage the fishery and a reduction in available resources. The soft-shell sampling program collects biological data from the fishery in order to move away from fixed opening and closure dates towards shorter closure periods that are based on the biology of the crab population. This data is self-reported and the Association has worked with the Department on sampler selection, training and ensuring consistency and credibility in the data (Scherr 2009).

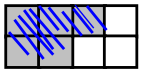
The closure of the Atlantic cod fishery had the result of limiting information on stock trends. The Fisheries Resource Conservation Council (FRCC) recommended the establishment of sentinel programs involving a number of fishermen in order to monitor the evolution of cod stocks. The program was implemented in the fall of 1994. The primary objective of a sentinel fishery program is to develop time series of abundance indices to be used in the assessment process of cod stocks. The northern Gulf of St. Lawrence sentinel fishery program became the first to incorporate abundance indices into stock abundance assessment analyses (Anon. 2009a).

Appendix 2 Data collection sheet English ERF scheme

TRIPCODE:	VESSEL NAME:	FISHING
GEARref 1	RIGS: 2	TARGET: Nephrops &	SOAK:	BAIT:

	START OF LINE	END OF LINE	GEAR MODS / DAMAGE / INTERRUPTION / SLIPPED:
Date:	02/06/2008	02/06/2008	Extended sweeps by
Time:	0600 bst	1130 bst	
Depth:	35 units: m	42 units: m	
Lat:	54°	55°	
Long:	01°	01°	

Wind direction: NE Force: 3

Cloud cover: 

Rain: None / Mist / Drizzle (circled) / Light / Heavy

Sea state: Calm / Slight / Moderate (circled) / Rough

TOTAL BULK CATCH: 20 UNITS: baskets ESTIMATED: Y (N) TIME CLEARED: 1630 bst DIS Tag No: 45896321 Prop. discs: 1/3

SPECIES	RETAINED						DISCARDED						SURVIVAL PROSPECTS (%)			
	Large	Medium	Small	UNITS	ESTIMATE	MEASURED	Size	U/size	UNITS	RATIO	ESTIMATE	MEASURED	None	Poor	Good	Excellent
COD	1	2	5	Count	N	N	1	3	Count	1/1	N	N	25		50	25
WHG		4	½	Box	N	N	1/4	1/4	Baske	1/3	Y	N	100			
NEP	½	3	1	Box	N	N		20	Count	1/3	Y	N		50	50	
CUR			3	Count	N	N										
SYR			1	Count	N	N		4	Count	1/3	N	N			50	50
SQC	1			Count	N	N										
CRE							5	20	Count	1	Y	N	4			96
Non																
MXR							20		Count	1/3	Y	N	100			
MXF							1/4		Baske	1/3	Y	N	75	25		
GUX							5		Count	1/3	N	N	100			
MXC,MXH,STF,							1/8		Baske	1/3	Y	N				

Data collection sheet English Codwatch scheme

NORTH SEA COD WATCH - SURVEY OF THE 2005 AND 2006 YEAR CLASSES OF NORTH SEA COD (AND ALSO ALL COD TAKEN)
A FISHERIES SCIENCE PARTNERSHIP PROJECT BETWEEN DEFRA, CEFAS AND THE EEFPO

VESSEL NAME ______
NUMBER OF FISHING DAYS IN TRIP ______
GEAR TYPE ______
MESH SIZE ______
COD END MESH ______
AVAILABLE COD QUOTA ______

GEAR DIMENSIONS ______
GROUNDROPE LENGTH ______
HEADLINE HEIGHT ______
LONGLINE FLEET LENGTH ______
GILLNET FLEET LENGTH ______
NO AND SIZE OF PANELS, HOOKS, ETC ______
BAIT ______

ABUNDANCE SCALE : (0 = zero, 1 = small numbers, 2 = moderate numbers, 3 = high numbers, 4 = very high numbers)

DATE & TIME HAULED	LAT		LONG
LAT/LONG (in format 37° 24')			E / W
TOW/SOAK TIME (hrs)			
TARGET SPECIES			
COD TYPE	ABUNDANCE	KGS AND NOS RETAINED	KGS AND NOS DISCARDED
2005 YC	0 1 2 3 4		
2006 YC	0 1 2 3 4		
ALL AGES	0 1 2 3 4		

DATE & TIME HAULED	LAT		LONG
LAT/LONG (in format 37° 24')			E / W
TOW/SOAK TIME (hrs)			
TARGET SPECIES			
COD TYPE	ABUNDANCE	KGS AND NOS RETAINED	KGS AND NOS DISCARDED
2005 YC	0 1 2 3 4		
2006 YC	0 1 2 3 4		
ALL AGES	0 1 2 3 4		

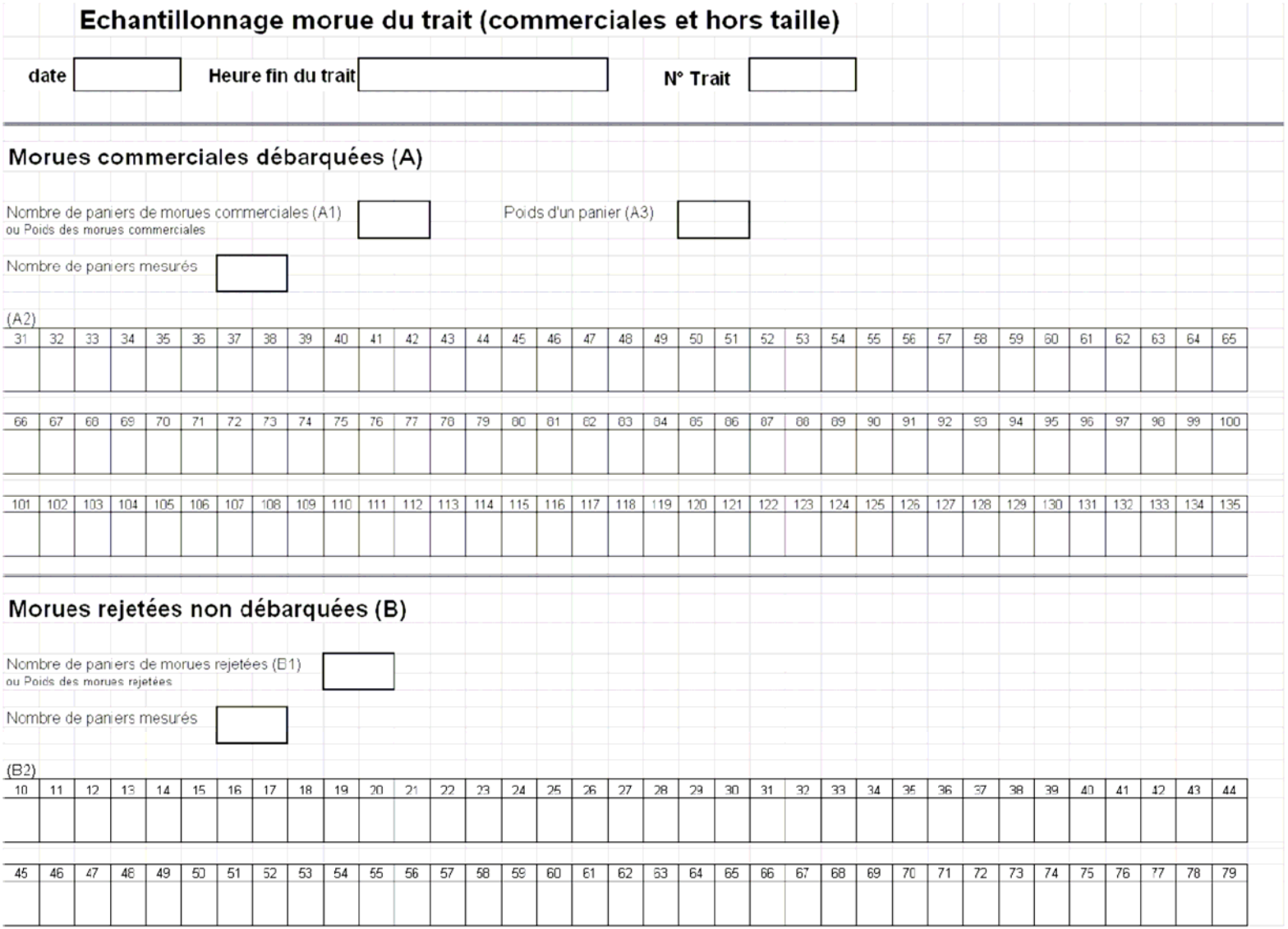
DATE & TIME HAULED	LAT		LONG
LAT/LONG (in format 37° 24')			E / W
TOW/SOAK TIME (hrs)			
TARGET SPECIES			
COD TYPE	ABUNDANCE	KGS AND NOS RETAINED	KGS AND NOS DISCARDED
2005 YC	0 1 2 3 4		
2006 YC	0 1 2 3 4		
ALL AGES	0 1 2 3 4		

DATE & TIME HAULED	LAT		LONG
LAT/LONG (in format 37° 24')			E / W
TOW/SOAK TIME (hrs)			
TARGET SPECIES			
COD TYPE	ABUNDANCE	KGS AND NOS RETAINED	KGS AND NOS DISCARDED
2005 YC	0 1 2 3 4		
2006 YC	0 1 2 3 4		
ALL AGES	0 1 2 3 4		

DATE & TIME HAULED	LAT		LONG
LAT/LONG (in format 37° 24')			E / W
TOW/SOAK TIME (hrs)			
TARGET SPECIES			
COD TYPE	ABUNDANCE	KGS AND NOS RETAINED	KGS AND NOS DISCARDED
2005 YC	0 1 2 3 4		
2006 YC	0 1 2 3 4		
ALL AGES	0 1 2 3 4		

DATE & TIME HAULED	LAT		LONG
LAT/LONG (in format 37° 24')			E / W
TOW/SOAK TIME (hrs)			
TARGET SPECIES			
COD TYPE	ABUNDANCE	KGS AND NOS RETAINED	KGS AND NOS DISCARDED
2005 YC	0 1 2 3 4		
2006 YC	0 1 2 3 4		
ALL AGES	0 1 2 3 4		

Data collection sheet (cod length), French self-sampling study



Echantillonnage morue du trait (commerciales et hors taille)

date | Heure fin du trait | N° Trait

Morues commerciales débarquées (A)

Nombre de paniers de morues commerciales (A1)
ou Poids des morues commerciales

Poids d'un panier (A3)

Nombre de paniers mesurés

(A2)

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65

66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135

Morues rejetées non débarquées (B)

Nombre de paniers de morues rejetées (B1)
ou Poids des morues rejetées

Nombre de paniers mesurés

(B2)

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44

45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79

2.3 Task 3 - Design and implementation of pilot projects regarding the participation of fishermen in ongoing scientific surveys on board research vessels.

2.3.1 Collation and Analysis of Information from Industry Science Collaborative Surveys

Project specification

Collaborative fishing surveys are being carried out in the North Sea by fishers and scientists within several EU Member States. The surveys have common characteristics: use of commercial boats and gears to conduct surveys that are scientifically monitored and whose design is based on fisher's knowledge of the area to be surveyed. The surveys generally cover restricted areas of the North Sea, therefore the results are not considered to reflect abundance trends across the North Sea as a whole. Although there are common methodologies and objectives across the surveys there has been no international coordination and comparison of results. Potentially, if parameters are estimated by integrated analysis across the variety of gear types and methodologies used, a combined analysis could provide the industry with a stock survey that would complement the International Bottom Trawl Survey (IBTS), especially at the older ages at which catch numbers are low.

Aims

- A collation of information on all industry based North Sea surveys that can be obtained by the project team, on request. The aim would be to provide the an inventory of industry surveys that can be used by analysts responding to requests for advice from the NSRAC and other management agencies.
- Classification of the surveys in order to find links that allow the integration of information within and across areas for species of interest. This will identify survey series correlations highlighting the potential for integration of information, such as year class abundance, across larger areas.
- Analysis of the data from the surveys. A series of questions related to issues that are relevant to fishers will be formulated and analysis carried out in order to test the utility of the collected data. Recommendations for additional surveys and or modifications to additional surveys would be made from the study in order to provide and enhanced program for future data collection.
- The utility of the collated data sets for answering requests will be dependent on the temporal length of the time series and the spatial extent and gear and species coverage.

Suggested exploratory analysis

In order to examine the scales at which the combined data can be used for analysis it is proposed that two studies are initiated that use data for the whole of the North Sea area at a global and fine scale:

1) At the North Sea scale - Can information from commercial fishing surveys using a variety of gears, vessel types, with differing spatial coverage and designs be collated and combined to produce a commercial gear based index of stock trends, particularly with respect to the abundance of older/larger fish? Current IBTS catch rates of older gadoids are low and noisy

and supplementing the information with commercial CPUE for these age/size groups may result in a more precise estimation of spawning stock biomass trends.

2) At a regional scale - Do commercial catches of cod from substrate types not covered by the International Bottom Trawl Survey (IBTS) show the same trend as the current assessment? If the proportion of cod found on rough substrate is non-linearly correlated with abundance the assessment may estimate the biased trends in population size during periods of recovery and decline.

Summary

Discussions on the project were ongoing from the beginning of the project as this study was of particular interest to the NSRAC members. The two studies resulted in three reports:

A review of industry surveys conducted in the North Sea identified five that could potentially provide regional indices of stock abundance. Two surveys were targeted at species (anglerfish and lemon sole) that were different from the remainder (whitefish) and comparative studies could not be made. However, the angler fish survey has sufficient resources to cover the majority of the area of the stock that it is surveying and was conducted with a protocol that is considered a valuable example of the potential for collaborative industry programmes. Recommendations were made to develop the survey further, if possible, since the sampling has not recorded by-catch species details apart from cod in the most recent year, which would provide a valuable comparison with other surveys being conducted in the area.

Two surveys had been designed with the industry, independently, to provide information on the abundance of cod in separate areas of the North Sea. The studies could not be analysed together due to the short time period over which one has occurred, but they were analysed separately to investigate two issues of significance to the industry. Firstly, whether cod population abundance varies independently or in synchrony on hard and soft substrates and secondly whether commercial catch rates of cod have similar trends to those of the IBTS research survey. The findings that catch rates of cod on hard and soft substrates are significantly different but have not differed in their relative trends in recent years demonstrates the power of such studies in addressing the concerns of the industry. The limited analyses that could be conducted also showed similar trends in year class strength between surveys highlighting the potential for combination on the future.

In addition to the survey series that were currently being conducted the project team were consulted on the design of a new survey covering as much of the North Sea as possible using a single vessel, that was proposed as part of the UK industry science partnership. The survey areas were discussed with the industry and modified following suggestions from the project industry participants. The survey began in June 2009 and results will be reported to the NSRAC when published.

2.3.2 Fisheries Science Partnership programmes conducted within the North Sea

Report 2 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea. Reference: SI2.464218

Introduction

Fisher's knowledge of the current dynamics of the stocks they exploit is based upon many years of experience of the catch rates available to them within the areas they utilise. In the recent years there has been a substantial reduction in the level of information, collected directly from fleets exploiting a fishery, that has been used within assessments. Deterioration in the reliability of reported effort, lack of trust in quality of reported catches and landings data etc. have all resulted in removal of the data and consequently management advice from working and study groups that has a greater degree of uncertainty. This has led to widespread distrust of the assessment results by the industry, and has had undesirable consequences at every level of the fishery management process.

Collaborative fishing surveys are being carried out in the North Sea by fishers and scientists within several EU Member States. The surveys have common characteristics: use of commercial boats and gears to conduct surveys that are scientifically monitored and whose design is based on fisher's knowledge of the area to be surveyed. The surveys have improved data collection and agreement on the local stock dynamics and fisheries interactions and have been used to give localised management advice. However, within the North Sea, the surveys generally cover restricted areas and consequently the results are not considered to reflect abundance trends across the North Sea as a whole. The wider the area of coverage, the greater the potential utility of such information, but also increased cost to individual countries.

Although there are common methodologies and objectives across the surveys there has been no international coordination and comparison of results. Potentially, if target species are consistent across surveys and stock dynamics are estimated by integrated analysis across the variety of gear types and methodologies used, a combined analysis could provide the industry with a stock survey that would complement the International Bottom Trawl Survey (IBTS), especially at the older ages at which catch numbers are low.

Collaborative surveys in the North Sea

A review was conducted of the information available from countries conducting collaborative fishing surveys within the North Sea. There were two main objectives of the study:

- To provide the an inventory of industry surveys that can be used by analysts responding to requests for advice from the NSRAC and other management agencies.
- Classification of the surveys in order to identify common characteristics that would allow the integration of information within and across areas for example; vessel type, fishing gear, target and by-catch species.

Five collaborative surveys, one historic, three current and one new in 2009 were found to be suited to aims of the review. Table 1 presents the survey series, the years over which they have been conducted, the areas of study, the target species and gear types. Appendix 1 lists each survey and provides more details of its characteristics with references to the main information source.

Two of the surveys were comparable in terms of the species targeted, the information collected and the survey protocols, the English North East Coast survey and the Danish REX project. The newly commissioned English FSP North Sea gadoid survey, which was designed in collaboration with this project, will complement these surveys as its time series develops. The Scottish survey is targeted at anglerfish and megrim, but does have a by-catch of whitefish although currently they are not recorded by the observers. The English Lemon sole survey has been terminated but has provided useful information on catches of lemon sole and plaice and also the by-catch rates of cod.

Potentially data from the Scottish, two English and Danish surveys which all cover commercial fishing grounds using trawl gears, three of which target whitefish and one which has a by-catch of whitefish, could be analysed to provide integrated indices of abundance in the future. Unfortunately for this project the Scottish survey did not record the data for cod (only) until 2009 and it is therefore too early to establish whether the information on by-catch species is utilizable.

The utility of the data from the English and Danish surveys is analysed in the following sections of this report. It is shown that, although the time series over which the standardised Danish survey has been conducted is too short to allow quantitative comparisons between surveys, the results from analysis within surveys are directly comparable and give similar conclusions as to the catch rates of cod in recent years. As the time series of Danish data develops more complex analyses will be conducted to compare results.

Summary

Four collaborative fishing surveys that being conducted in the North Sea by fishers and scientists by EU Member States, and one historic survey, have been identified. Three of the surveys have common characteristics in targeting whitefish, specifically whitefish in the North Sea, a fourth survey targets anglerfish and megrim in the northern North Sea and the fifth is a recent but completed study of flatfish catch with by catches in the central North Sea.

Each survey is providing valuable localised information about specific fisheries, species dynamics and by-catches. Only the Scottish anglerfish and megrim survey is designed to provide sufficient spatial coverage to be considered as collecting representative data for analysis of the dynamics a stock (northern anglerfish) in isolation. However, the English North East Coast whitefish, the Danish REX, the English North Sea gadoids survey provide potential for the future combination of the surveys as the Danish and gadoid surveys develop time series; the anglerfish survey could be added to this in time if data is collected on gadoid catches and would be a valuable addition due to its coverage of the northern area.

The time series over which the standardised Danish survey has been conducted is too short to allow quantitative comparisons between the comparable English and Danish surveys. However, the analysis within surveys gives results that are directly comparable and has been used to demonstrate the similarity of catch rate trends on differing substrates. The study shows the utility of industry validated data in the solution of problems that are of concern to them. As the time series of data develop more complex analyses can be conducted.

The possibility of the inclusion of commercial vessel surveys into a North Sea fishers index similar to that of the IBTS is feasible and warrants further investigation. Scientists and fishers are already collaborating in the development of a number of studies and bringing them together to formulate an industry survey of the North Sea is a realistic ambition. Such a programme would require

substantial initial effort to set it up and then less but significant input to ensure standardisation across time. Vessel and gear selection criteria, survey areas and times agreed by the industry, as have been set out for the individual FSP surveys would ensure standardisation.

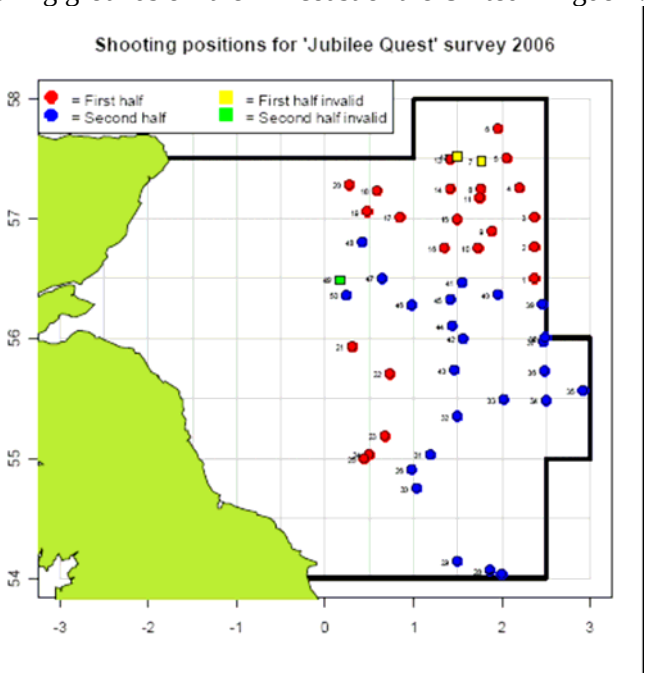
It is unlikely that the information would be used initially due to the short time series and management of expectations is critical, but as the data collection progresses there is no reason to doubt that such series would contain sufficient information to be used in the stock assessment process. In the short term the information would achieve two essential purposes, to involve industry directly in data collection and to facilitate industry science discussions on the interpretation of the results.

Appendix 1 North Sea Fisheries Science Partnership programmes

The North Sea lemon sole FSP (UK – England and Wales, Cefas)

Survey

A UK Fisheries Science Partnership survey was carried out in August 2004 and June-July 2005 and 2006 on the lemon sole and plaice fishing grounds off the NE coast of the United Kingdom.



Objective

To quantify the catch of lemon sole and plaice and the associated by-catch and to compare age and size compositions of target species and of cod over the three years 2004-2006; the dominant component of the retained catch was flatfish (plaice, lemon sole and witch), with haddock making up the bulk of the balance.

Vessel and gear

A single commercial twin-rig trawler using gear described in the reference; the surveys in 2005 and 2006 used 100 mm cod-ends throughout, whereas a mixture of mesh sizes was used in 2004.

General

The FSP survey provided data on catch compositions over a wide area of the fishing grounds off the NE coast of the United kingdom, using a vessel, gear and fishing method typical of the flatfish fishery.

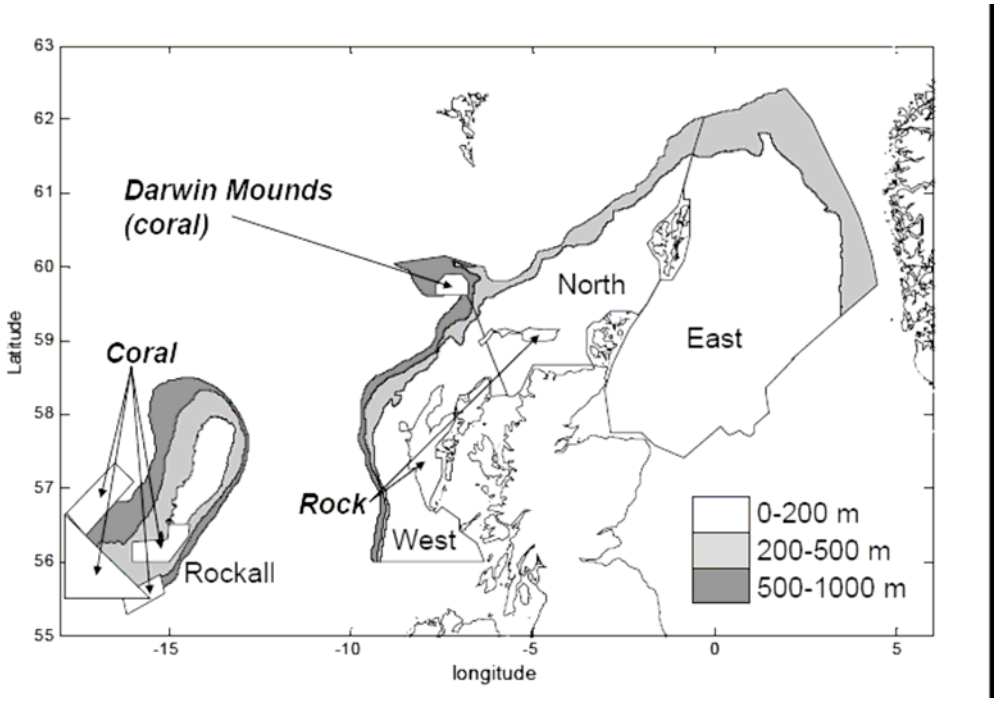
Reference

Parker-Humphreys, M., Randolph Velterop and Robert Bush Final Report. Programme 11: North Sea lemon sole and plaice Fisheries Science Partnership: 2006/07
http://www.cefas.co.uk/media/40271/fsp200607prog11nsealemonsolefinal.pdf

The Northern Shelf Anglerfish (UK Scotland - FRS)

Survey

A Fisheries Science Partnership survey carried out in April of each year since 2005 covering the area of the known distribution of northern shelf anglerfish (ICES Divisions IVa, VIa and VIb at Rockall).



Objective

To produce an absolute abundance estimate of anglerfish (i.e. a total number and biomass of anglerfish), as opposed to an index of relative abundance which is normally produced from surveys; and to involve the fishing industry throughout, from planning through to the execution of the surveys.

Vessel and gear

One research vessel and three commercial vessels all towing the same rock-hopper gear type, agreed in discussions with the industry, described in the reference material.

General

Species other than anglerfish and megrim were not recorded until 2009 when cod were also measured recorded by length for the first time.

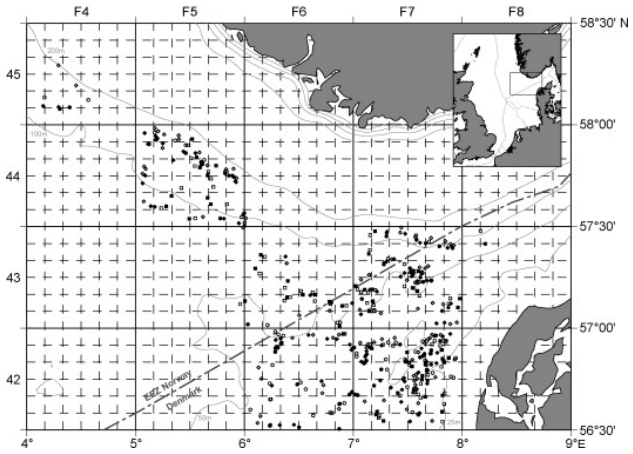
Reference

Fernandes, P.G., Armstrong, F., Burns, F., Copland, P., Davis, C., Graham, N., Harlay, X., O'Cuaig, M., Penny, I., Pout, A.C. and Clarke, E.D. (2007). Progress in estimating the absolute abundance of anglerfish on the European northern shelf from a trawl survey. *ICES CM2007/K:12*, 14 pp.
http://www.ices.dk/products/CMdocs/CM-2007/K/K1207.pdf

The REX project (Denmark, DTU-Aqua)

Survey

A collaborative fisheries science project examining spatial dynamics in the catch rates of North Sea cod (REX); conducted biannually from June 2006 - February 2009 on commercial fishing grounds off the west coast of the Denmark



Objective

To provide information on the distribution, density and size composition of cod catches with respect to bottom type and provide local comparisons with the ICES IBTS survey.

Vessel and gear

Three commercial vessels representing different fishing methods: a twin trawler, a fly-shooter and a gill-netter.

General

During the first two surveys in 2006 the fishermen were almost free to select the fishing positions, resulting in clustering, with most of the stations mainly located on rough ground. The survey design was changed in January/February 2007, in order to allow investigation of a potential effect of bottom type and modified further in August 2007 since when the design has been standardised. The survey area is divided into 5 * 5 nmi squares; with randomly selected fishing positions within the square chosen by the fishermen; at least 25 % of the stations on sand.

An additional survey was conducted with the fly-shooter in the western Skagerrak in September 2007 and a survey with three other commercial vessels in the western and eastern Skagerrak in June/July 2008.

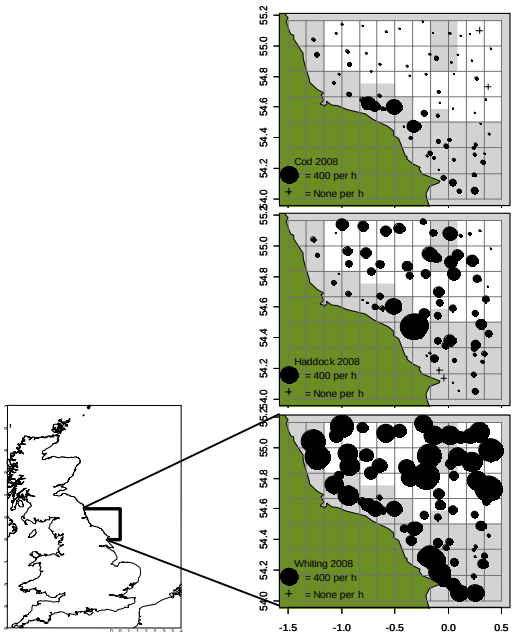
Reference

Wieland, K., E.M. Fenger Pedersen, H.J. Olesen & J.E. Beyer (2009a): Catch rates of North Sea cod depending on bottom type. Fish. Res. 96: 244-251.

The North East cod FSP (UK – England and Wales, Cefas)

Survey

A UK Fisheries Science Partnership survey conducted in October from 2003 - 2008 on the main grounds for cod and allied species fished by bottom trawlers operating from ports on the NE coast of the United Kingdom.



Objective

To provide year-on-year comparative information on distribution, relative abundance and size/age composition of NE coast cod and whiting. The surveys also provide data on catches of other species important to the NE coast fishery, including haddock

Vessel and gear

The surveys in 2003 and 2004 were exploratory using a range of gears several vessels. The survey has been standardised since 2006 to use a commercial trawler and standard gear described in the reference

General

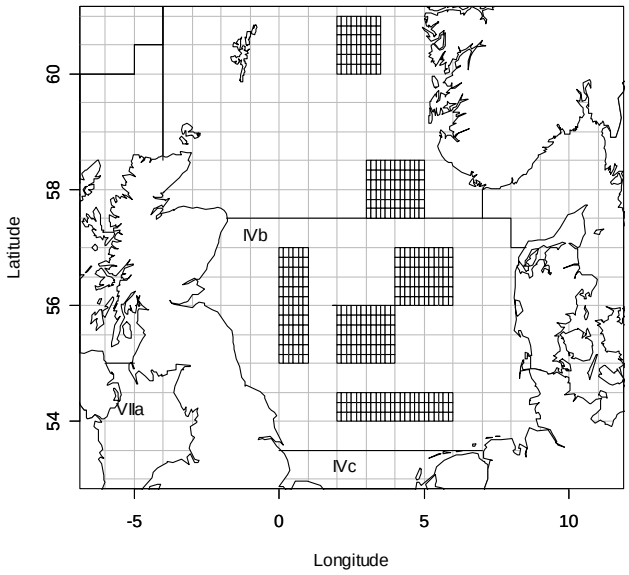
The FSP survey provided data on catch compositions over a wide area of the fishing grounds off the NE coast of the United kingdom, using a vessel, gear and fishing method typical of the flatfish fishery.

Reference
José De Oliveira, Guy Pasco, Mike Armstrong and Peter Randall. Final Report, North East Cod Survey, Fisheries Science Partnership: 2007/08
http://www.cefas.co.uk/media/130764/fsp200809necodfinal.pdf

The North Sea whitefish FSP (UK – England and Wales, Cefas)

Survey

A UK Fisheries Science Partnership survey conducted in June - July from 2009 on the main fishing grounds for whitefish in the North Sea.



Objective

To provide year-on-year comparative information on distribution, relative abundance and size/age composition of North Sea whitefish from six industry selected areas on hard and soft substrate. The surveys also provide data on catches of other species including flatfish.

Vessel and gear

The survey was conducted in 2009 for the first time by a commercial trawler independent hard and soft ground trawl gears.

General

Within each survey area 9 hard and 9 soft ground sub-rectangles are to be selected during the initial year. In subsequent years the rectangles shall be fished again but the skipper has discretion to move the tow within them.

Reference
http://www.cefas.co.uk/ (in press due September 2009)

2.3.3 Surveys with commercial fishing vessels: results from a Danish collaborative biologist-fishermen project on spatially-explicit management methods for North Sea cod (REX), June 2006 – February 2009

Report 3 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea. Reference: SI2.464218

Kai Wieland, Eva Maria Fenger-Pedersen, Hans J. Olesen, Jan. E. Beyer
Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua)

L-426
Flyshooter

L-757
Trawler

L-353
Gillnetter

Introduction

Commercial CPUE series are not included in the tuning procedure of the assessment for North Sea cod and the tuning solely depends on indices from the International Bottom Trawl Survey (IBTS) conducted in the 1st and the 3rd quarter of the year. Fishermen, however, do not consider the IBTS as representative for the stock status as the commercial fishery maintained viable catch rates also in areas where the IBTS reported no or low densities of cod above minimum landings size. The fishermen complained that the IBTS does not cover rough bottom where highest commercial CPUE of cod is usually obtained and have thus a much less pessimistic perception of the status of the stock than the most recent assessments suggested. Against this background, a collaborative biologist-fishermen project on spatially-explicit management methods for North Sea cod (REX) was initiated by DTU-Aqua (National Institute of Aquatic Resources at the Technical University of Denmark) and the Danish Fishermen Association in summer 2006. Three commercial vessels representing different fishing methods participated in the study. These were a trawler, a flyshooter and a gillnetter, and the initial survey area consisted of 7 ICES statistical rectangles in the north-eastern central North Sea. The main objective of the surveys has been to provide information on distribution, density and size composition of North Sea cod in particular in respect to bottom type and for comparison with the IBTS.

Material and Methods

Survey strategy

During the first two surveys in June and August 2006 the fishermen were almost free to select the fishing positions. This resulted in a few clusters of stations accumulating in the favourite areas of the fishermen with most of the stations mainly located on rough bottom which is usually not covered by scientific bottom trawl surveys. In order to allow an unbiased investigation of a potential effect of bottom type, the fishermen were requested to select paired stations within 10 * 10 nmi squares with one station on sand bottom and the other one on other bottom types (gravel and stone bottom as well as ship wrecks in the case of the gillnetter) during the next two surveys in January/February and June 2007. In order to obtain a better impression on the spatial distribution in a wider area, a higher degree of randomisation in the survey design was used in surveys conducted in August 2007 and thereafter (survey area divided into 5 * 5 nmi squares; randomly selected with fishing position with the square chosen by the fishermen; at least 25 % of the stations on sand bottom, number of squares to covered in an ICES rectangles differed between the vessels to account for differences in fishing method; Tab. 1). This strategy was also used in an additional survey with the flyshooter in the western Skagerrak in September 2007 and in a survey with three other commercial vessels in the western and eastern Skagerrak in June/July 2008.

Vessel and fishing gear specifications

The flyshooter L-426 used ropes of 3100 m length and a diameter of 50 mm. Duration of the operation from setting the buoy to the recovery of the net was approximately 2 hours of which fishing time amounted usually to 1 hour. According to the length of the ropes each set covered an area of about 1 nmi² at each set. Hence, catch per tow can directly be considered as a measure of catch per unit effort (CPUE). All fishing operations were conducted during daylight because catch rates depend critically on visibility for this fishing method. Three different nets were used during survey 1 to 3. These were a flatfish net, a roundfish net with medium-sized rubberdisks (diameter: 10” (25.4 cm) in the middle section and 8” (20.3 cm) in the wings) in the groundrope and a roundfish net with 2” larger rubberdisks. The flatfish net was used on sand bottom, the roundfish net equipped with the large rubberdisks on rough ground and the roundfish net with medium-sized

rubberdisk on all bottom types. In the later surveys, all fishing was conducted with the medium-sized rubberdisk roundfish net. This net has an overall length of 91 m. The length of the ground rope is 36.2 m, which gives a wingspread of 8 to 10 m during normal fishing operation, and the maximum vertical opening is about 7 to 8 m. The mesh size in the codend has been 100 mm in all of the three nets.

The trawler L-757 fished with two trawls of the same type simultaneously with a roller clump between them (double trawl fishing). If valid, the catches of the two trawls were added or the catch of the one trawl was multiplied by two if one trawl was damaged. Stations with damages of both trawls were rejected as invalid. Towing time varied from 0.5 to 3.75 hours but was between 1 and 2 hours in most cases, and total catch by station was transformed to CPUE (in kg/hr) accordingly. Towing speed was usually about 3 knots, and trawling was conducted from early morning to late evening but not during the night. Trawl doors were Thyborøn type 4 96" (4.84 m², 900 kg) on the first three surveys and Thyborøn type 11 92" (4.33 m², 900 kg) on the two later surveys. The weight of the roller clump between the two trawls was 1000 kg in both cases. Total doorspread was monitored with a Simrad ITI system. Two combitrawls for flat- and roundfish were used during survey 1 to 3 and a part of survey 4. These trawls had a total length of 63.8 m and were equipped with small rubber disks (6 and 8" at wing section, 10" in the middle section; total ground rope length: 57.7 m, with 3 chains of subsequent shorter length in front). Vertical opening was about 3 – 3.5 m at normal operation. The combitrawls performed well on sand and on gravel while problems occurred on stone bottom. Hence, the combitrawls were replaced by rockhopper roundfish trawls in the later part of survey 4 and during survey 5 in order to allow fishing also on rougher bottom. The rockhopper trawls had an overall length of 65.0 m and the groundrope consisted of 10" and 12" rubberdisks in the wing and the central section, respectively. The total groundrope length amounted to 34.9 m, and vertical opening was usually about 6 – 6.5 m. Depending on water depth, door spread ranged from 195 to 240 m for the combitrawl stations and from 170 to 200 m at the rockhopper trawl stations. The meshsize in the codend of the combitrawl was 100 mm and has been 105 mm in the codend of the rockhopper trawl.

The gillnetter L-353 used set of nets with a combination of three different meshsizes. In general, 18 nets were used on each station (6 * 65 mm + 6 * 75 mm + 6 * 85 mm), but in some cases when fishing at isolated structures such as ship wrecks or on top of small stone reefs a lower number of nets of each mesh size were used. Soaking time of the nets varied between 6 and 27 hours and was about 14 hours on average with no systematic difference in respect of bottom type. CPUE at a station was calculated as catch per net and hour of fishing.

Results

Effect of bottom type on catch rates

In general, mean survey CPUE (in weight per unit effort) was considerably lower on sand than on gravel or stone bottom or at ship wrecks (Fig. 1). An analysis using paired data from all survey from August 2006 to June 2008 revealed that the difference of CPUE in respect to bottom category was highly significant in all seasons except for the flyshooter in winter and for the trawler in summer and winter (Wieland et al. 2009a). An update of this analysis, which includes results from the surveys in August/September 2008 and January/February 2009, revealed a highly significant difference in the CPUE also for the winter surveys with the trawler, and suggest that the negative results for the winter surveys (January/February) with the flyshooter and the summer surveys (June) with the trawler may be due to the relative low number of observations (Tab. 2, Figs. 2a-c) rather than to seasonal effects, and that substantial higher CPUE on rough than on smooth bottom (Tab. 3) is a general phenomenon at current population size.

Mean ratios of CPUE on the two bottom types were below 1 for all three fishing methods considering the past five surveys with 'restricted-random- allocation of sampling locations. So far, these CPUE ratios show no relation with density (Fig. 4) which may indicate that the proportion of the population living on smooth bottom has not changed in the most recent years.

Age dependent catchability in the IBTS

The 1st and 3rd quarter surveys in 2008 conducted with the trawler and the flyshooter had the widest spatial overlap with the IBTS (Tab.1, Fig. 5) and were therefore selected for a detailed comparison. Length distributions indicate that the IBTS catches fewer large cod although they are well presented in commercial catches from the same area and time of the year (Fig. 6). Length frequencies were converted to age distributions using combined age length data from the IBTS and commercial samples from the Danish fishery for the central and north-eastern North Sea including the Skagerrak. Age distributions by statistical rectangle were averaged for the overlapping areas weighted by the number of stations in each rectangle. Cod at age 1 were not well represented in the catches of the trawler and the flyshooter due to mesh size selection in both quarters (Fig. 7a,b). Cod at age 5 and older were rare in the 3rd quarter IBTS in both quarters, but occurred in the catches of the commercial vessels (Fig. 7b). CPUE ratios by age computed as $CPUE_{IBTS}$ divided by $CPUE_{commercial\ vessel}$ show an exponential decline from age 2 to 3 and an increase beyond age 4 for the 1st quarter and a continuous but moderate decrease with age for the 3rd quarter (Fig. 8). The age specific CPUE ratios for IBTS vs. trawler and IBTS vs. flyshooter were combined using an adjustment for the mean CPUE ratio of age 2 to 6 for each vessel. Linear regressions with the log transformed CPUE ratios for the combined data revealed that the changes in catchability with age in the IBTS compared to the commercial catches are highly significant for both quarters (1st quarter: $P < 0.01$, age 3 to 6; 3rd quarter: $P < 0.01$, age 2 to 6). Resulting IBTS index multipliers required for achieving equal catchability for the older ages relative to age 3 (1st quarter) and age 2 (3rd quarter) amounted to 0.4 and 2.6 for age 5, respectively (Tab. 4). These results were not affected by the low number of stations in the IBTS compared to the commercial vessel as similar slopes for the catchability ratios by age were obtained when adding 16 (1st quarter) or 14 (3rd quarter) adjacent statistical rectangles, which increase the number of IBTS stations included in the comparison to 46 and 44, respectively (Fig. 9).

CPUE ratios by bottom type showed not clear pattern concerning changes with age for the trawler in both quarters and for the flyshooter in the first quarter (Fig. 10). In contrast, an increase of the proportion of cod older than age 3 on sand bottom is indicated for the flyshooter in the third quarter 2007 and especially in 2008 (Fig. 10). The later was due to relative high sand bottom catches at three stations in the statistical rectangles 43F6 and 43F7 in areas of high sandeel densities according to the observed stomach contents of the cod there, and such areas were obviously not sampled by the IBTS in that year (Fig. 5). Hence, there is no indication that the varying efficiency in the IBTS with age is due a change of the distribution of cod towards rough bottom with increasing age in the 3rd quarter. Trawl avoidance or selection issues alone, however, would not explain that the difference in the pattern between the first and the third quarter. Behavioural factors may play a role as well and clustered aggregations of spawning cod in the first quarter may not be detected representatively by the IBTS due to the its relative coarse station grid. The pattern of age dependent catchabilities and its remarkable difference between the 1st and the 3rd quarter, however, needs confirmation with more years of data and for other parts of the stock area.

Year class strength and trends in biomass

Flyshooter and gillnetter CPUE's for age 2 in the 3rd quarter suggest the strength of the 2006 year class was higher than the 2005 year class at that age while the corresponding data from the trawler show the opposite (Tab. 5). The 1st quarter data for the trawler suggest that the 2007 year class being considerably stronger than the 2006 year class at age 2. Both the 2005 and the 2006 year class were considered to be small in the ICES assessment (ICES 2008), and results from 4 statistical rectangles with about 10 stations in each on average are not sufficient to validate a general increase in recruitment. Scaling catch rates from the 3rd quarter surveys with the flyshooter and the trawler in the north-eastern central North Sea with IBTS indices revealed that the age 2+ biomass in the entire North Sea may have increased faster than the SSB estimated in the assessment (Fig. 11). However, the approach applied in that study would require more years of data and further analyses for validation and should not be interpreted as an alternative assessment.

Summary and Conclusions

Catch rates of all three commercial vessels were consistently lower on sand bottom than on gravel/stone bottom or at ship wrecks, but so far no relation between the proportion of the population found on the different bottom types with stock density was found. This, however, is based on a few years of data and hence, the hypothesis that IBTS indices, which area mainly derived from smooth bottom stations, are biased can yet not be rejected. The IBTS indices cover only a relative low part of the population and a bias is introduced to the assessment if the distribution of the stock changes towards rough bottom at low stock sizes and thus the proportion of the stock fished by the IBTS is not longer constant.
The comparison of catch rates at age from the commercial vessel with IBTS indices revealed that the efficiency of the IBTS may vary substantially with age. It appears therefore highly desirable if representative time series of commercial CPUE could be re-introduced in the tuning of the assessment model. Such data, however, may not exist to date, and in this case collection of the required information e.g. from surveys with commercial vessels covering a sufficient large part of the stock distribution area is urgently needed.

References

ICES (2009): Report of the Working Group on the assessment of demersal stocks in the North Sea and Skagerrak (WGNSSK), May 2009.
Wieland, K., E.M. Fenger Pedersen, H.J. Olesen & J.E. Beyer (2009a): Catch rates of North Sea cod depending on bottom type. Fish. Res. 96: 244-251.
Wieland, K., M. Vinther, E.M. Fenger Pedersen, H.J. Olesen & J.E. Beyer (2009b): Estimating biomass of North Sea cod from surveys with commercial vessels and IBTS indices. WD#6 ICES WKROUND, 16-26 January 2009, Copenhagen.

Acknowledgements

We gratefully acknowledge the co-operation with skipper Tonny Nees and his crew on the flyshooter, with skipper Tamme Bolt and his crew on the trawler and skipper Kenneth Nielsen and his crew on the gillnetter. Many thanks go also to Kurt Madsen (Chairman of Fishermen Association Thyborøn) for coordinating the activities of the commercial vessels. The 'REX ' project is funded by the Danish Ministry of Food, Agriculture and Fishery (DFFE).

Table 1: Survey dates, area coverage and station allocation strategies.

Survey period	Days at sea	ICES Rectangles *	Survey strategy
June '06	4	42F6, 42F7	A) no restrictions concerning station selection
Aug '06	9	43F6, 43F7, 42F6, 42F7	
Jan/Febr '07	9	44F5, 43F7, 42F7	B) pairs of different bottom types within 10 nmi distance
June '07	6	43F6, 43F7, 42F6, 42F7	
Aug '07	9	44F5, 43F6, 43F7, 42F6, 42F7	C) 'restricted-random': ICES rectangles divided in 5 * 5 nmi squares;
Febr '08	9	45F4, 44F5, 42F6, 42F7	75 % of squares randomly selected,
June '08	5, 6 *	43F7, 42F6, 42F7	25 % of squares selected by fishermen**;
Aug/Sept '08	12, 13, 14 *	44F5, 43F5, 43F6, 43F7, 43F8, 42F6, 42F7	at least 25 % of the stations on sand bottom;
Jan/Febr '09	12, 14 *	45F4, 44F5, 44F6, 43F5, 43F6, 43F7, 42F6, 42F7	fishing positions within 5 * 5 nmi squares choosen by fishermen

*: differed between vessels; no gillnetter in June '08, no flyshooter in Jan/Febr '09

**: appr. 10 to 12 random selected squares (out of 36 if all suitable in respect to depth (< 200 m) and bottom condition) per rectangle for trawler and flyshooter, higher number of pre-selected 'micro-squares' for gillnetter (results in a lower number of rectangles covered in the same survey period)

Table 2: Number of paired stations with different bottom types by vessel and gear ([a)] flatfish net on sand, roundfish net on gravel and stone bottom; [b)] roundfish net on both bottom types).

Survey	Dates	Flyshooter different gear [a)]	Flyshooter same gear [b)]	Trawler Combitrawl	Trawler Roundfish trawl	Gill-netter	
1	12 - 15 Jun 2006	2	-	10	-	4	
2	6 -1 8 Aug 2006	3	3	12	-	14	
3	29 Jan - 6 Feb 2007	10	3	17	-	17	
4	10 - 15 Jun 2007	-	13	2	7	10	
5	20 - 30 Aug 2007	-	12	-	20	8	*
6	13 - 21 Feb 2008	-	9	-	14	10	*
7	9 - 15 Jun 2008	-	7	-	7	-	*
8	27 Aug - 11 Sep 2008	-	15	-	21	17	*
9	21 Jan - 5 Feb 2009	-	-	-	18	16	*

* surveys were conducted with 'restricted-random' station allocation and pairs within 12 nmi distance were selected afterwards

Table 3: Statistical tests and analysis results for the effect of bottom type at paired stations.

Fishing method	Survey dates	Number of observations	Normality test at P = 0.05	Statistical test	Significance (P-value)
Flyshooter *	all months	77	failed	Wilcoxon Signed Rank test	P < 0.001
	January/February	22	passed	paired t-test	n.s. (0.456)
	June	22	passed	paired t-test	P < 0.001
	August/September	33	failed	Wilcoxon Signed Rank test	P < 0.001
Trawler **	all months	87	passed	paired t-test	P < 0.001
	January/February	32	passed	paired t-test	P < 0.05
	June	14	passed	paired t-test	n.s. (0.154)
	August/September	41	passed	paired t-test	P < 0.001
Gillnetter	all months	96	passed	paired t-test	P < 0.001
	January/February	41	passed	paired t-test	P < 0.001
	June	14	passed	paired t-test	P < 0.001
	August/September	39	passed	paired t-test	P < 0.001

*: all data
**: only roundfish rockhopper trawl

Table 4: CPUE ratios IBTS vs. Trawler and IBTS vs. Flyshooter combined for the 1st and 3 quarter 2008and IBTS index multipliers for compensation of changing efficiency of the IBTS for older ages of cod in the north-eastern central North Sea.

1st quarter 2008

Age	CPUE ratio regression *	relative to age 3	IBTS index multiplier
2	-	-	-
3	0.42	1.00	1.0
4	0.67	1.61	0.6
5	1.08	2.58	0.4
6	1.73	4.15	0.2

3rd quarter 2008

Age	CPUE ratio regression *	relative to age 2	IBTS index multiplier
2	1.66	1.00	1.0
3	1.20	0.72	1.4
4	0.87	0.52	1.9
5	0.63	0.38	2.6
6	0.46	0.28	3.6

*: age 2 to 6, log-transformed

Table 5: Numbers at age for vessel and quarter specific areas (statistical rectangles with comparable coverage given in brackets, numbers in italics are not representative due to changes in survey design or mesh size selection).

a) Flyshooter, mean CPUE (n/nmi^2)

1st quarter (44F5)

Age/Year	2007	2008	2009
2	*29.1*	13.5	-
3	*10.2*	15.5	-
4	*4.5*	5.7	-
5	*3.4*	2.4	-
6	*1.3*	0.7	-
7+	*1.2*	0.5	-
total age 2+	*49.6*	38.2	

3rd quarter (43F7, 42F6, 42F7)

Age/Year	2006	2007	2008
2	*285.2*	316.6	384.1
3	*94.0*	128.2	165.9
4	*24.9*	24.9	40.0
5	*11.7*	7.0	13.6
6	*2.8*	1.7	4.0
7+	*1.3*	0.7	1.5
total age 2+	*419.9*	479.2	609.0

b) Trawler, mean CPUE (n/h)

1st quarter (45F4, 44F5, 42F6, 42F7)

Age/Year	2007	2008	2009
2	-	8.6	18.9
3	-	6.0	8.6
4	-	2.6	4.1
5	-	1.3	2.2
6	-	0.3	0.7
7+	-	0.2	0.3
total age 2+	-	19.0	34.8

3rd quarter (44F5, 43F7, 42F7)

Age/Year	2006	2007	2008
2	-	103.8	70.8
3	-	36.0	25.8
4	-	6.7	4.3
5	-	1.2	1.0
6	-	0.3	0.3
7+	-	0.1	0.1
total age 2+	-	148.1	102.4

c) Gillnetter, mean CPUE (n/net/h)

1st quarter (44F5, 42F7)

Age/Year	2007	2008	2009
2	*0.027*	*0.022*	*0.005*
3	*0.096*	0.064	0.043
4	*0.087*	0.061	0.055
5	*0.042*	0.032	0.036
6	*0.010*	0.008	0.011
7+	*0.003*	0.002	0.005
total age 2+	*0.266*	0.189	0.157

3rd quarter (43F6, 43F7)

Age/Year	2006	2007	2008
2	*0.019*	*0.026*	*0.035*
3	*0.033*	0.058	0.078
4	*0.023*	0.057	0.051
5	*0.018*	0.040	0.032
6	*0.007*	0.012	0.010
7+	*0.005*	0.007	0.007
total age 2+	*0.105*	0.200	0.214

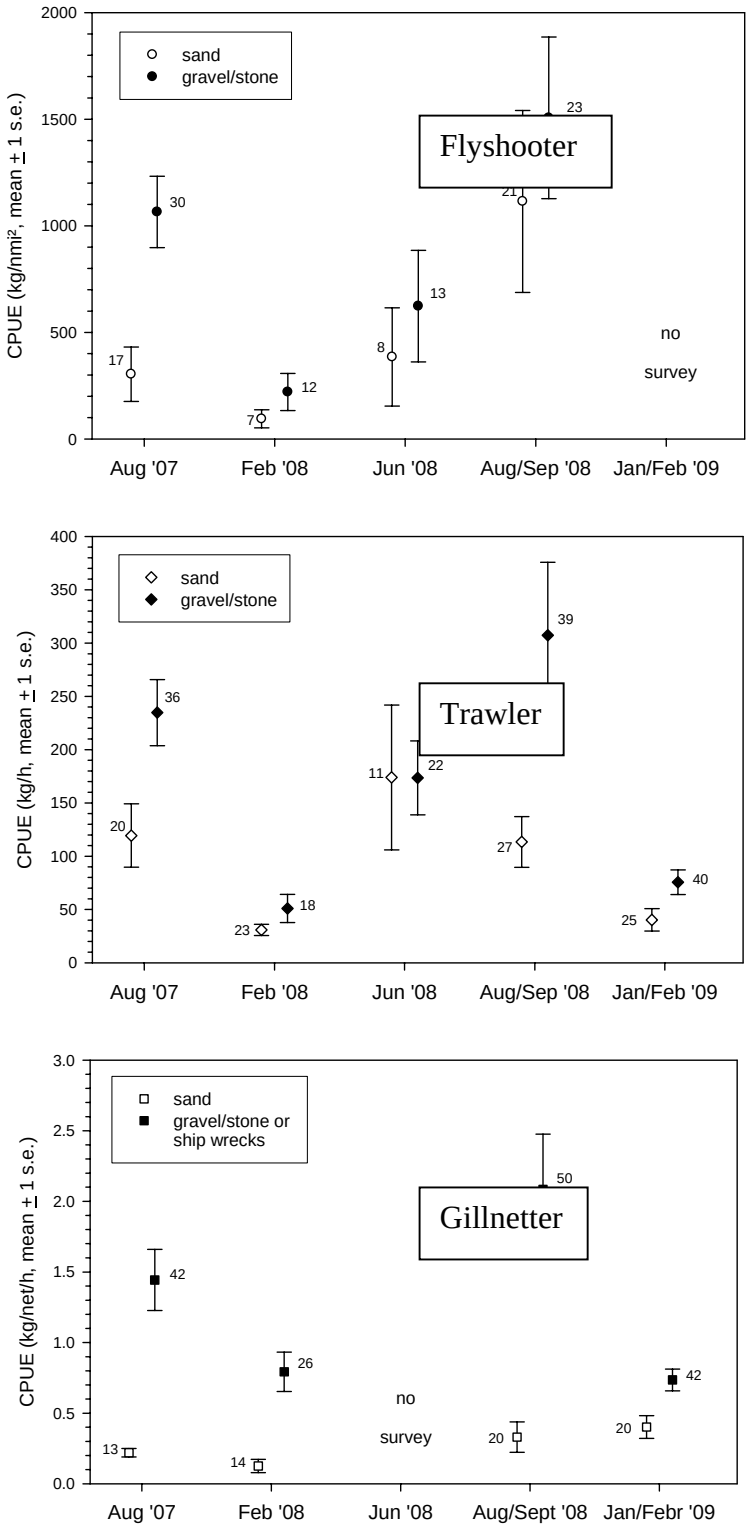


Figure 1: Comparison of mean survey CPUE on sand and on gravel or stone bottom and at ship wrecks (only surveys conducted with ‘restricted-random’ station allocation and ICES rectangles in which at least 80 % of the planned coverage was obtained considered; number of stations denoted at symbols).

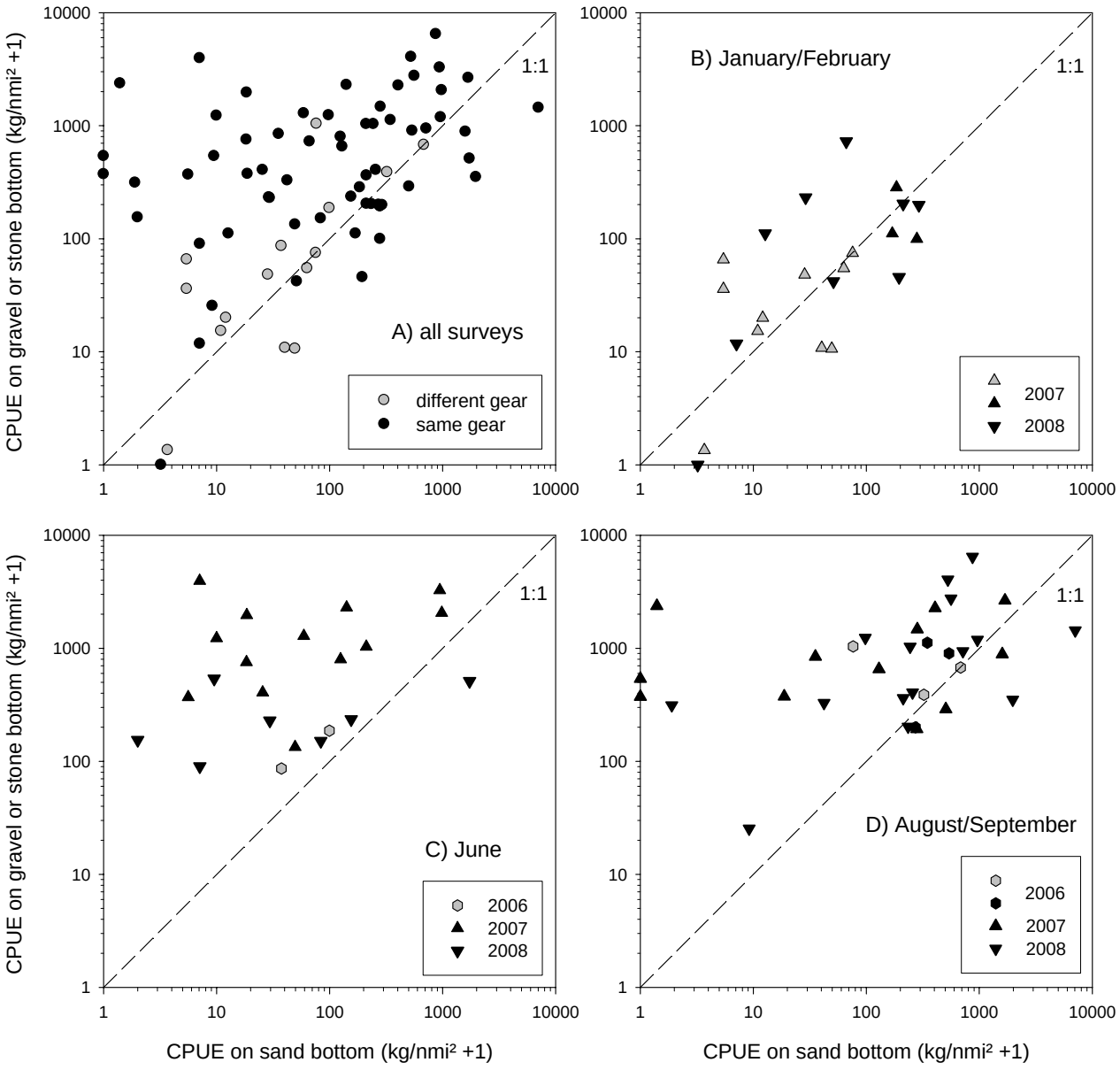


Figure 2a: Comparison of catch rates of cod in respect to bottom type based on paired stations for the flyshooter (different gear: flatfish net on sand and roundfish net on gravel or stone bottom, same gear: roundfish net on both bottom types; average distance between members of a pair 5 nmi).

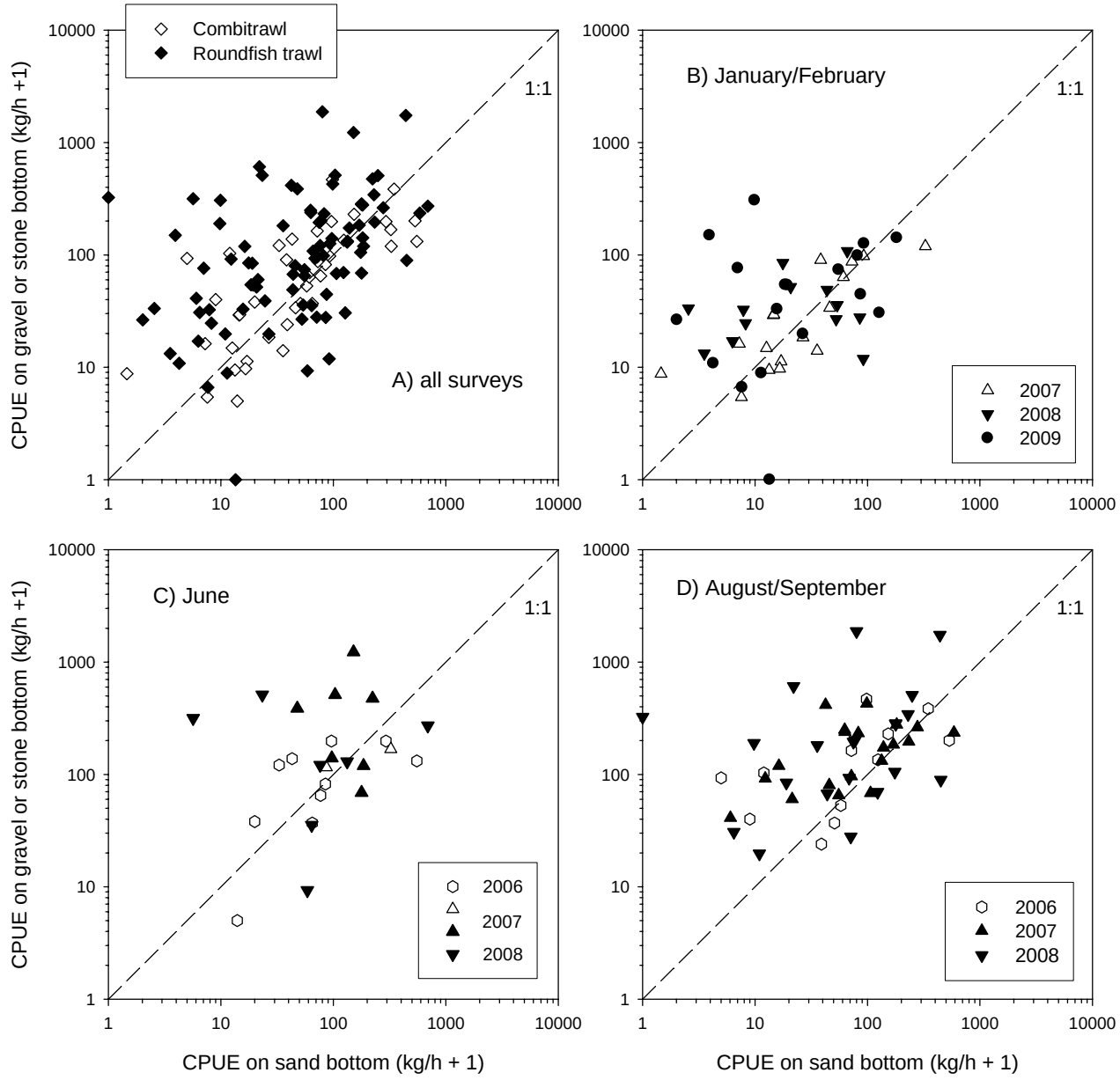


Figure 2b: Comparison of catch rates of cod in respect to bottom type based on paired stations for the trawler (average distance between members of a pair 5 nmi).

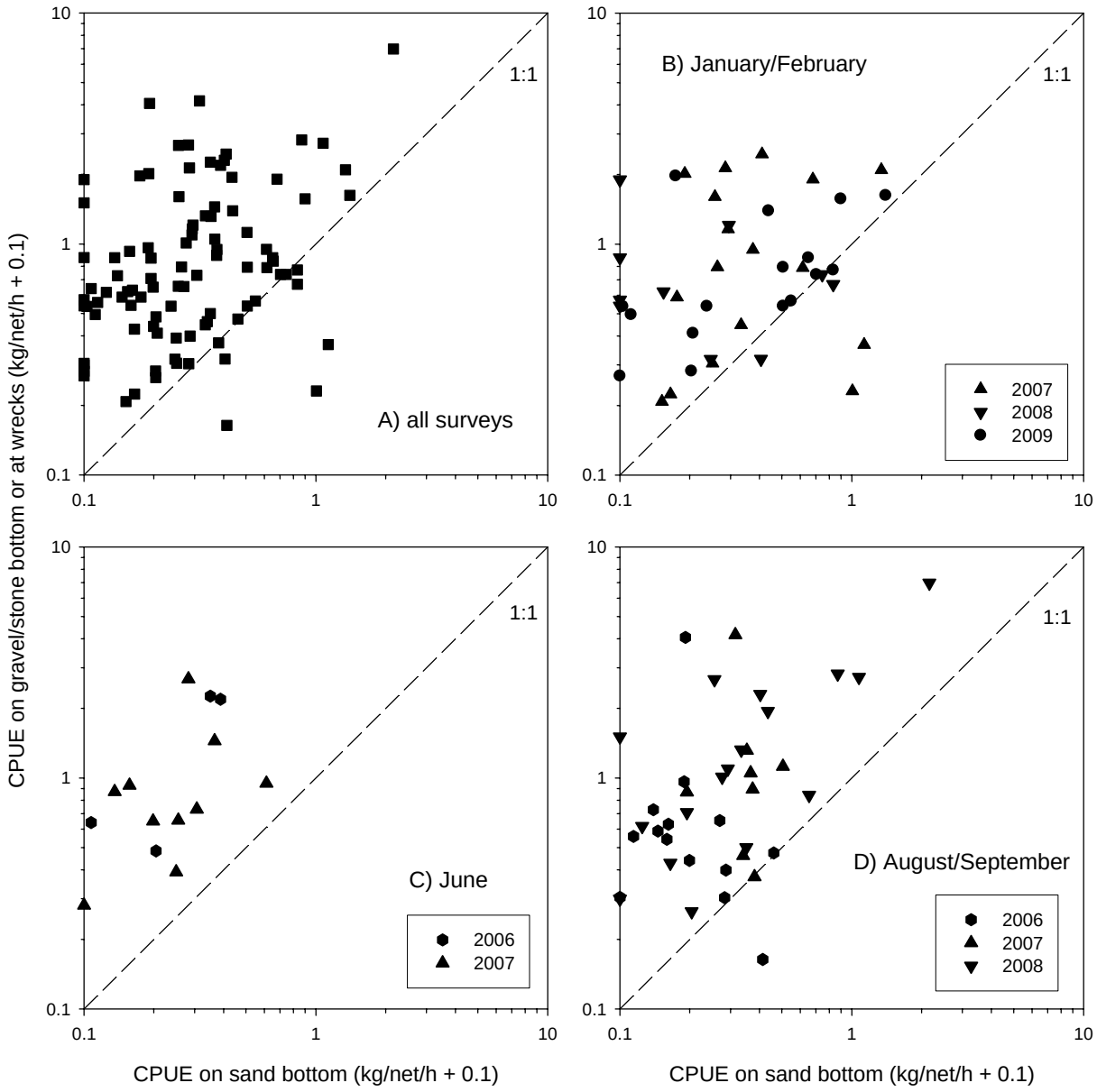


Figure 2c: Comparison of catch rates of cod in respect to bottom type based on paired stations for the gillnetter (average distance between members of a pair 2 nmi).

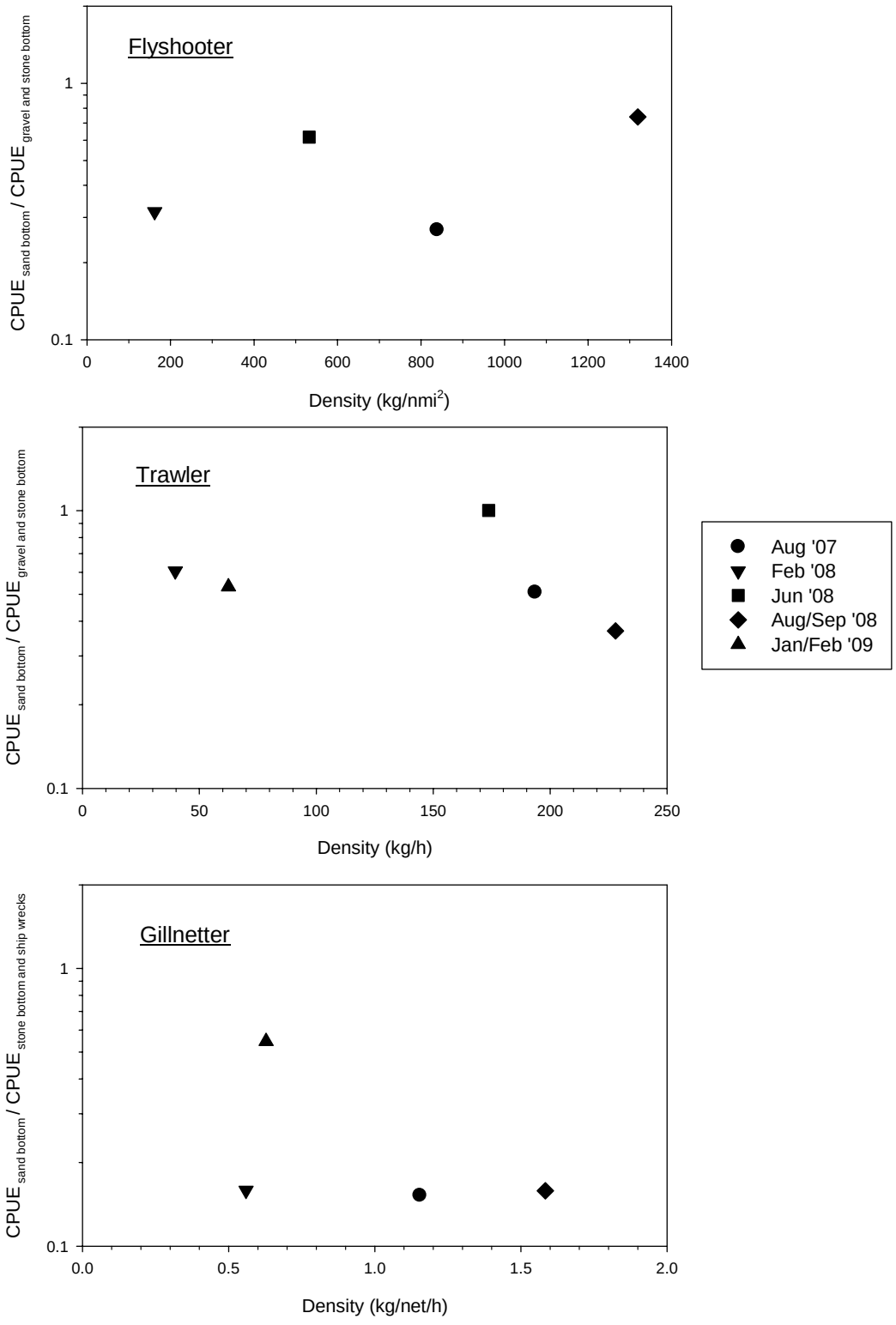


Figure 4: Ratio of CPUE on sand bottom and CPUE on other bottom types in relation to survey mean density of cod (only surveys with 'restricted-random' station allocation considered).

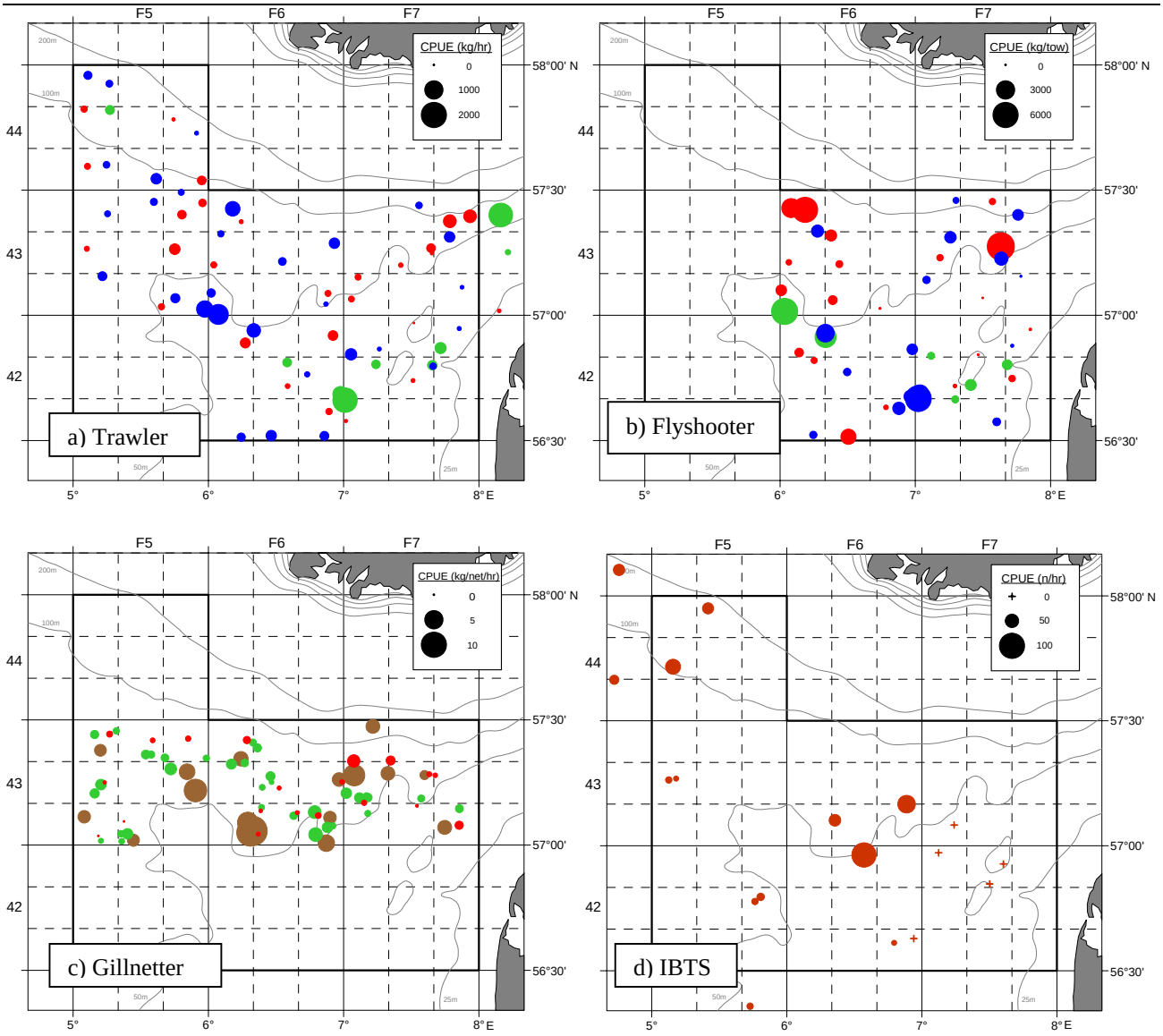


Figure 5: Distribution of cod in the north-eastern central North Sea in August/September 2008. a) Trawler, b) Flyshooter (each 'tow' covered 1 square nautical mile), c) Gillnetter. (red: sand, blue: gravel, green: stone and stone reefs, brown: ship wrecks), d) IBTS age 2+.

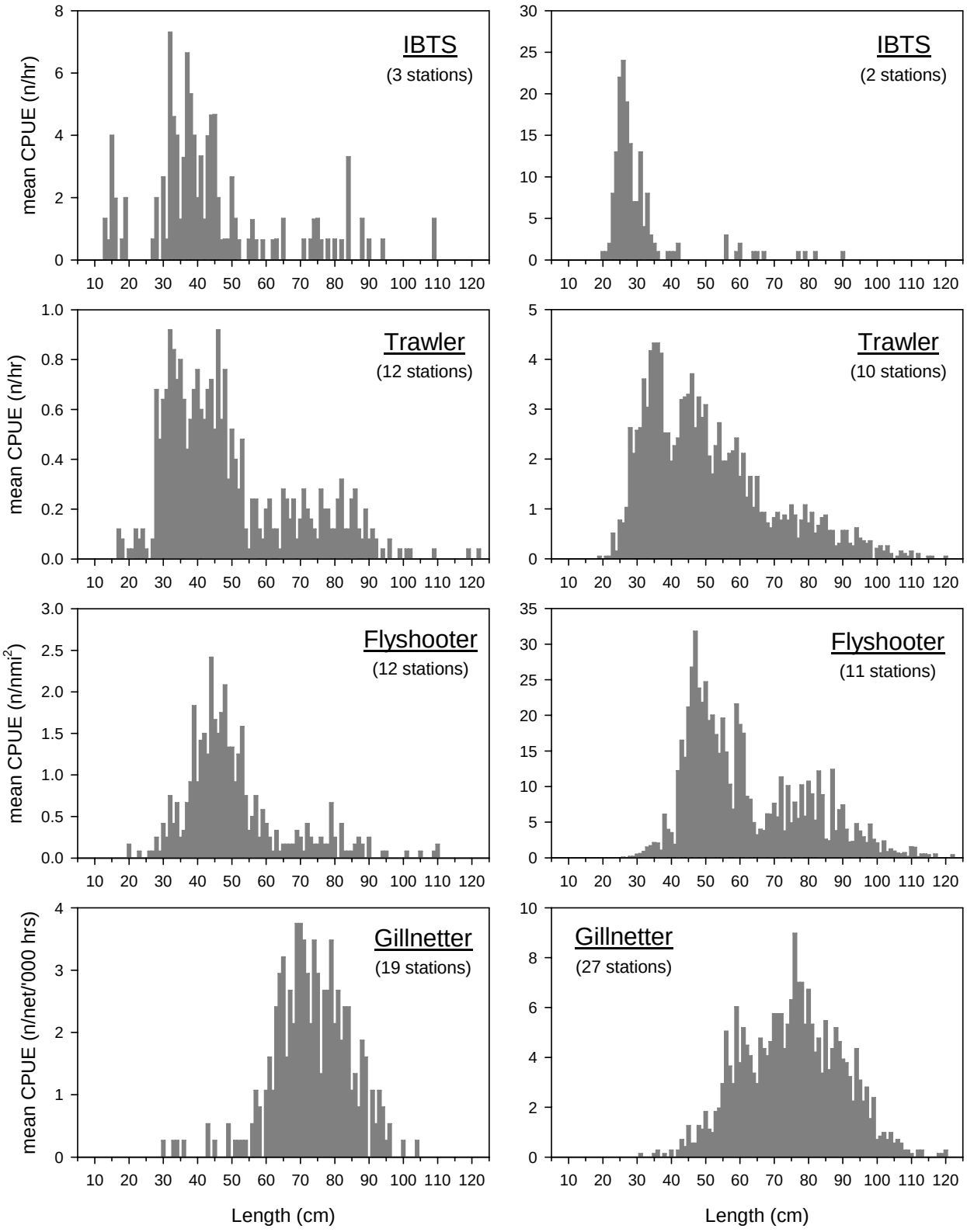


Figure 6: Cod length frequencies (examples), 1st quarter 2008 ICES rectangle 44F5 (left column) and 3rd quarter 2008 ICES rectangle 43F6.

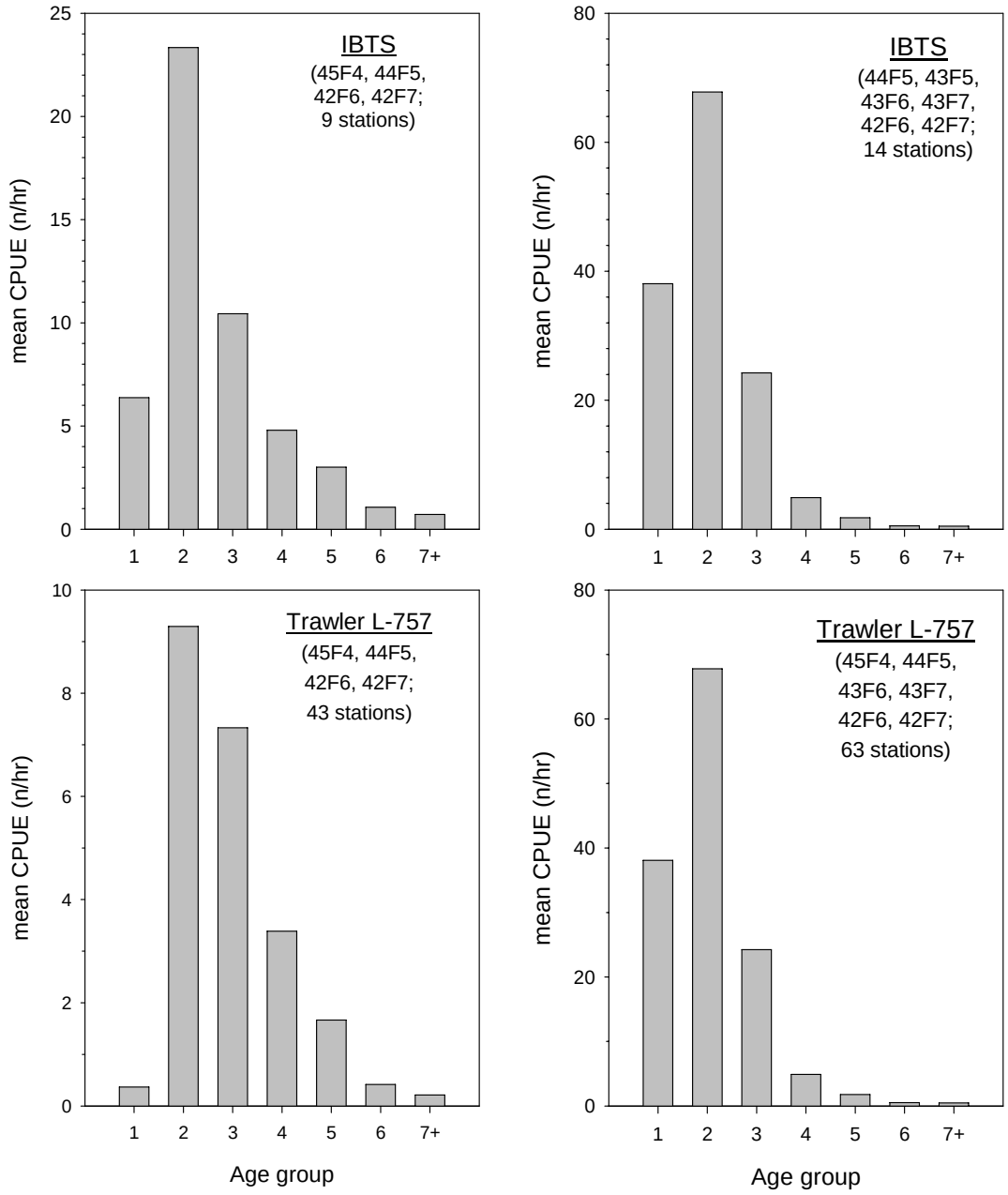


Figure 7a: Cod age distributions for vessel specific areas in the 1st quarter 2008 (statistical rectangles and number of stations given in brackets).

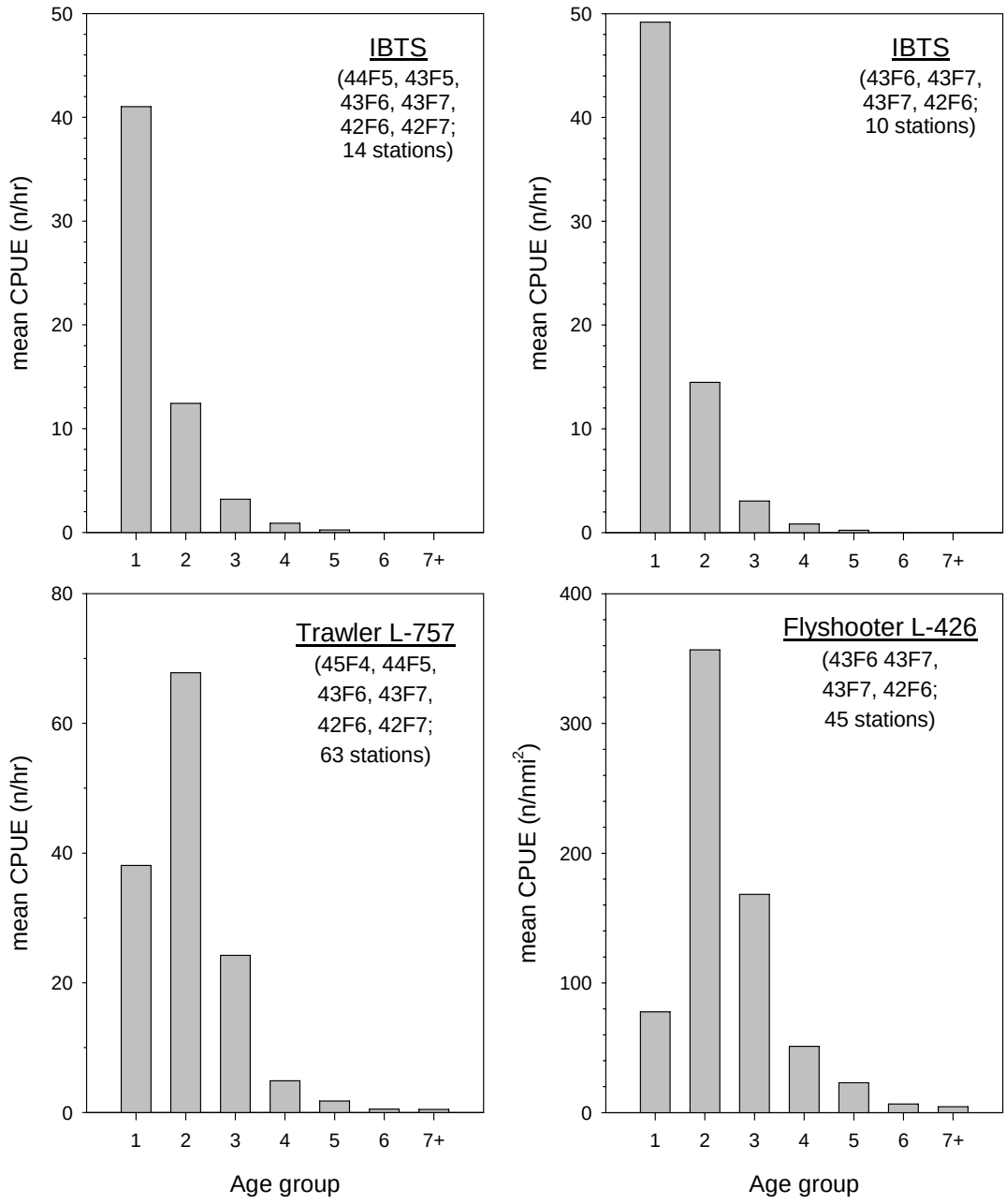


Figure 7b: Cod age distributions for vessel specific areas in the 3rd quarter 2008 (statistical rectangles and number of stations given in brackets).

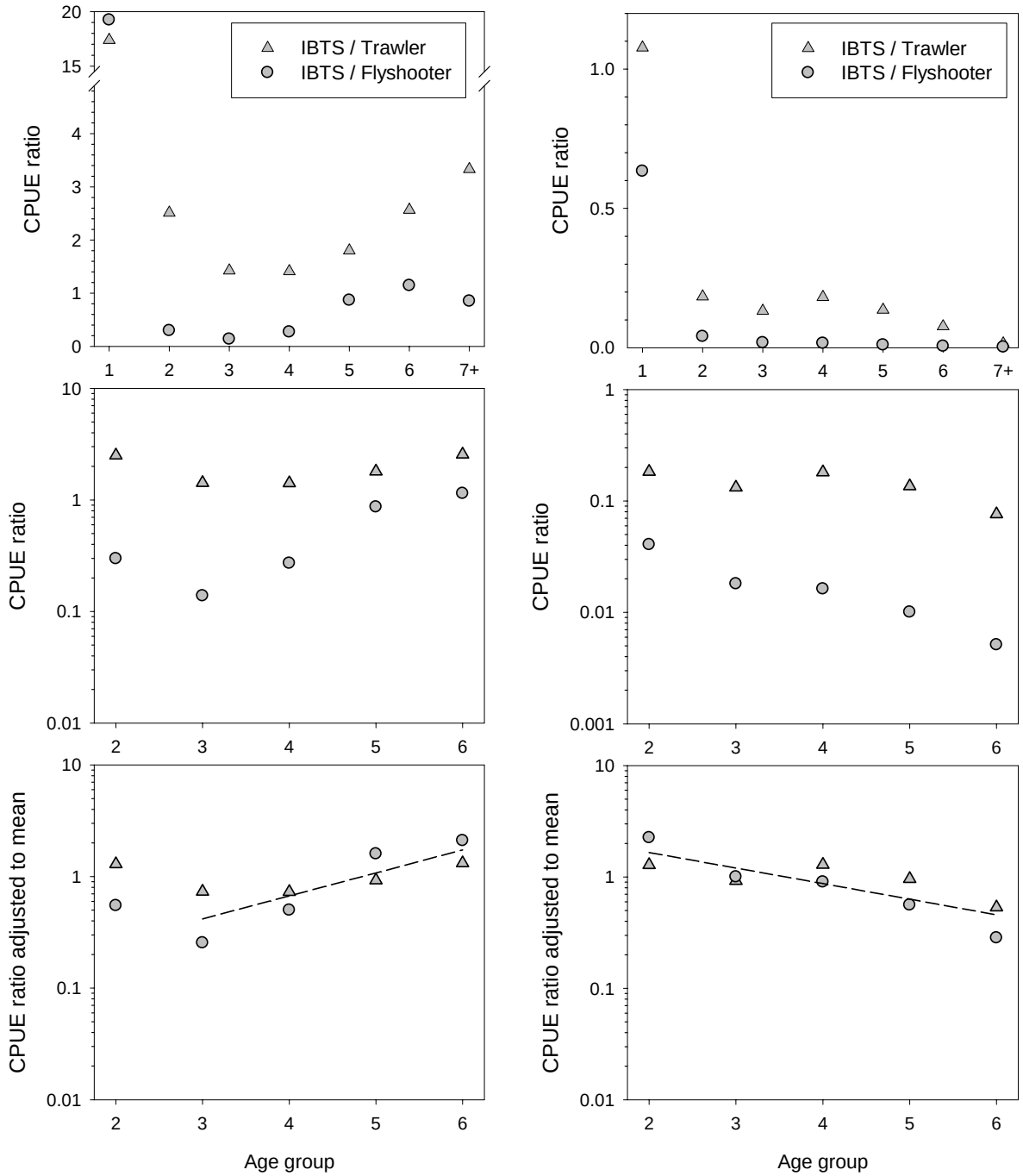


Figure 8: CPUE ratios IBTS vs. Trawler L-757 and Flyshooter L-426 for the 1st quarter 2008 (left column) and the 3rd quarter 2008 (right column) for overlapping areas.

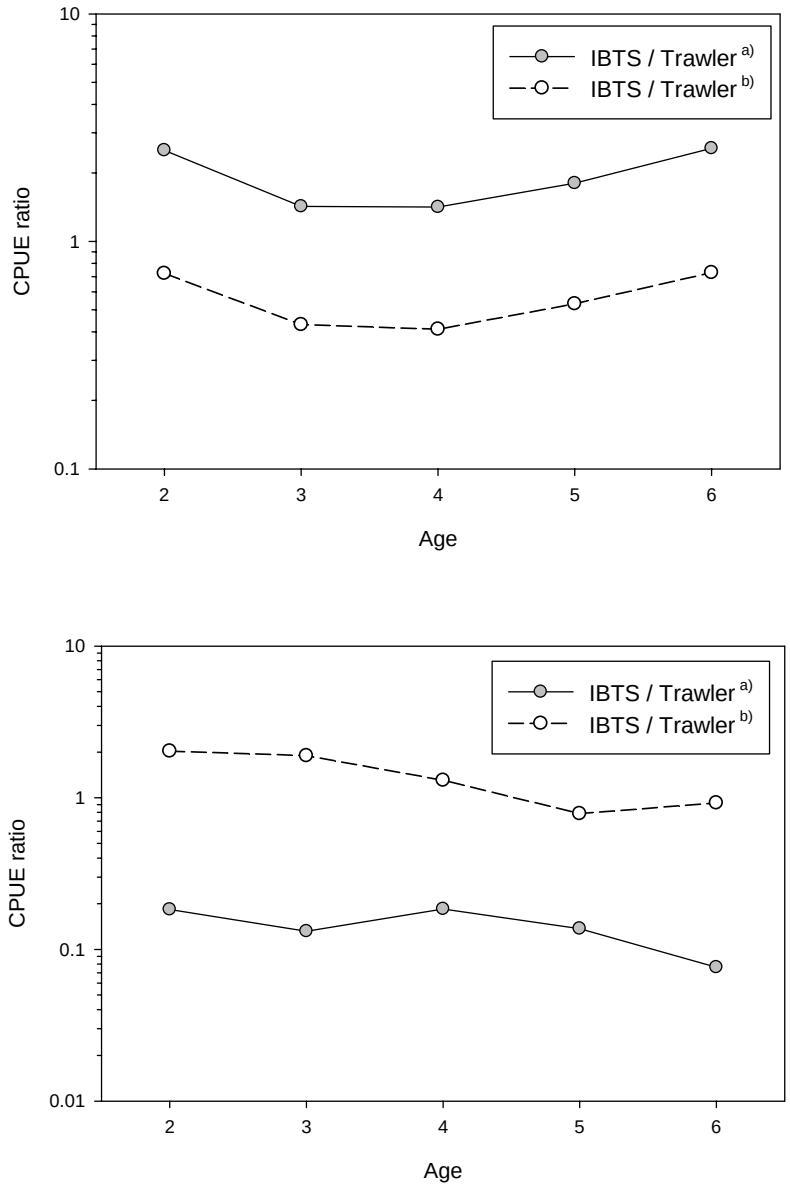


Figure 9: CPUE ratios IBTS vs. Trawler L-757 for the 1st quarter 2008 (upper panel) and the 3rd quarter 2008 (lower panel) for the overlapping and an extended IBTS area.

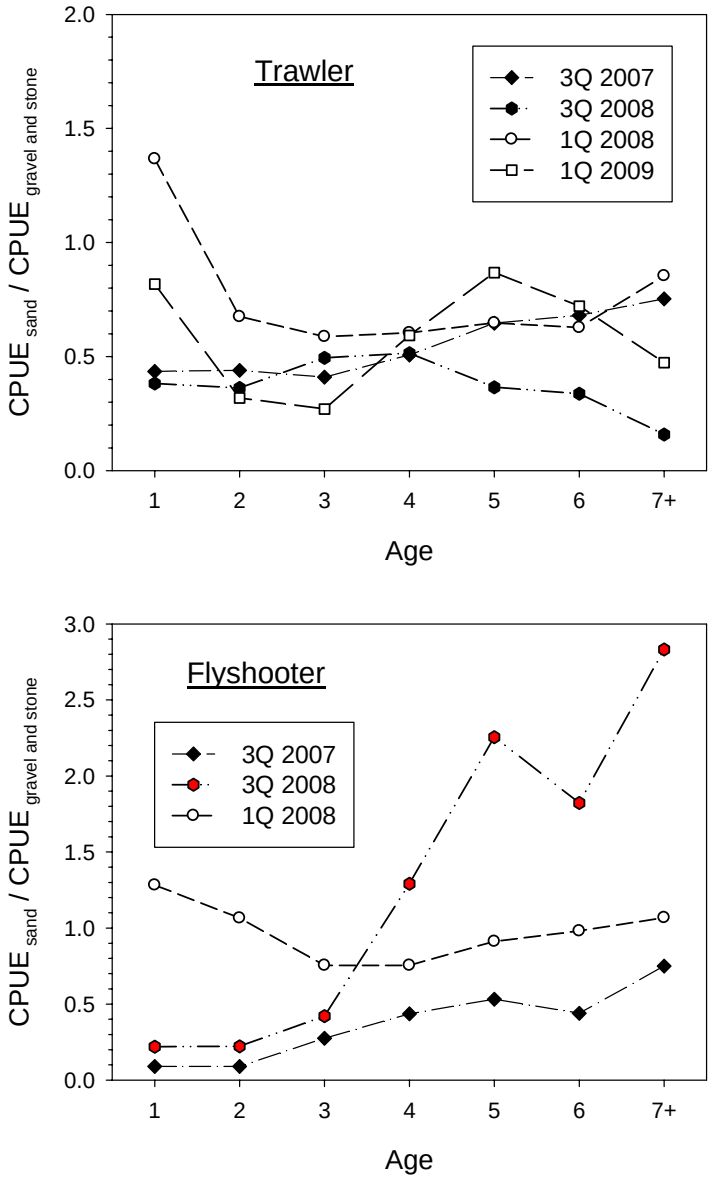


Figure 10: CPUE ratios on sand vs. gravel and stone bottom for the trawler L-757 and the flyshooter L-426 (only surveys conduted with 'restricted-random' station allocation considered).

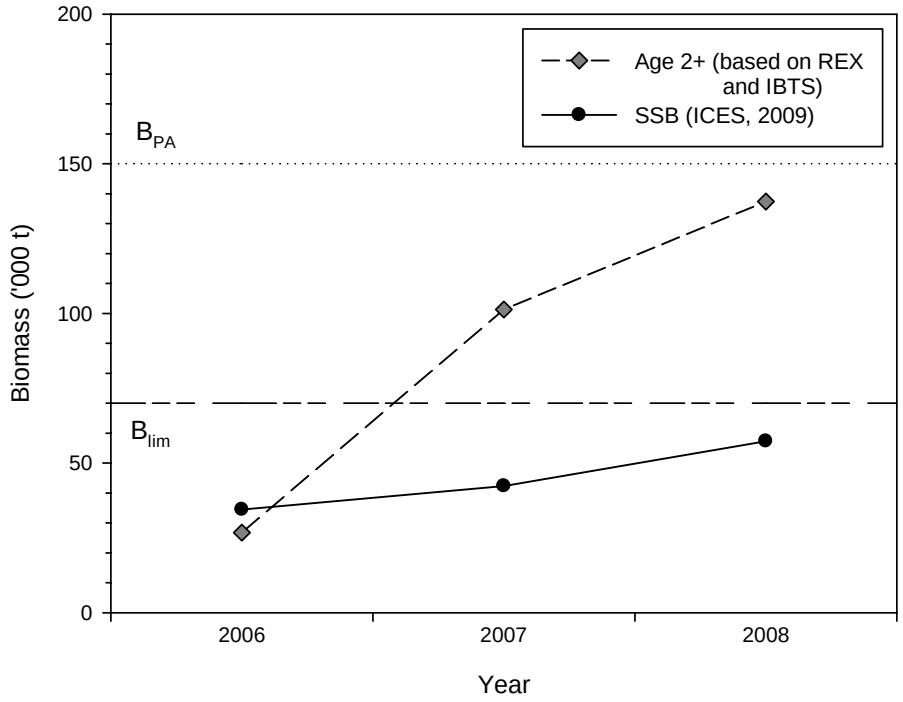


Figure 11: Comparison of cod age 2+ biomass estimated from surveys with the trawler and the flyshooter in the north-eastern central North Sea scaled to entire North Sea using IBTS indices with the estimate of spawning stock biomass from the most recent assessment (see Wieland 2009b for details on method).

2.3.4 Analysis of hard and soft ground survey catches based on the UK North East Coast Cod Survey

Report 4 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea
Reference: SI2.464218

Chris Darby, Matthew Parker-Humphreys, José De Oliveira Cefas

Introduction

It is of the greatest importance to the management of the North Sea stocks that fishermen and scientists agree on the basic data that goes into stock assessments so that decisions can be made with greater accord. The benefits include increased compliance, reduced uncertainty and therefore risk to the stock and future yields, reductions in the time taken to arrive at decisions and the costs associated with management. Within the Lot 7 EU funded project “Joint data collection between the fishing sector and the scientific community in the North Sea”, Task 3, Project (1) "Collation and Analysis of Information from Industry Science Collaborative Surveys", a study examining the commercial catch data available for hard and soft grounds was agreed with the North Sea Regional Advisory Council (NSRAC). The project was designed to improve understanding of surveys and examine one of the primary areas of concern for the industry that, based on the known cod behavioural preference for hard substrate sea bed habitat and the location of the majority of North Sea research vessel survey fishing stations on soft substrate, survey indices of cod abundance do not reflect the true dynamics of the cod stock in the North Sea. This study addresses these concerns by analysing fishers data collected as part of a time series of information from a joint industry science partnership research programme. The paper is linked to Wieland *et al* (2009), which was produced in collaboration under the Lot Project and analyses data from a similar study carried out in Danish waters.

The UK North East Coast Cod Survey

Within the UK, a Fisheries Science Partnership (FSP) programme has been established, between the Department for Environment, Food and Rural Affairs (Defra), the Centre for the Environment, Fisheries and Aquaculture Science (Cefas) and the fishing industry. Its aims are to build relationships between UK fishermen and scientists and to involve fishermen in the co-commissioning of science. The programme mainly involves chartering of fishing vessels to carry out surveys or other studies developed collaboratively between fishermen and fishery scientists at Cefas, addressing issues of relevance to fishery management and stock assessment. Fishing vessels are chartered to fish commercially to obtain data on the catch rate and size distribution of target species, and in some cases by-catch species. Cefas deploys sea-going staff to record data that are subsequently returned to the laboratory at Lowestoft for analysis.

The UK North East Coast Cod Survey (http://www.cefas.co.uk/media/37878/fsp-03-04-project-3.pdf) is a designated time-series survey conducted in the autumn since 2003 as part of the FSP program providing information on a fishery for cod off the northeast coast of England. The FSP survey mainly occurs in ICES Area 104B from 54^{o} N to $55^{o}10'$N, roughly corresponding to between Whitby and Bridlington, and out to around 30 ^{o}E (ICES statistical rectangles 37E9, 37F0, 38E8, 38E9, 38F0, 39E9 and 39F0, Figure 1). The surveys in 2003 and 2004 were largely exploratory, and examined factors such as effect of gear type and time of day on catch rates of cod

and other species (Cotter *et al.*, 2004; Armstrong *et al.*, 2005). Subsequent surveys were conducted following an open tender for a vessel to carry out the surveys using a specified gear during each of the years 2005–2007. The survey series is expected to continue on a similar basis following another open tender covering the period 2008-2010.

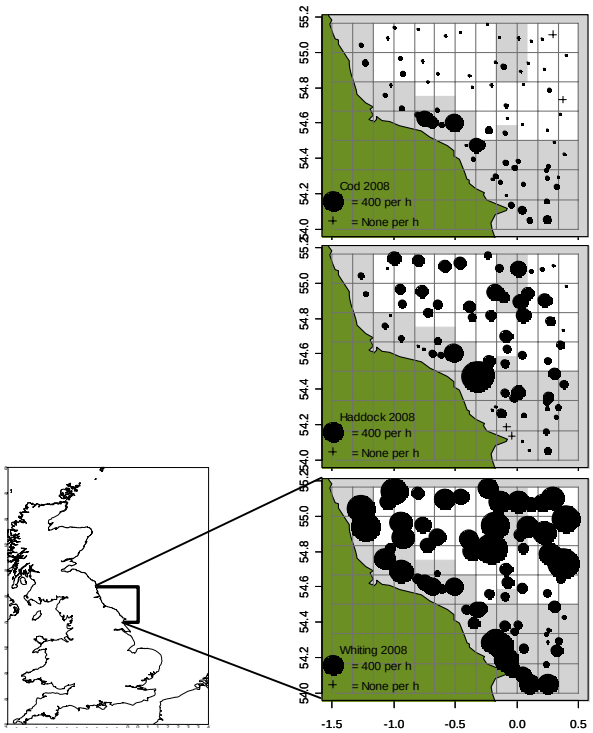


Figure 1 The distribution of cod, haddock and whiting in the 2008 FSP. Areas of spots are proportional to numbers caught per hour. Shading within the grid lines indicates area with coarse seabed type. Same scale for all plots. (From De Oliveira et al.2008 http://www.cefas.co.uk/media/130764/fsp200809necodfinal.pdf)

The objective of the NE cod survey series is to provide year-on-year comparative information on the distribution, relative abundance and size/age composition of cod and whiting off the NE coast of England. The surveys also provide data on catches of other species important to the NE coast fishery, including haddock.

The geographic limits of the survey were initially defined to encompass the main grounds for cod and allied species fished by bottom trawlers operating from ports such as Scarborough, Bridlington and Whitby on the NE coast. A routine sampling Cefas observer scheme has established that vessels using whitefish otter trawls operate mainly on the strip of coarser sediments running along the coast, particularly between autumn and spring; the area of coarse sediment is referred to as “hard ground” throughout this report. Inshore hard ground provides a typical habitat for young cod up to 2–3 years old, which remain in the area until they reach maturity then begin to migrate seasonally between feeding and spawning grounds. They are therefore present in such areas throughout the year.

The FSP surveys of NE cod in 2003 and 2004 were exploratory and investigated a series of concerns raised by the industry. They were not designed with statistical rigour in mind targeting mainly the hard ground using a variety of boats and a range of gear types. The survey was re-designed in 2005 to provide broader coverage of a range of seabed types off the NE coast, while allowing increased survey intensity on the hard ground. The same survey design was used in 2006

and 2007. A similar design but with a coarser grid and fewer stations was used in 2008 to allow for approximately a 10% curtailment of the survey due to rising fuel costs.

Fishing and sampling methods

The survey deploys a Whitby Jet otter trawl, which is used extensively by vessels off the NE coast to fish for cod. Throughout the programme, vessels have towed during night and day to allow the effect of time of day on catch rates to be investigated. Sampling of all catches is carried out using standard methods employed by Cefas fishery observers. This entails recording of the numbers and lengths of all the large or unusual fish that stand out from the rest of the catch, and sorting, counting and measuring a known fraction of the remaining catch of smaller fish. Numbers in the sample are raised up to total numbers in the haul. Data are recorded separately for fish discarded and retained for landing. Otoliths from samples of cod, haddock and whiting are taken to determine the age of the fish, and to allow the age composition of the catches to be calculated.

Analysis

The primary aim of this study is a comparison between the catch rates of cod taken on hard and soft substrate in order to establish whether there are differences in the dynamics of the abundance of cod located on the hard and soft substrate types that could result in the soft ground trawl series conducted by the ICES IBTS research survey being unrepresentative of the dynamics of the cod population. Cod was chosen for this analysis as it was the stock for which there was the greatest difference in the perception of the stock dynamics between fishers and the assessment trends as presented by the International Council for the Exploration of the Seas (ICES).

In addition to variation in habitat or substrate type several factors affect vessel catch rates. They can be divided into two categories: those resulting from the characteristics of the stock, and those influencing the fishing process. The density of fish at each trawling location is determined by the abundance of the North Sea cod stock year classes (recruitment), local distribution within the stock, exploitation and natural mortality rates, and the species preference for habitat type during resting, migration, etc. It can also be associated with prey species when feeding. Factors influencing the capture rate include the type of substrate, the type of gear in use, towing time, and to a lesser extent, tidal and weather conditions, and time of day. The gear type and towing time, restricted to 2 to 3 hours duration and standardised before analysis, are controlled in the experimental design and are therefore considered constants.

Analyses of the level and trends in indices of cod abundance by length and age were used to test the hypothesis of differing dynamics between substrates and also the time of day at which the tow was conducted. Initially, comparative plots of the annual length distributions of the cod data were used to examine the structure of the catches within sampling strata. Following the length based analysis, the numbers of fish at each length caught at each sampling station were converted to numbers at age in order to separate out the individual year classes, where overlap in length occurs, and allow a full statistical analysis of their dynamics.

Results

Length distributions

Figure 2 compares the length distributions of all cod caught by the survey for the years 2003 to 2008 by substrate type; Figure 3 presents the length distributions separated by time of day (night = 19:00 - 06:00).

Substrate type

The average annual length frequency distributions standardised to an hours tow, separated by substrate type are presented in Figure 2. A substantial difference in the catch rates at length was recorded between the hard and soft ground tows; catches of cod at all lengths are greater on the hard ground by a factor of around 3:1 in the majority of years surveyed; apart from 2008 which is 6:1. A change of vessel occurred in 2008 and also a variation in the set up the gear used on soft ground, either of these factors, as well as a change in density or fish behaviour could have resulted in the variation in the ratio of catch rates noted in the most recent survey. These factors are examined later in the analysis of aged data.

Although the absolute values differ and there is more noise in the distributions on soft ground, due to the lower catch rates, the relative proportions of fish caught at length do not appear to be influenced by ground type. The range of fish sizes caught and the structure of the distributions are equivalent between ground types; for instance, the higher frequency of 0 group fish caught at 160 - 180mm in 2005. Some variation is noted in the position of the modes of the distributions, which appear to be shifted to the right on hard ground compared to the soft, for instance 2006. This could be increased catch rates on hard ground but, given that overall there is no clear differences in the number of modes in any of the distributions, could also be faster growth in more optimum conditions.

The length data do not indicate that there are selection differences resulting from fishing on a particular ground type.

Time of day

Length distributions were derived for tows carried out at night (after 6pm) and in daylight hours (after 7am), in order to test for the influence of any behavioural pattern on the survey catch rates. Figure 3 presents the average annual length distributions of the cod standardised to one hour.

Catch rates during the night were higher in 2003 and 2007, higher during the day in 2008 and similar in all other years; there does not appear to be a consistent effect across years. The magnitude of the difference in the modes of the distribution between substrates in 2003, 2007 and 2008 is consistent with that of the difference between the catch rates on hard and soft ground in those years. Detailed examination of the time at which each substrate type was surveyed indicated that the ratio of hard to soft ground survey stations conducted during the day or night in any year resulted in the difference in the catch rates seen in Figure 3. A greater number of hard ground stations were surveyed during the night in 2003 and 2007 and during the day other years; there is an interaction between substrate type and time in the catch rates. The design of the survey, which does not stratify tows by time of day, does not allow a visual separation of the effects of time of day isolated from substrate type; this will be analysed using an analysis of variance in the age based analysis.

Age distributions

The length data for each survey haul was converted to age using age-length keys collected during each FSP survey. The age structure of the survey catches (Table 1) is dominated by the presence of juvenile cod of ages 1 - 3 and the relatively stronger 2001 and 2005 year classes, which can be tracked through the age distribution. Note that the overall means in Table 1(a) differ slightly to the values presented in the FSP reports (De Oliveira *et. al.*, http://www.cefas.co.uk/media/37878/fsp-03-04-project-3.pdf) as the mean values presented in Table 1(a) are not calculated using a substrate stratification.

Cod of the incoming year class (age 0) are caught infrequently, most notably the relatively more abundant 2005 year class. At the oldest ages, very few cod are caught at age 5 and no older fish were recorded. Data for ages 0 and 5 were excluded from the subsequent analysis to prevent the high degree of variation resulting from very low catch rates resulting in spurious model fits.

Tables 1(b) - (d) present the catch rate data separated by ground type and the ratio of the means of the ground types. In the majority of years, catch rates on hard ground are higher than those on soft. Catch rates in 2003 were of similar magnitude at the youngest ages but substantially higher on soft ground at ages 3 - 5, the only year in which this occurred. In 2008 hard ground catch rates were much higher than those on soft, which almost certainly results from the change in the gear used on soft ground in that year. The structure of the catches at age by ground type indicates similar availability of the 2001 and 2005 year classes on each ground type; which is also indicated in the ratios by year and age. There does not appear to be any correlated change in the ratios with year class strength, such that higher or lower catch rates from strong or weak classes are found predominantly on one substrate type; this is formally tested within a structured analysis in the next section.

ANOVA Modelling

An analysis of variance model was applied to the catch at age data in order to determine the significant causes of variation in catch rates within and between survey years. The sources of variation affecting catch rates that can be fitted within the model are: year class strength, catchability at age and by substrate, gear type and boat effects. The objective of the analysis was to investigate the hypothesis that catch rates recorded on different substrates (soft and hard ground) have different trends in time or give differing relative estimates of year class abundance; in other words, one would expect a significant year class - substrate interaction. The catch rate data exhibit a distribution that contains a high proportion of low abundance catch rates, consequently, after verification through exploratory analysis, a negative binomial distribution was used in the model fitting process.

Graphical pre- analysis

Figures 4 and 5 present plots for the mean catch rates of each age class on hard and soft substrate and for day and night catches on each substrate type. Higher catch rates on hard ground, at ages 1 - 3, are clearly illustrated, with higher abundance but considerably more noise at ages 4 and 5 on the same substrate. There is no clear pattern in the effect of time of day on the catch rates.

ANOVA results

Following a series of iterations to fit a variety of analysis of variance models, in which combinations of the effects of factors that could influence catch rates were examined, the significant main effects on catch rates were, as expected:

- year class strength - the 2001 and 2005 year classes are estimated to be significantly stronger than the adjacent year classes;
- age effects - which decrease as abundance decreases with increased cumulative mortality at age;
- substrate - lower catch rates on soft substrate;
- gear - the change to the set up in 2008 significantly decreased catch rates on soft ground in that year

Time of day had no significant effect on the catch rates. Model fits to the data for all years initially highlighted a significant year class - substrate interaction, indicating that there was a difference in the effect of substrate on the catch rates of at least two year classes (Table 2). Detailed analysis of the model fit and data established that this resulted from the relatively higher catch rate on soft ground at ages 3 - 5 in 2003 being estimated as significantly different from all other years in which there was an equal or higher catch rate on hard ground at those ages; a year effect noted previously in Table 1(d). A sensitivity analysis performed by removing the data for 2003, the year in which the survey was established and the formal protocol of later years had not been adopted, resulted in the fitted model showing no significant difference in the effect of substrate on catch rates for individual year classes. The significant interaction terms result from differences in the ratio of catch rates at the older ages, in the first year of the survey, noted previously. A secondary consequence of the fitting of the interaction terms for each year class and substrate is that the main effect for soft ground is estimated to be positive (Table 2) which is inconsistent with the conclusions from the previous analyses. This artefact of the model fit results from confounding between the main effect and the stronger negative estimates for each interaction, the two effects cannot be considered in isolation and are combined when final estimates are derived.

The first two years were sampled by different boats, with variations in gear type, relatively fewer soft ground stations and the fishing skippers were less constrained as to where they could fish. The less rigorous survey design and protocol for fishing in those years has most likely resulted in the observed differences in the catch rates of the oldest year classes in the analysis. If all the survey years are considered the hypothesis of no effect of substrate on estimated trends in abundance is rejected, there is an effect for the first two year classes but not for the subsequent year classes. For the years in which the survey protocol was standardised the hypothesis that catch rates recorded on different substrates have different trends in time or give differing relative estimates of year class abundance is rejected.

Prediction of the effect of substrate on year class catch rates

Without a more detailed breakdown of the protocol of the 2003 and 2004 surveys isolation of the causes of the differences in the initial survey years cannot be carried out, however a sensitivity analysis of the effect of including or excluding the interaction term in the fitted model can be evaluated by predicting the expected relative year class strength for each year on hard and soft substrate and comparing the trends. Therefore, although provisionally rejected the interactions terms were carried forward into model predictions in order to establish their impact on trends in the derived indices.

The estimates and their approximate confidence regions, based on +/- two standard errors, are presented in Figure 6. The figure highlights that, as concluded in the previous sensitivity analysis, it is the early year class abundance that is uncertain with significantly higher catch rates on soft ground. Subsequent year class abundance is estimated to have exhibited the same dynamics on each substrate type with a relatively constant change in catch rate between substrates. Although the model has estimated significant interaction effects when fitted to all survey years, apart from the

first two year classes, the estimated effects are relatively constant and the derived abundance indices have similar trends. The difference between the initial years could be a valid result, but, is most likely to result from differences in the early survey design and the impact on the predicted abundance on each substrate is marginal, in the majority of years there is no difference in the relative change in the derived abundance index on soft and hard ground.

Comparison with ICES IBTS survey data

Table 3 presents the ICES IBTS survey indices for ICES roundfish area 4, the area in which the survey is conducted. In comparison with the FSP survey catches recorded in Table 1(a), there is a similar lack of fish at older ages; the FSP which has more survey stations in the area, catches more fish at age 4, especially in recent years at low stock abundance. Data for all roundfish areas are combined to produce the index used within the ICES North Sea cod assessment and the combined index includes catches at ages 4 and 5. However, the absence of cod IBTS catches at age 4 in subarea 4, most likely due to low sample size, does give rise to concern about the utility of the IBTS data for the provision of regional indices at the oldest ages, at low abundance.

Figures 7(a) and (b) compare the estimates of year class strength from the model fitted to the NE coast FSP data with that from the IBTS survey in quarter 3 for the FSP soft and hard ground substrates respectively. The indices show similar trends in time except for the initial year class. The relatively strengths of the year class estimates are consistent between series, for instance the more abundant 2001 and 2005 year classes.

Conclusions

Analysis of the North East Coast Fisheries Science Partnership survey data has established that there is an effect of substrate type on the catch rates of cod. Catches on soft ground are, generally, significantly lower than those recorded on hard ground. Apart from the first two survey years, survey catches from each year class exhibited correlated changes in abundance on the two substrates indicating similar dynamics. Therefore indices derived from either substrate or a stratified combination of both could be used to assess the status of the stock in the area without accounting for interaction terms (such as year class – substrate). The departure from this, noted in the first two years of the survey, in which catch rates were higher on soft ground than hard, is most likely to have resulted from differences in survey protocol in those years.

In comparison with historic levels, North Sea cod stock abundance has been at a relatively low level during the period over which the North East Coast cod survey has been conducted. The 2002 and 2005 year classes have provided a contrast of relatively higher abundance that allowed the effects of increased abundance to be tested, but they are well below the levels recorded previously. Therefore, although this analysis has established that there is no significant difference in the year class abundance trends estimated on hard and soft ground, this has been for a relatively low dynamic range of stock abundances and the hypothesis cannot be extrapolated to historic stock levels. Hopefully, as the stock is rebuilt following recent reductions in mortality rates, the dynamics at higher abundances can be included in the analysis.

Relative year class strength estimates at the youngest ages of the FSP survey are consistent with those estimated by the ICES IBTS survey which is conducted in the same area on soft ground. However, due to the low catch rates by both surveys at the older (4+) ages, especially the IBTS survey, comparisons of the older fish dynamics could not be made.

Even with the high sample size conducted by the FSP, few fish older than age 5 were caught. The absence of older fish could result from high mortality rates, seasonal or permanent migration from the area and is beyond the capability of this analysis. Gaining an understanding of the reasons for this is essential to provision of advice on the dynamics of the local and North Sea cod stock distributions.

This comparison has established that the FSP survey could contribute to a larger fishery - science industry survey at the scale of the North Sea because it is providing indices of the year class abundance of the local cod stock. Surveys such as the FSP, could, if a suitable survey design and analysis procedure is applied, provide a combined index using commercial boats fishing in different areas with comparable gear types, similar to that conducted by the ICES IBTS. Such a survey would make a valuable contribution to the annual assessment process, especially at the older ages where low catch rates are recorded in the IBTS.

References

Wieland Kai, Eva Maria Fenger-Pedersen, Hans J. Olesen, Jan. E. Beyer (2009) Surveys with commercial fishing vessels: results from a Danish collaborative biologist-fishermen project on spatially-explicit management methods for North Sea cod (REX), June 2006 – February 2009 Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea. Final report. Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua)

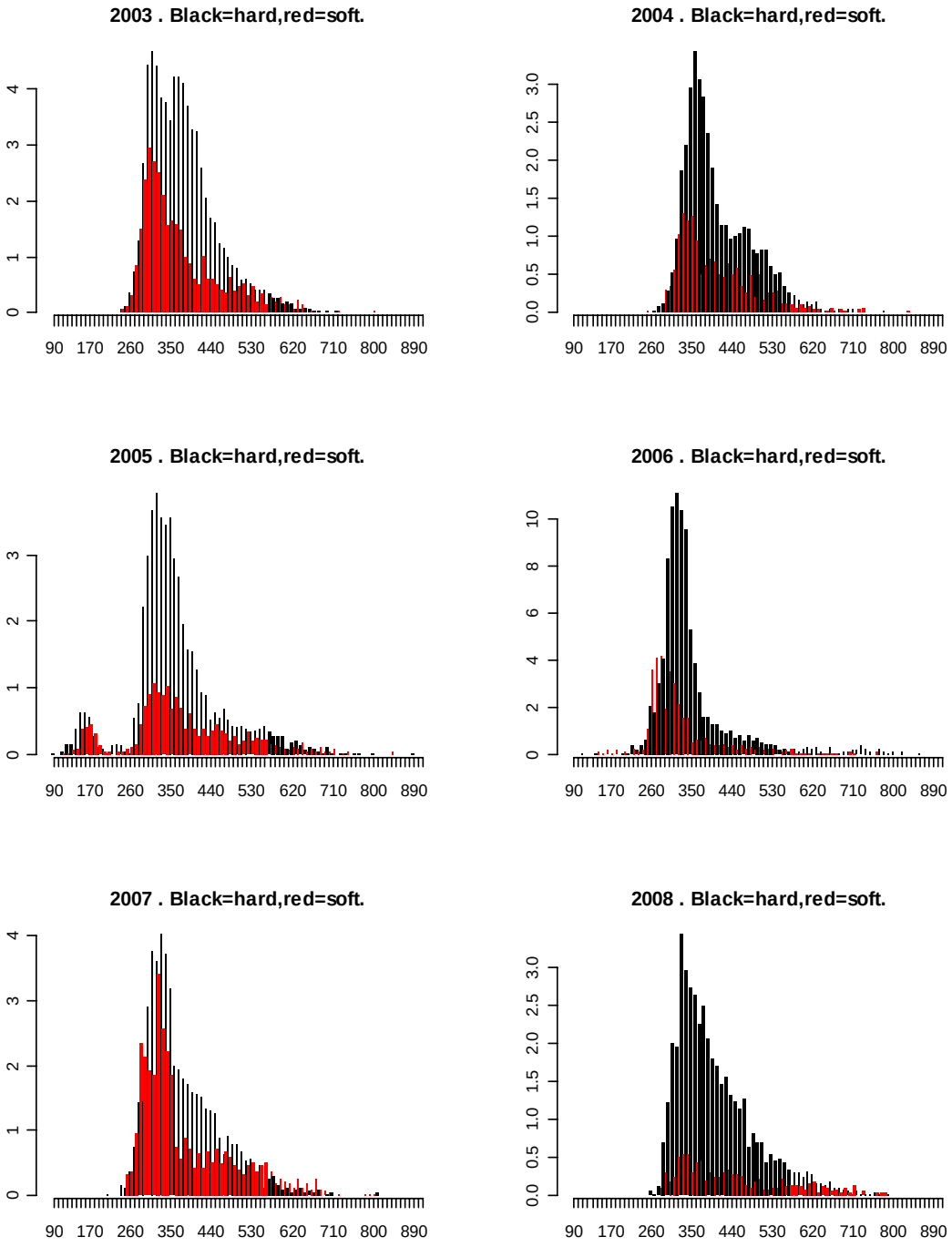


Figure 2. North east coast FSP survey cod catch: Average length distributions recorded on soft and hard ground tows in each year standardised to one hour.

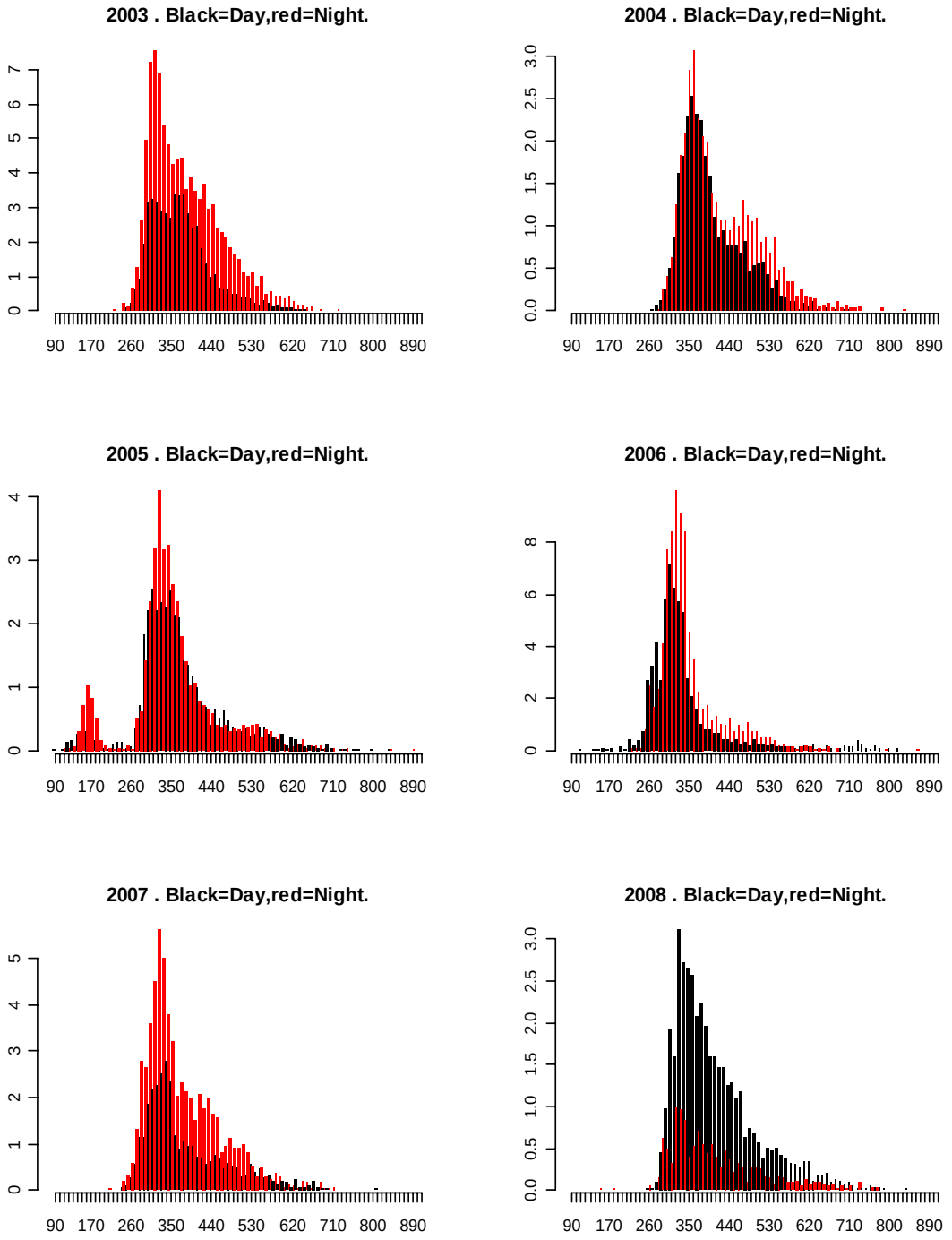


Figure 3. North east coast FSP survey cod catch: Length distributions recorded during tows conducted in daylight and at night, standardised to one hour.

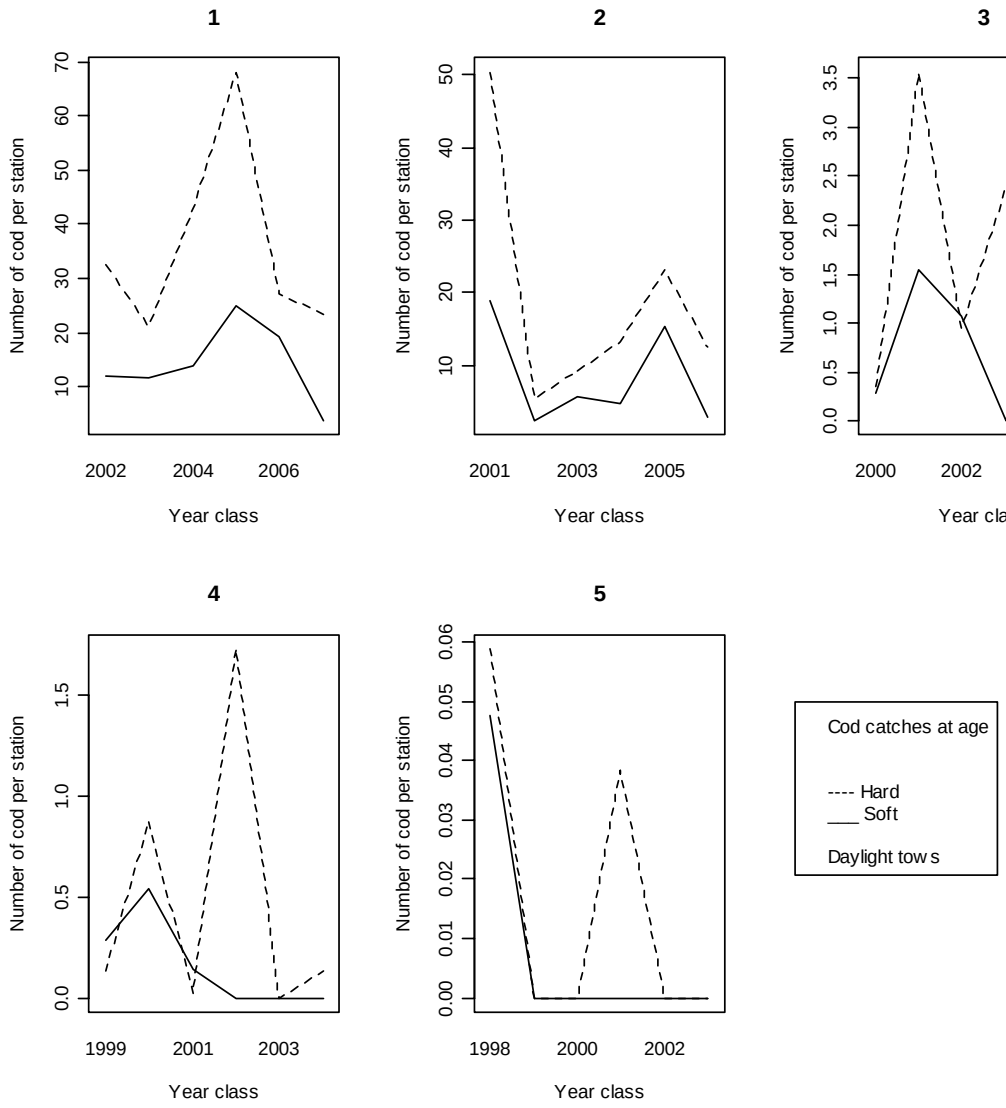


Figure 4. North east coast FSP survey cod catch: Average catch per hour at age recorded on hard and soft ground substrates, illustrating the higher catch rates on hard ground.

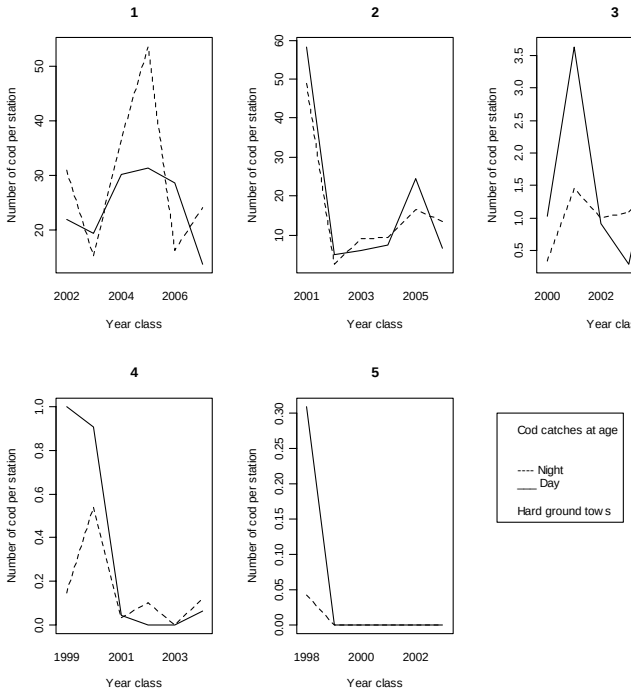


Figure 5a. North east coast FSP survey cod catch: Average catch per hour at age recorded at night and during daylight on hard substrate.

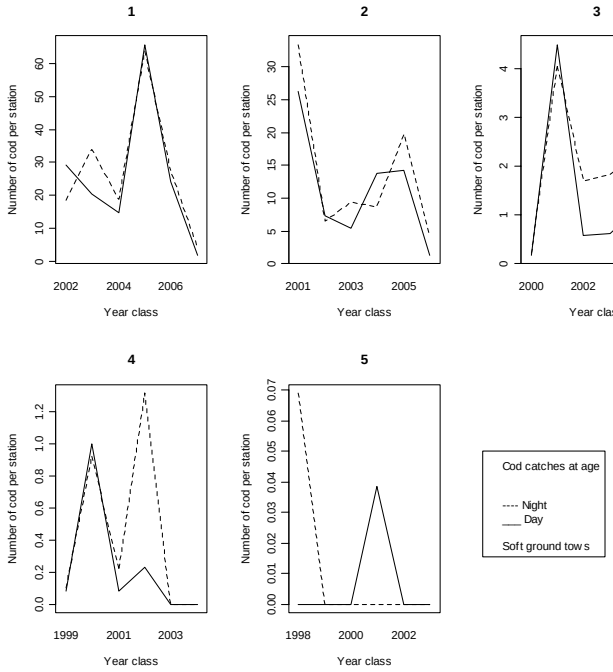


Figure 5b. North east coast FSP survey cod catch: Average catch per hour at age recorded at night and during daylight on soft substrate.

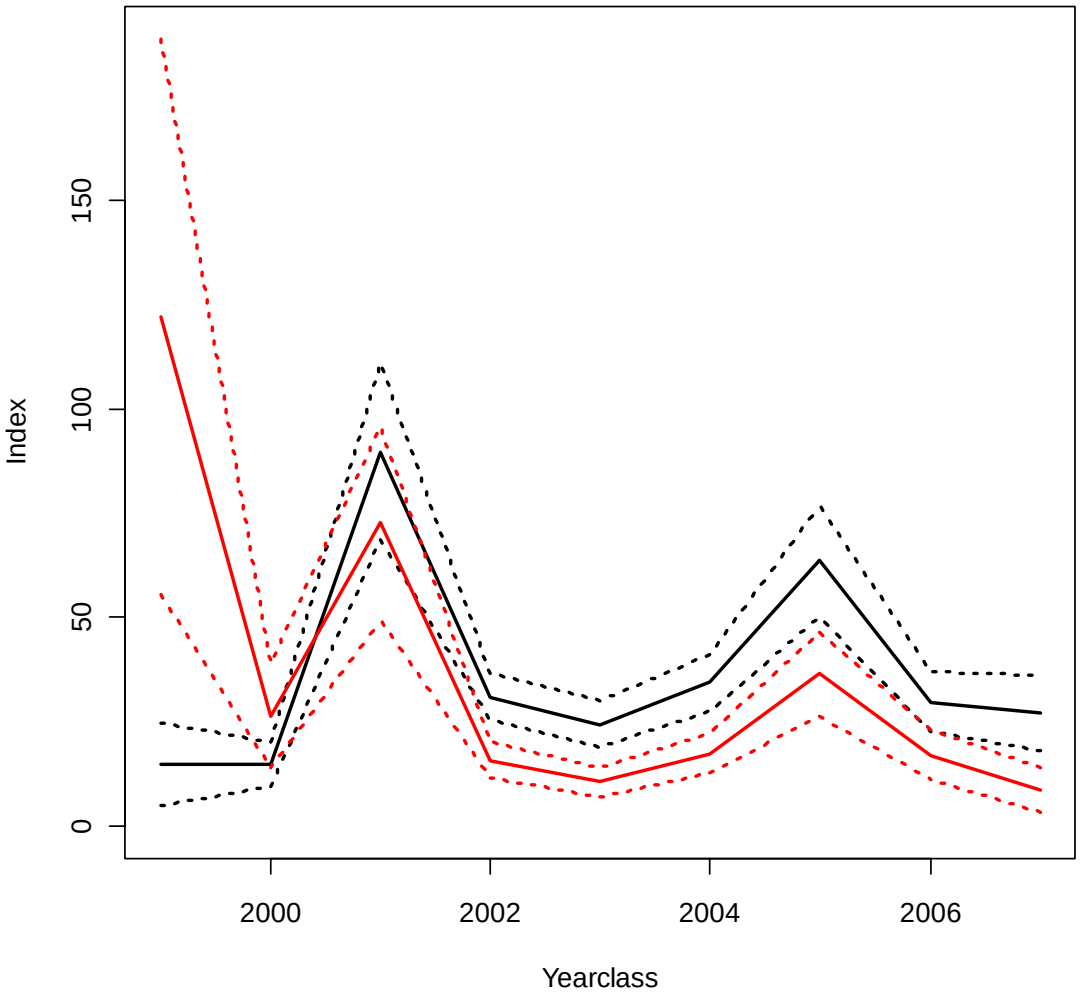


Figure 6. North east coast FSP survey cod catch: Estimated year class strength indices (catch rate at age 1) for soft (red) and hard (black) ground substrates; approximate confidence intervals are given based on +/- 2 standard errors.

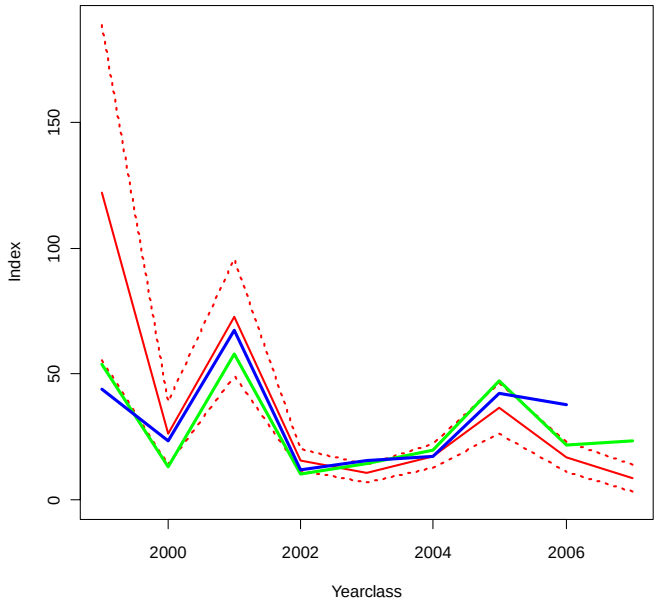


Figure 7a. North east coast FSP survey cod catch: Estimated year class strength indices (catch rate at age 1) for the soft ground substrate with approximate confidence intervals based on +/- 2 standard errors, and IBTS survey indices at age 1 (green) and 2 (blue); scaled to equate the mean of 2002 - 2004 with that of the soft ground index.

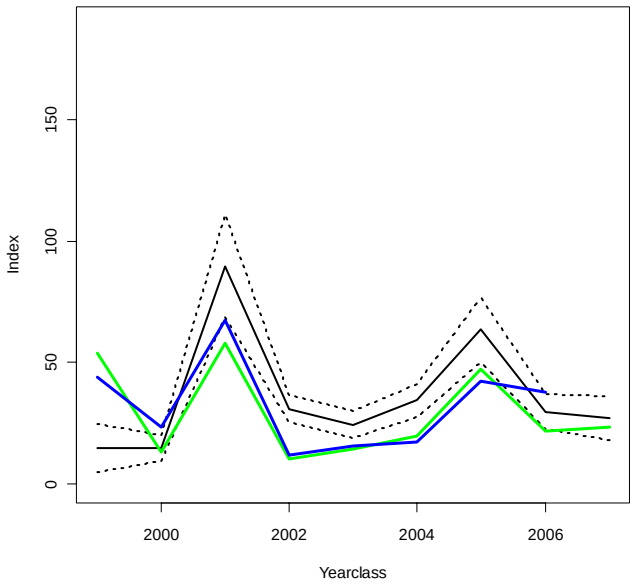


Figure 7b. North east coast FSP survey cod catch: Estimated year class strength indices (catch rate at age 1) for the hard ground substrate with approximate confidence intervals based on +/- 2 standard errors, and IBTS survey indices at age 1 (green) and 2 (blue); scaled to equate the mean of 2002 - 2004 with that of the soft ground index.

Table 1. Average number of cod caught per hour at age by year on all substrates combined, and on hard and soft substrates by the UK North East Coast FSP survey.

a) Total

Age\Yr	2003	2004	2005	2006	2007	2008
0	0.00	0.00	2.71	0.29	0.00	0.01
1	25.16	22.83	28.43	60.22	23.31	18.08
2	46.50	4.97	7.71	10.37	19.46	10.08
3	0.62	3.25	1.06	1.24	1.79	2.11
4	0.48	0.81	0.13	0.70	0.00	0.11
5	0.21	0.00	0.00	0.06	0.00	0.00

b) Hard

Age\Yr	2003	2004	2005	2006	2007	2008
0	0.00	0.00	3.03	0.11	0.00	0.02
1	27.12	27.45	36.86	77.23	25.91	27.01
2	47.64	6.05	9.21	13.53	22.17	14.54
3	0.40	3.92	1.21	1.67	1.84	2.70
4	0.20	0.94	0.13	1.05	0.00	0.15
5	0.13	0.00	0.00	0.08	0.00	0.00

c) Soft

Age\Yr	2003	2004	2005	2006	2007	2008
0	0.00	0.00	2.08	0.60	0.00	0.00
1	19.98	11.66	11.57	31.48	18.88	4.99
2	43.51	2.36	4.71	5.02	14.85	3.54
3	1.19	1.63	0.75	0.52	1.71	1.24
4	1.21	0.49	0.12	0.11	0.00	0.05
5	0.40	0.00	0.00	0.04	0.00	0.00

d) Ratio Hard/Soft

Age\Yr	2003	2004	2005	2006	2007	2008
0	-	-	1.46	0.18	-	-
1	1.36	2.35	3.19	2.45	1.37	5.41
2	1.09	2.56	1.96	2.70	1.49	4.11
3	0.34	2.40	1.61	3.21	1.08	2.18
4	0.17	1.92	1.08	9.55	-	3.00
5	0.33	-	-	2.00	-	-

Table 2. The model output from the fit of a negative binomial model to the NE FSP survey catch rate data for cod numbers at age.

```
Call: glm.nb(formula = INumFish ~ factor(YrClass) * factor(ground) +
      factor(Age) + factor(sgear) - 1, link = log, init.theta = 0.893298884876134)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-2.58318  -0.99502  -0.50821  -0.01695  10.70157

Coefficients:
                                       Estimate Std. Error z value Pr(>|z|)
factor(YrClass)1999                     2.71050    0.32753   8.276  < 2e-16 ***
factor(YrClass)2000                     2.68977    0.18344  14.663  < 2e-16 ***
factor(YrClass)2001                     4.49786    0.11688  38.481  < 2e-16 ***
factor(YrClass)2002                     3.43348    0.08918  38.499  < 2e-16 ***
factor(YrClass)2003                     3.19740    0.11368  28.126  < 2e-16 ***
factor(YrClass)2004                     3.53812    0.10056  35.183  < 2e-16 ***
factor(YrClass)2005                     4.15333    0.10436  39.800  < 2e-16 ***
factor(YrClass)2006                     3.39500    0.11831  28.697  < 2e-16 ***
factor(YrClass)2007                     3.29944    0.16794  19.647  < 2e-16 ***
factor(ground)soft                      2.09429    0.38053   5.504 3.72e-08 ***
factor(Age)2                           -0.87450    0.08086 -10.815  < 2e-16 ***
factor(Age)3                           -3.07957    0.09634 -31.965  < 2e-16 ***
factor(Age)4                           -4.69942    0.13627 -34.486  < 2e-16 ***
factor(sgear)1                         -0.57143    0.21290  -2.684  0.00728 **
factor(YrClass)2000:factor(ground)soft -1.50865    0.46676  -3.232  0.00123 **
factor(YrClass)2001:factor(ground)soft -2.30713    0.41556  -5.552 2.83e-08 ***
factor(YrClass)2002:factor(ground)soft -2.76462    0.41233  -6.705 2.02e-11 ***
factor(YrClass)2003:factor(ground)soft -2.93306    0.42254  -6.942 3.88e-12 ***
factor(YrClass)2004:factor(ground)soft -2.77695    0.41134  -6.751 1.47e-11 ***
factor(YrClass)2005:factor(ground)soft -2.64969    0.41372  -6.405 1.51e-10 ***
factor(YrClass)2006:factor(ground)soft -2.65738    0.43394  -6.124 9.13e-10 ***
factor(YrClass)2007:factor(ground)soft -3.23453    0.51538  -6.276 3.47e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for Negative Binomial(0.8933) family taken to be 1)

    Null deviance: 27506.4  on 1924  degrees of freedom
Residual deviance:  1916.8  on 1902  degrees of freedom
AIC: 9937.7
Number of Fisher Scoring iterations: 1
              Theta:  0.8933
          Std. Err.:  0.0379
 2 x log-likelihood:  -9891.7070
```

Table 3. Average number of cod caught per hour at age and year by the ICES 3rd quarter IBTS survey in groundfish area 4.

Age\YC	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	15.40	3.79	16.63	3.00	4.19	5.68	13.48	6.30	6.75
2	5.07	6.02	3.22	9.21	1.63	2.14	2.36	5.80	5.18
3	0.80	0.88	0.95	1.00	0.58	0.20	0.22	0.40	1.12
4	0.40	0.00	0.20	0.19	0.00	0.00	0.00	0.00	0.10
5	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00

2.4 Task 4 – Design and implementation of schemes to use catch and effort information better for stock assessments and management evaluations. This includes better use of existing logbook information 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 about the marine environment, the fish stocks and the fisheries. If data from self-sampling programmes are available, for instance through an associated project under item 2, their potentials could be explored. The schemes should be evaluated in relation to other available information sources (e.g. scientific surveys, observer data, VMS data etc)

2.5 Task 5 – Pilot projects to involve stakeholders in quality assurance and assistance to data interpretation in conjunction with analysis of data for stock assessments, evaluations of management measures etc. This can for instance be workshops prior to stock assessment working groups with interactions between stakeholders and researchers regarding data screening and quality.

2.5.1 Spatial and temporal analysis of VMS data to provide standardised estimates of fishing effort in consultation with the fishing industry

Tasks 4 & 5 are covered by this project.

Project specification

VMS data are potentially hugely useful for estimating the spatial distribution of fishing effort, however, raw VMS data alone are of little use because they are just point observations, and they do not identify whether a vessel was fishing or the fishing gears used. Processing raw VMS data to create useful estimates of effort has previously not been straightforward due to large volumes of data, data quality issues and the use of novel, non-standardised methods. This study brings together scientists working in the field to start to develop and test standardized protocols for estimating fishing effort from VMS data. The protocols developed and their outputs will be used for consultation with the fishing industry, addressing the industries desire to produce maps of fishing activity to feed into proposed spatial planning processes.

Aims

1. Developing standard European protocol for estimating fishing effort from VMS data
2. Estimation of the accuracy & precision of estimates of fishing effort from VMS
3. Produced standardized map of fishing effort for selected case studies
4. Open discussion with the fishing industry on estimates and distribution of fishing effort and the methods used to create them.
5. The outcome of this work will increase understanding of the spatial distribution of fishing effort and fleets, and will feed directly into the NSRAC request for a mapping of fishers information to inform the spatial management of fisheries.

Suggested analysis

During the time that discussions on the project proposal were taking place, representatives from the UK Joint Nature Conservation Committee (JNCC, the UK agency which advises on nature conservation for UK offshore waters) presented to the NSRAC a draft proposal for offshore Natura 2000 sites located within the North Sea. The Natura Directives aim to stop biodiversity loss within the European Union by protecting natural habitats and species. One of these is on the Dogger Bank which has been proposed for the conservation of 'Sandbanks slightly covered by seawater all the time' and 'Harbour porpoise'. Consultation between the Lot 7 Project team and the NSRAC identified the Dogger Bank SAC as a suitable case study the fits the goals of the Lot 7 VMS analysis project.

Summary

The project initially faltered due to the resignation of the project leader from their institute, the project was therefore re-assigned to a new project leader and restarted.

An initial round of correspondence discussions and exchanges of data formats was followed by a two day workshop to review progress, present VMS analysis studies and discuss analysis procedures in order to define a common protocol.

During the second day of the workshop the request from the NSRAC for an analysis of the fisheries occurring on the Dogger Bank, specifically within the area proposed for the Natura 2000 SAC, was discussed. Analyses, in the context of the protocols for VMS interpretation agreed previously, were outlined to define distribution of effort by gear type, species caught and value of catches within the proposed area and tasks assigned within the team. Following the workshop, reports were prepared by correspondence on the meeting and the agreed protocol for the analysis analyses of VMS data.

Analysis of the VMS and logbook data retrieved from National databases for the proposed Dogger Bank SAC were carried out and a report prepared. The SAC report was presented to the NSRAC Executive Committee in June 2009 who passed it to the NSRAC Demersal Working Group July meeting at which it was presented by the project team.

2.5.2 Developing standard European protocol for estimating fishing effort from VMS data

Report from EU Lot7 workshop, Cefas Lowestoft, April 6-7th 2009

Report 5 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea . Reference: SI2.464218

Andy South, Janette Lee and Chris Darby: Cefas
Niels Hintzen: Imares
Emilie LeBlonde, Martial Laurans: Ifremer
Neil Campbell: Marine Scotland

Introduction

Vessel Monitoring System (VMS) data provides the potential for more resolved and accurate determination of fishing effort than that historically available based on logbook data at the ICES rectangle level. This project aims to increase understanding of the spatial distribution of fishing effort and fleets by investigating methods used to predict fishing activity from VMS data and to make some move toward the development of standardised methods.

A workshop was held at the Cefas laboratory in Lowestoft in April 2009 to bring together scientists from across Europe in order to evaluate existing methods, and start to develop standardised protocols, for estimating fishing effort from VMS data. Representatives from Imares (Netherlands), Ifremer (France), Cefas and Marine Scotland were present. The agenda and list of attendees can be found as appendix 1. Charlotte Johnstone represented UK Joint Nature Conservation Committee (JNCC) in discussions concerning the proposed closure. Analysis of VMS at the national institutes follows a common set of processing steps although some differences occur in the detail of the processes. This report presents a brief summary of the rationale for the methods employed at each institute. This is followed by some further detail of how each stage is conducted at each institute with a brief assessment of the differences on the generated outputs from the various methods.

Cefas use a point summation method, based upon simple fishing speed rules applied across all gears, to generate national scale relative distributions of fishing activity. These data are used to inform marine planning. The approach is clear, simple, quick and easily repeatable.

Imares use a point summation method with a ‘raising factor’ applied to account for vessels for which they don’t have access to data. Effort days fished is taken from the logbooks, multiplied by 17.7 hours (empirically derived), and the effort allocated across the VMS locations in a trip. Fine scaled track reconstruction methods to allow looking at benthic impacts on a fine scale are also being developed.

Marine Scotland use a point summation method based upon gear-specific speed rules. The method is applied to specific gears on a case-by-case basis as required to answer specific questions.

For Ifremer, the main objective is to improve the knowledge that they have about the behaviour of vessels and to be able to qualify the reliability of the logbook data. To support this, Ifremer have invested significant research effort into the development of trip reconstruction algorithms. The Ifremer approach is based upon the construction of straight-line tracks between the VMS points rather than a summation of points within grid cells.
At present the extent to which these approaches produce differing results is not clear. Increasing access to VMS and collaboration between institutes over the next few years will facilitate greater comparison of the results of different approaches being applied to common data sets. This will inform judgements on the level of sophistication of analysis that will best answer particular questions. These issues are going to be addressed comprehensively in the upcoming EU Lot2 contract. The identification, within this project, of possible sources of differences between methods will inform the first stages of Lot2.

Differences in the following stages of the VMS analysis process will influence the results produced:

- temporal resolution of input data;
- rules for cleaning the data to remove errors and duplicates;
- rules for removing locations in, or close to, port;
- how the activity time assigned to a location is determined;
- how the fishing gear being used is determined;
- how fishing and steaming activity are differentiated;
- how points are converted to a spatial estimate of the density of fishing activity.

A summary of the methods employed by each institute is presented as Table 1.1 with additional detail provided in the following section.

Table 1.1: Summary of VMS methods used in different institutes

	Ifremer	Imares	Marine Scotland	Cefas
1) Temporal resolution of input data	1 hour	Maximum 2 hours	Maximum 2 hours, some 20 minutes. Vessels in the Norwegian sector at least every hour.	Maximum 2 hours.
2) Cleaning the data to remove errors and duplicates		Duplicate positions	A significant number of "non-fishing" trips are excluded by lack of logbook data. These represent vessels performing contract duties for the oil and gas industry. Trips with erroneous logbook values, e.g. unrealistic mesh/gear combinations are discarded.	Duplicate positions and those on land removed. A significant number of "non-fishing" records are excluded by lack of logbook data. These may represent vessels performing contract duties for the oil and gas industry.
3) Removing locations in, or close to, port	Not removed, but used to define the beginning and the end of the fishing trips.	most positions located in a harbour are removed (VMS records that cannot be merged with logbook records because they are in a harbour and not part of a trip anymore)	Stationary in port excluded.	< 0.05 degrees from port all speeds.
4) Assigning a time to each location	If time between 2 positions at sea > 6 hours: do not consider the fishing/steaming time, and flag the event. If > 12 hours: fishing trip stopped, with invalid flag. Start another trip at the next position.	Time from position $_{j-1}$ to position $_{i}$ is assigned to position $_{i}$.	No time associated with pings – each assumed to represent a "unit of effort"	If time to previous location > 4 hours set interval to 2 hours for start of trip.
5) Establishing the fishing gear being used	Not in the algorithm. Afterward: from logbook or fishing activity, Ifremer survey, or EU vessels register if no other information.	Link to logbook by date/time/ship. If no link then exclude point.	Link to logbook by trip, where available (approx. 63% of VMS positions). For vessels without logbook link, those with peak in speed distribution below 3 knots assumed to be using static gears, peak above 3 knots assumed to use mobile gears.	Link to logbook by date/time. If no link then exclude point.
6) Differentiating between fishing and steaming	4.5 knots. Historically based on bottom trawlers, but seems to be a good compromise for all the gears.	TBB < 300hp 3-6 knots = fishing TBB > 300 hp 5- 8 knots = fishing OTB < 300hp 3-5 knots = fishing OTB > 300hp 3-4 knots = fishing TBS 3-4 knots = fishing	4.5 knots for demersal otter trawls.	1-6 knots fishing for all gears at national scale. Other gear-specific rules have been used for regional studies.
7) Converting points to a spatial estimate of the density of fishing activity	Track. Estimation of the effective time in the sector on the basis of the distance inside the sector or a specific polygon (assumption: straight line between 2 positions)[1]. 10' by 10' grid at the moment, 2' by 2' soon.	Point summation. 2' in longitudinal direction, 1' in latitudinal direction. Resolution approximately 1x1nm	Point summation. Variable, depending on application. Real-time cod closures uses grid of 0.25 longitude * 0.125 latitude (1/16th ICES rectangle). Fine scale impact work uses grid of 0.1 (6').	Point summation. 3' (0.05 degree) grid used for national scale outputs.

[1] In the case of statistical rectangles, at the moment, allocation is proportional to the number of rectangles crossed by the vessel.

Methods employed for the analysis of VMS data

a. England & Wales, Cefas Andy South and Janette Lee

Cefas has access to VMS data for all vessels in UK waters and for UK vessels in all waters. These data can be used for research and advisory purposes under certain conditions, the main restriction being that they are not published in a way that allows individual vessels to be identified. A prototype database linking VMS to logbook data, allowing vessel attributes and gears to be identified, has been developed and is in the process of being fully implemented.

The following analysis steps are undertaken:

- data are cleaned to remove errors and duplicates;
- locations in, or close to, port are removed;
- the time interval between successive locations is determined;
- the fishing gear being used is established;
- fishing and steaming activity are differentiated;
- points are converted to a spatial estimate of the density of fishing activity.

In the first two steps, duplicate points (for the same vessel, time and location) and those within approximately three nautical miles of recorded port locations are removed. The time interval between locations is calculated based on the recorded VMS timestamp. If the time between successive points is greater than 4 hours the assumption is that one trip has been completed (with the VMS being switch off) and the interval is set at 2 hours assuming the start of a new trip. The fishing gear being used is established by linking the VMS data to UK landings logbook data by means of vessel identifier and date/time. Gear codes used are equivalent to the métier Level 4 from the EU Data Collection Regulations (e.g. DRB for boat dredge and TBB for beam trawl).

Simple speed rules are used to classify whether each VMS location is associated with fishing activity. For national scale analyses a single speed rule of 1-6 knots is applied to classify fishing activity for all gears, with the aim of having a single, rapid, and transparent process. Histograms of vessel speeds show peaks of activity in this speed range for all gears. Speeds of zero are excluded to avoid the risk of including areas where vessels are idling or waiting to return to port. A comparison with maps based on other likely speed rules indicates patterns of relative activity that are very similar. To convert the VMS locations to an estimate of the spatial distribution of fishing activity, time intervals associated with each VMS location are summed within a 0.05 degree grid, to arrive at an estimate of the hours fished per cell. The grid is based upon units of latitude and longitude so that cells fit exactly within the ICES rectangles used for the reporting of fish landings (200 per rectangle).

Methods similar to these, sometimes with different speed rules, have been used to produce maps of fishing activity for UK waters for all gears (métier level 4) and aggregated to gear class (métier level 2). Such maps have been used in the creation of fishing value layers to inform the choice of wind farm areas and there has been consultation with the fishing industry at a national level. Activity maps produced for southwest England using these methods have been presented to the local industry with favourable responses.

b. Scotland, Marine Scotland Neil Campbell

VMS data has been freely available to Fisheries Research Services (now known as Marine Scotland - Science) for research and advice provision since mid-2008. Analytical methods are still at a developmental stage and no single approach to analysis has been dictated. Data availability covers all vessels in Scottish waters, and all vessels registered in Scotland. Flat files containing VMS data linked to trip landings for key commercial species have been developed for 2007 and 2008, and these are used most commonly. Landings data are only available for Scottish vessels and boats landing into Scotland, therefore some information in the VMS data is lost.

Data processing is currently carried out using an R script, although a Fortran routine is in development. Logbook data are taken from the Scottish Government's Fisheries Information Network (FIN) database for all vessels 15m in length or greater (vessel PLN number, date of departure, date of landing, gear code, mesh size, vessel length and landings by species). VMS data (vessel ID, time, speed, heading, latitude and longitude) is extracted separately. A common field is introduced by using a PLN – Vessel ID look up table. Logbook data are filtered to exclude all but key commercial species (cod, haddock, whiting, saithe, plaice, monkfish, megrim, herring, mackerel, blue whiting, *Nephrops*, edible crab, velvet crab and lobster). For each trip in the logbook database, a subset of the VMS polls recorded by that vessel between 12:00AM on the day of departure and 23:59 on the day of landing is taken. Duplicate records and polls taken when the vessel is stationary in port are discarded. Landings and vessel data are associated with each poll, PLN number is discarded to prevent identification of individuals and the data are outputted to a .csv file.

Further analysis is carried processing the .csv file in R (or within a GIS environment such as ArcView or EonFusion). Data can then be filtered by gear type, speed, catch composition and so on. A number of common functions have been created in R to bin VMS polls into variable sized cells to map effort, to calculate landings per unit effort (which can then be binned and averaged), or to plot location of pings associated with landings of particular species.

The approach used by Marine Scotland – Fisheries Data Unit in administering the Scottish 'conservation credits' real-time closure scheme is slightly different, and detailed elsewhere.
Several problems are evident with this approach. Data processing is highly computationally intensive; vessels of other nationalities not landing into Scotland become invisible to the analysis; the coarse temporal scale (2 hourly interval) makes interpretation of fishing tracks difficult; and landings data are currently only available at the trip level. Some of these problems are being dealt with, for instance, through the introduction of e-logbooks from 2010.

c. The Netherlands, IMARES Floor Quirijns and Niels Hintzen

Wageningen IMARES has access to VMS data for all foreign vessels in NL waters and for a substantial part of the Dutch vessels in all waters (see table 2.1). Under the new VMS regulations it is expected that data from the whole Dutch fleet will become available: both historical data and new data. These data can be used for research and advisory purposes under certain conditions, the main restriction being that they are not published in a way that allows individual vessels to be identified.

Currently, VMS data are linked to logbook data, allowing vessel attributes and gears to be identified. A prototype database has recently been put into place to link these data, including the automatic update of VMS data provided by the ministry.

Table 2.1. Percentage of vessels in VMS dataset in relation to vessels registered in the databases of the Ministry or EC logbooks (registered values between brackets) in 2007.

	260-300 pk	> 300 pk
Beam trawl	57% (56)	57% (113)
Otter trawl	50% (42)	60% (10)

The following analysis steps are undertaken:

- data are cleaned to remove errors and duplicates;
- the time interval between successive locations is calculated;
- the fishing gear being used is established;
- fishing and steaming and floating activity are differentiated;
- points are converted to a spatial estimate (1’ longitude by 2’ latitude) of the density of fishing activity;
- the computed effort allocated to the grid is raised by availability of VMS in relation to effort allocated based on logbooks based on horsepower classes.

In the first step, data points that refer to a position on land are removed. If negative or very high speeds are recorded (>20 nmph), these are either removed or replace with NA. Positions far away from the North Sea (-12 <= longitude >= 12, 40 >= latitude >= 70) are removed and recordings of heading > 360 degrees are replaced with NA. Data points with the same time and location are removed. In the second step the time interval between locations is computed in minutes. If the interval is greater than 48 hours, the interval is set at 1 minute: we assume that at this point a new trip starts. In step 3, logbook data are combined with VMS data to obtain information on gear, effort and horsepower, based on date/time of registration. If VMS data cannot be combined with logbook data, these records will not be used as its activity (fishing, steaming, floating) is unclear. In step 4, each record is assigned an activity (fishing, steaming, floating) based on a simple rule regarding speed and horsepower (described in Piet *et al*., 2007, Rijnsdorp *et al.*, 1998). In step 5, each record is assigned to a 1’ longitude, 2’ latitude grid cell based on proximity to grid cell centre. Registered points are summed within each cell.

Effort allocated per grid cell is obtained by raising the number of registrations in each cell to the total effort of the fleet (fleet in this case is the combination of hpclass and gear). Total effort is a yearly measure. Hours of fishing per grid cell equals the number of registrations ascribed to a grid cell, multiplied with the raising factor.

Recently, a new method to estimate fishing distribution and effort allocation has been developed. The new technique is based on the interpolation of VMS data using a spline and is able to spatially allocate effort on a more precise basis (see Hintzen *et al.* submitted).

d. France, IFREMER
Emilie LeBlonde and Martial Laurans

Ifremer has worked for 3 years on the VMS data. The data are sent to Ifremer daily by the Ministry of Fisheries and loaded into our database. Thus we have the opportunity to follow and monitor the activity of the vessels almost in real time, unlike other data sources such as logbooks or calendar activity survey, where the response time is longer (between 3 and 12 months). To analyse the VMS data, Ifremer has developed two generic algorithms not restrictive to a particular fishing area, the French vessels being present in Atlantic, Channel, North Sea, Mediterranean Sea, Indian Ocean and Caribbean Sea.

- **First algorithm: rebuilding the fishing trips**

This algorithm has several objectives:
1. The primary aim is to define/rebuild the fishing trips of all the vessels in the same format as the logbooks. A VMS fishing trip is defined by a vessel, a start date-harbour and an end date-harbour.
2. The second part of the algorithm allows describing the spatial distribution of the vessel during a fishing trip. It aims to estimate the fishing effort and its distribution on a spatial grid selected by the user. Ifremer uses two grids: (i) spatial unit of 10' of latitude by 10' of longitude and (ii) 1° of longitude by 30' of latitude (ICES statistical rectangles), but the algorithm is currently improved to parameterise it.

The first step of the algorithm is to define the fishing trips. This operation consists in defining the start and end date and the start and end harbour of each trip. This treatment applies a reference table with all the harbours positions. If the distance between the VMS position and the closest harbour is less than 2 nautical miles, the vessel can be on its way back to the harbour. In this case, if the vessel is stopped (distance between 2 consecutive positions approximately equal to 0) we define the end of the fishing trip at this position. The beginning of the next fishing trip will be set when the vessel is going away from the port (more than 2 nautical miles).

The second step aims to estimate the fishing effort of each vessel inside its fishing trips, per day and fishing sector. To differentiate the activity of the vessel, we use the following assumption: if the average speed of the vessel between 2 positions is less than 4.5 knots, the vessel is fishing. Otherwise the vessel is steaming. The assumption was historically based on the bottom trawlers behaviour but the threshold of 4.5 knots seems to be a good compromise for all the gears.

[Ifremer has worked on further analyses and methods to define different thresholds for the different gears. The main difficulty of this work is to guess the gear used by each vessel. The gear of the vessel cannot be collected from the logbooks, which are received at best the following month (but usually several months late) whereas VMS data are received every day.]

The method applied is then to define the speed pattern of a vessel and to guess its gear by automatically analysing the pattern. The corresponding gear's threshold can then be applied. This method is not completely operational yet.

The fishing time or steaming time is allocated to the different geographical objects crossed by the vessel (statistical rectangles or 10' by 10'grid). If the vessel crosses two different rectangles, the fishing and steaming time are equally divided between each rectangle.

The VMS data can be erroneous, so we had to use additional rules:

- If the time between 2 consecutive positions is more than 6 hours, the fishing time of the vessel between these 2 positions is not considered. We do not have enough information to qualify the fishing effort.
- If the time between 2 consecutive positions is more than 12 hours, the fishing trip is stopped and tagged with an invalid pointer. The start of another trip will be set at the next positions.

This algorithm runs without any additional data, using only the VMS data. Then, the link can be done with other data sources, in particular to know the gear used and assign the fishing effort to the different gear.

- **Link with other data sources**

The standardized outputs of VMS tools are perfectly compatible with logbooks (as they are in the same format) and provide a solid foundation to compare and link VMS data to the logbook data. Ifremer is currently working on a project named “SACROIS”, whose goal is to compare and link the different data flows available (logbooks, sales, VMS) in order to improve information of logbooks and VMS. The logbooks provide gear and catch information while VMS fishing trips provide a very precise geographical allocation of the effort. The link between both will offer an accurate allocation of the fishing effort and catch by day, gear and fishing sector.

Furthermore, Ifremer has implemented an annual survey on the activity of the fleets. The entire vessels are surveyed yearly in order to rebuild their activity calendar, i.e. the list of the métiers performed each month of the year (métier = gear * targeted species). The data of this survey is available with a few months, but provides a more reliable and accurate data on gear than the European fishing vessels register.

- **Second algorithm: estimating fishing effort in a specific zone**

An application has been also developed to compute the fishing effort in a specific zone. This specific zone can be of any shape (for example the “Dogger Bank” area) and must be defined by its different geographical points. The main parts of the algorithm are:

- Get all the VMS positions inside the polygon and around the polygon (closer than 50 nautical miles from one side of the polygon). Positions around the polygon must be computed because travels between a position inside and a position outside must be considered.
- Define the path of every vessel inside the polygon. We use the following assumption: between 2 positions, the vessel is going straight. Each straight line between 2 consecutive positions is computed and the exact distance inside the polygon is estimated. To get the precise distance, we have to use an algorithm to determine which part of the line is inside the polygon. With the distance information, we are able to calculate the time of the vessel inside the polygon.
- Estimate the fishing and steaming time of every vessel inside the polygon. This estimation is based on a simple assumption: if the speed of the vessel is less than 4.5 knots, the vessel is fishing.
- Allocate the fishing time in geographical objects of size 10’ by 10’

The output of the software is available in two time scales, monthly and daily, and can be easily coupled with GIS software to generate maps.

Comparison of data at differing temporal resolution

Each of the institutes has undertaken some comparative analysis on the results obtained from VMS data at differing temporal resolution.

a. England & Wales, Cefas

Based on a speed range of 2-8 knots for fishing (from Eastwood *et al*., 2007), data at 15-minute interval were obtained for 10 beam trawlers during the period November 2000 to June 2001. These fishing data points were used to generate tracks. The data were then subset to replicate approximately 2 hourly data from which tracks were again generated. Table 3.1 shows the track length generated from each data set.

Table 3.1. Track length generated from 15-minute data and 2-hour data for ten vessels.

Vessel	Length of 15 minute tracks	Length of 2 hour tracks	% captured at 2 hour interval
1	44,841,871	14,761,382	33
2	41,909,379	16,218,676	39
3	40,223,268	17,133,909	43
4	35,898,448	12,644,475	35
5	30,147,578	11,835,705	39
6	19,308,751	6,150,306	32
7	16,132,106	7,009,612	43
8	15,705,962	5,887,252	37
9	6,019,118	2,461,779	41
10	4,794,351	1,741,322	36

On average the length of tracks generated at a two-hourly interval captures just 38% of the track generated using the 15-minute interval data.

These data were then used to generate four surfaces of fishing pressure: 15-minute and 2-hourly tracks converted to a proportion of grid cell impacted, and point summation of time spent in cell for 15-minute and 2-hourly data (figure 3.1)

Values for the surfaces derived from the tracked data ranged from 0% to 35% for the 15-minute data and from 0% to 14% for the 2-hourly data (table 3.2). This again illustrates the under-representation of activity when the 2-hourly data are used to create tracks.

The point summation surfaces totalled the time fished in each grid cell (using the time interval between consecutive ‘pings’) with values ranging from 0 to 46 hours for the 15-minute data and from 0 to 50 hours for the 2-hourly data (table 3.2). In this case the 2-hourly data produced a slightly higher estimate of fishing activity than the 15-minute data.

The correlation coefficients between the four surfaces are shown in table 3.3. The correlation between the 15-minute track data and the 2-hour point summation data was 0.94. This indicates that it may be possible to estimate area impacted from the point summation method using 2-hourly data without the need to generate tracks.

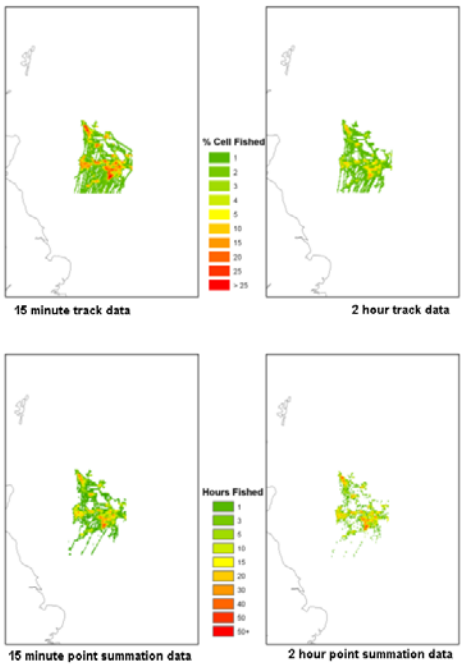


Figure 3.1. Comparison of surfaces derived from 15-minute and 2-hourly data, using track and point summation methods.

Table 3.2. Summary statistics for surfaces derived from 15-minute and 2-hourly data,using track and point summation methods.

	Mean	*Standard Dev*	*Minimum*	*Maximum*
Track area (15 min)	2.99	4.79	0.00	34.92
Track area (2 hour)	1.12	1.74	0.00	14.39
Total time (15 min)	3.83	6.55	0.00	46.50
Total time (2 hour)	3.83	6.91	0.00	49.80

Table 3.3. Correlation between surfaces derived from 15-minute and 2-hourly data, using track and point summation methods.

Correlation Coefficient	*Track area (15 min)*	*Track area (2 hour)*	*Total time (15 min)*	*Total time (2 hour)*
Track area (15 min)	1.00			
Track area (2 hour)	0.94	1.00		
Total time (15 min)	0.99	0.93	1.00	
Total time (2 hour)	0.94	0.91	0.95	1.00

b. Scotland, Marine Scotland

Marine Scotland has access to a positional data set collected from GPS data loggers, with a position and speed reporting frequency of around 5 minutes. This allows much finer temporal resolution of activity than the 2-hour frequency contained in the main VMS database. Some work has been carried out to compare patterns of activity revealed in this fine scale data with interpretation of activity based on subsamples of this data at standard VMS polling frequencies. Analysis has focussed on *Nephrops* trawlers fishing off the northeast coast of Scotland (figure 3.2). Preliminary analysis shows that estimates of fishing activity derived from the fine scale data (in this case, when the vessel is travelling at speeds of between 0.2 and 4.5 knots) are more precise but not significantly different from estimates of fishing activity obtained from subsetting the data to a rate of one poll every two hours. This may be dependent upon the spatial scale under analysis as. Piet and Quirijns (in press) indicate that trawling frequency distribution gets skewed if lower spatial resolution data is used. Higher spatial resolution data will more evenly distribute these trawling frequencies.

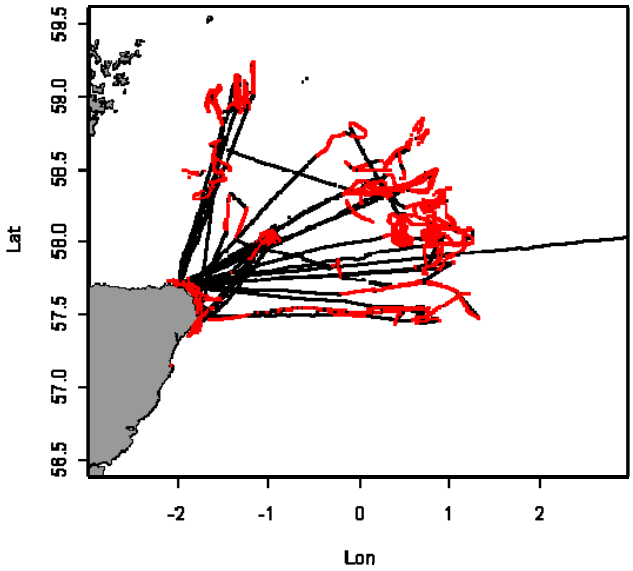


Figure 3.2. Activity of one vessel over three months, revealed by fine temporal resolution VMS data. Fishing activity is highlighted in red.

While estimates of effort using the same rules are relatively consistent between the 2 hour and 5 minute based data, the fine scale data raises some further questions about the use of VMS data to infer fishing activity. Examples are presented below.

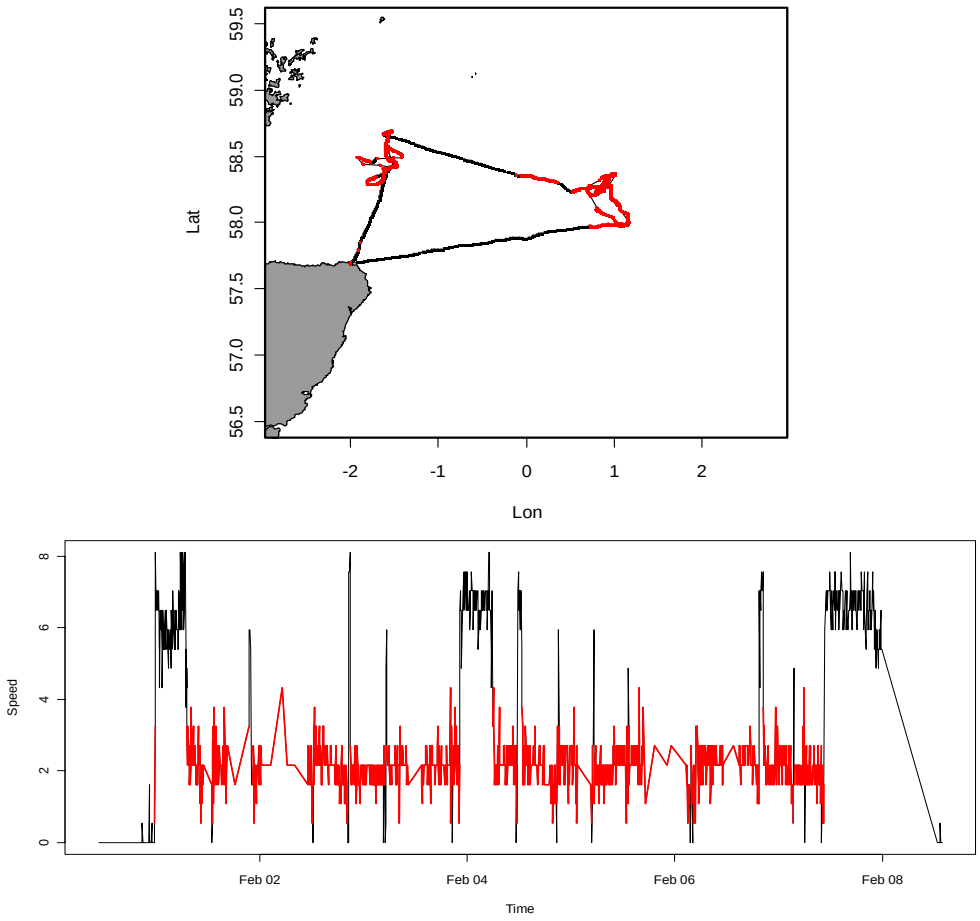


Figure 3.3. Example 1 vessel activity. Fishing activity is highlighted in red.

Example 1 (figure 3.3) illustrates a relatively “standard” fishing trip. The vessel leaves Fraserburgh harbour, cruises north by northeast across outer Moray Firth for several hours before slowing to fish, then travels around a hundred kilometres east and fishes in the Fladen before returning to Fraserburgh. The speed profile reveals a clear distinction between cruising behaviour at speeds of around 6-8 knots and fishing behaviour at speeds of 2-3 knots. In this example, fine scale data suggests 99 hours were spent fishing, as compared to a mean of 91 hours obtained from 2 hourly polling.

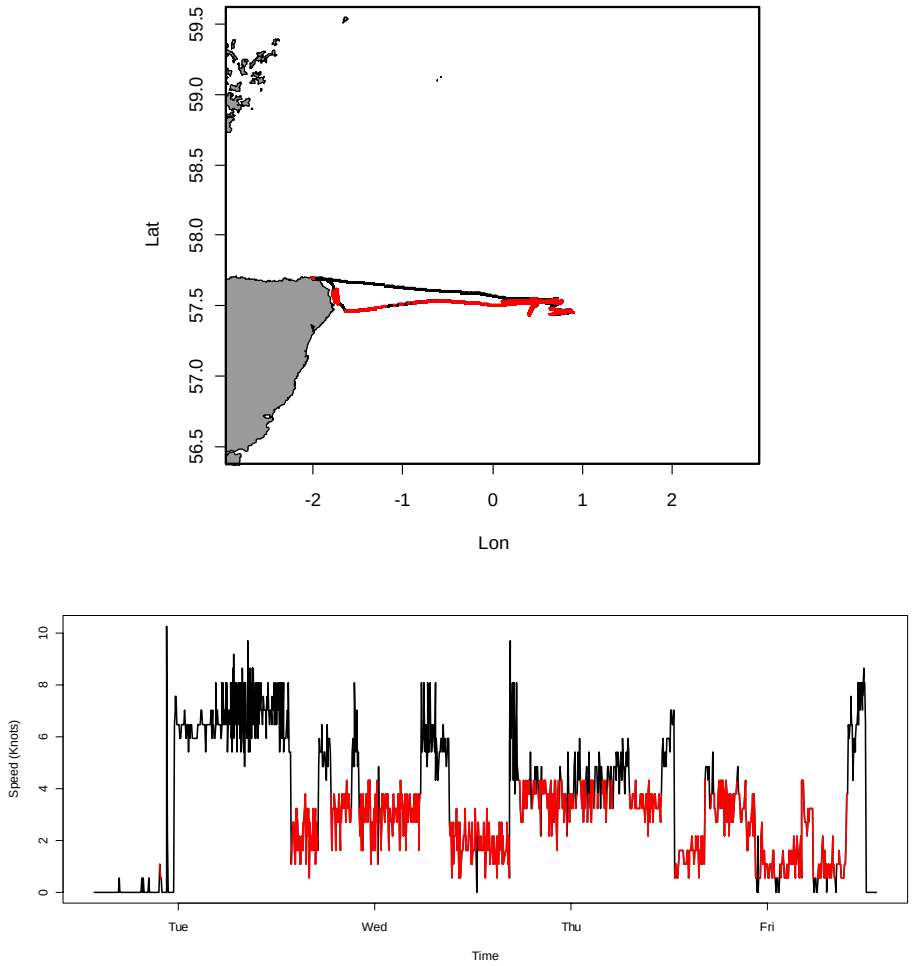


Figure 3.4. Example 2 vessel activity. Fishing activity is highlighted in red.

Example 2 (figure 3.4) shows the same vessel leaving Fraserburgh harbour and steaming eastwards for around twelve hours before starting to fish in the Fladen, at similar speeds to those seen in example 1. Having fished for several days, the boat sails back towards Fraserburgh at “fishing speeds” for around one day. The purpose of this is unclear – it may represent fishing or a desire to conserve fuel and arrive at the market at an appropriate time.

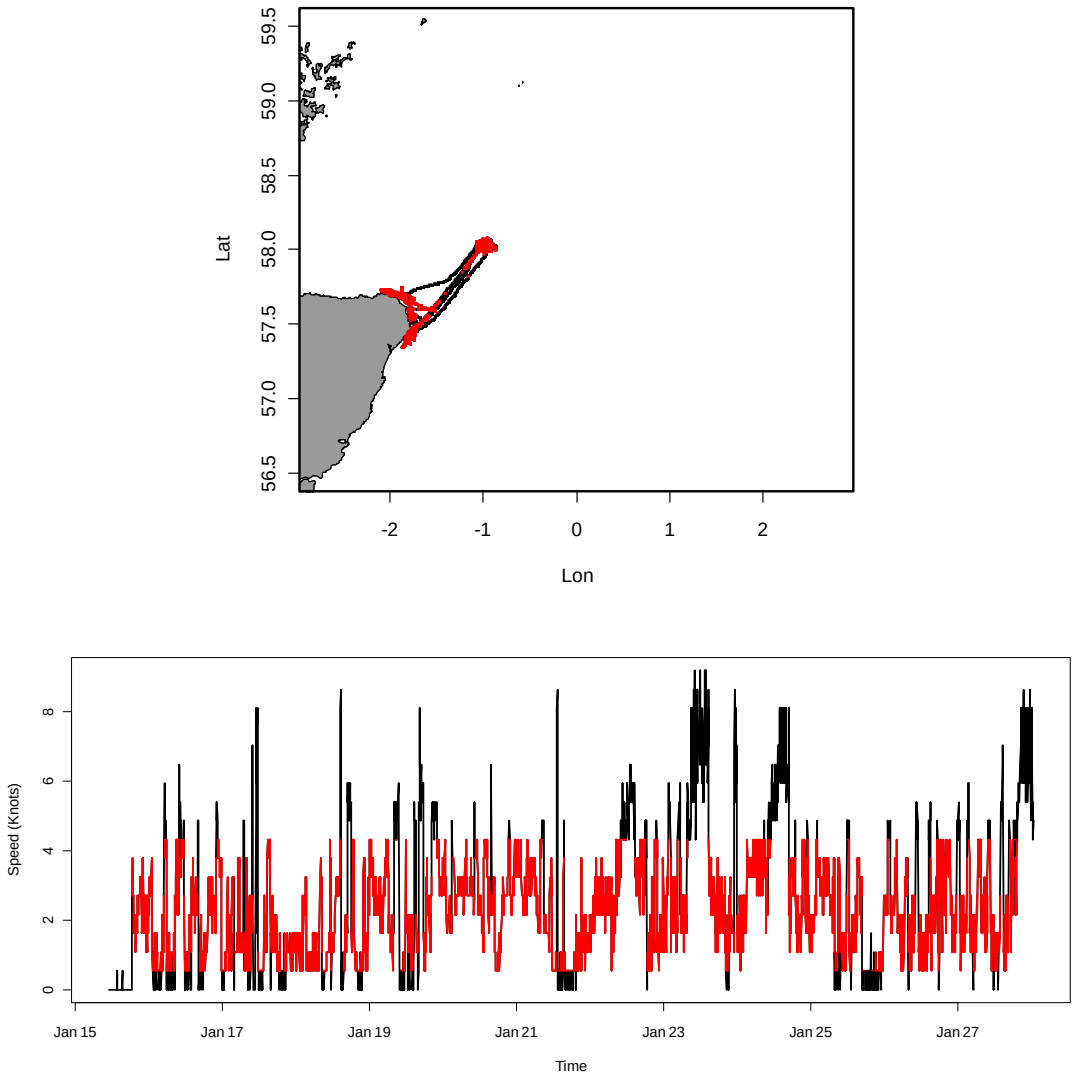


Figure 3.5. Example 3 vessel activity. Fishing activity is highlighted in red.

Example 3 (figure 3.5) illustrates a twelve-day trip where the boat makes several trips between the southwest corner of Fladen and the Aberdeenshire coast. There is no clear distinction between fishing and cruising, and the vessel appears to change its speed erratically. According to established rules estimating time-spent fishing, fine scale logger data shows 237 hours fished versus mean of 220 using 2-hour pings. Whether this is an accurate description of the activity which this boat was undertaking is another matter.

In conclusion this work suggests that the current method of estimating time fished from VMS data is not significantly influenced by the polling rate of the data, at least as far as demersal trawlers are concerned. In fisheries where the gear is deployed for a shorter time than the polling rate there is some potential for inaccuracy, however it is unlikely that estimates of effort are inherently biased.

c. The Netherlands, IMARES

Work has been ongoing at Imares to reconstruct fishing tracks from VMS data. This is a useful approach in fisheries that use a gear of known dimension, such as the Dutch beam trawl fishery, allowing a swept area to be calculated. Tracks have been interpolated using cubic Hermite splines. This allows the speed and heading at each polling location to inform the estimated track, rather than just linearly linking polling positions using more traditional approaches.

Comparing estimates of track length derived from linear joining of polling locations and cubic hermite spline interpolations with that obtained from fine scale VMS data shows improvements in the accuracy of the estimate by up to 50%. Looking at data from a single trip containing twelve hauls, nine were better estimated using cubic spline interpolation.

The calculation of interpolated tracks is computationally intensive; however for fisheries using specific gears it can be useful. For fisheries using a range of gears, or for static gears, point summation in a matrix can give a more useful measure of the distribution of effort, particularly if the VMS data is being used to provide a relative rather than absolute measure of effort (for example, “number of pings” in an area, rather than “hours fished”).

d. France, IFREMER

In order to estimate the sensitivity of the VMS data, an analysis was carried out using a complementary GPS data source from the Recopesca project. The temporal resolution differs between these two sources. In France, this time is one hour for the VMS data and 15 minutes for the Recopesca data. Using data from two vessels equipped with both systems, the present work compares the estimation of 2 trip parameters: the fishing time and the fishing distance.

The two vessels are trawlers. One works on the Bay of Biscay mainly targeting nephrops during one-day trips, the other works in the Western Channel targeting monkfish during one-week trips. For both data sources, a vessel is considered as fishing when the average speed between 2 positions is below 4.5 knots. For each trip an estimation is made of the fishing time and fishing distance. A comparison of the results obtained for the two vessels allows comments on the sensitivity of the results.

Results

Figure 3.6 illustrates the difference in the tracks from the two data sources. With a position every 15 minutes it is possible to observe the movement and activity of the vessel in more detail. The first consequence is the difference in the fishing distance value estimated by trip (Figure 3.7). Considering all of the trips in 2007 and 2008 (300 trips for vessel 1 and 80 trips for vessel 2), the fishing distance estimated from the VMS data is 10% lower than that estimated from the Recopesca data. This difference is significant for the estimation of various indices (species abundance or bottom impacts).

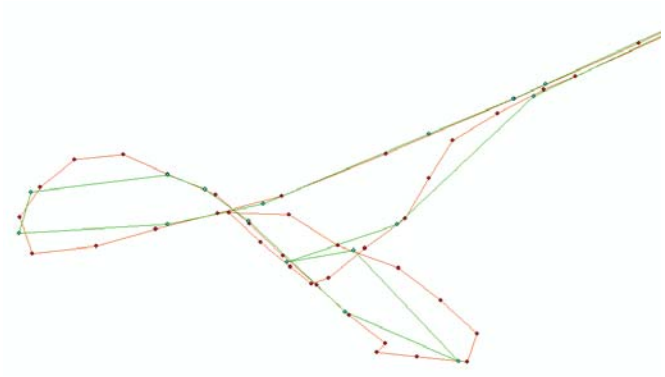


Figure 3.6. Comparison of the spatial scale of a trip from VMS data (green) and Recopesca data (red).

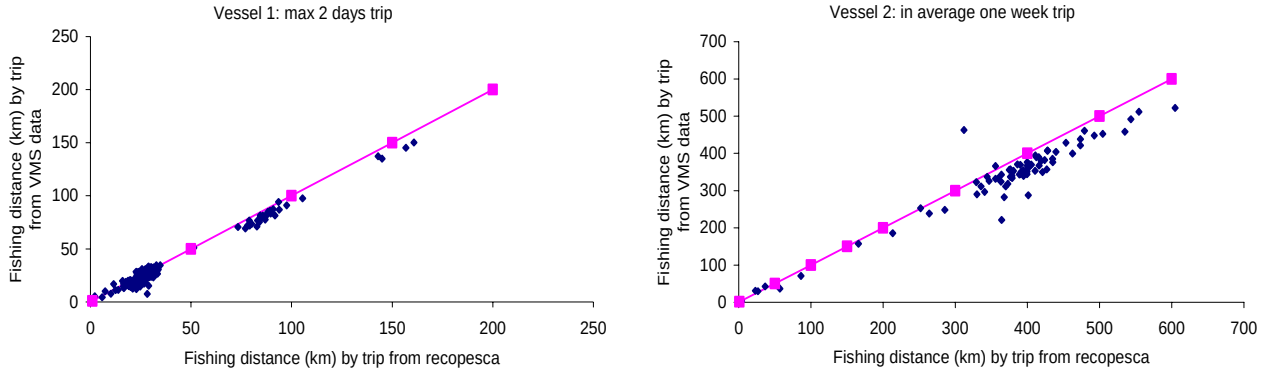


Figure 3.7. Data from the same boat comparing the fishing distance by trip estimated from VMS and Recopesca data.

From the two data sources, the comparison of the fishing time by trip does not present differences (Figure 3.8). In fact, the difference in the average speed from the two data sources is low and its values are below the threshold of 4.5 knots.

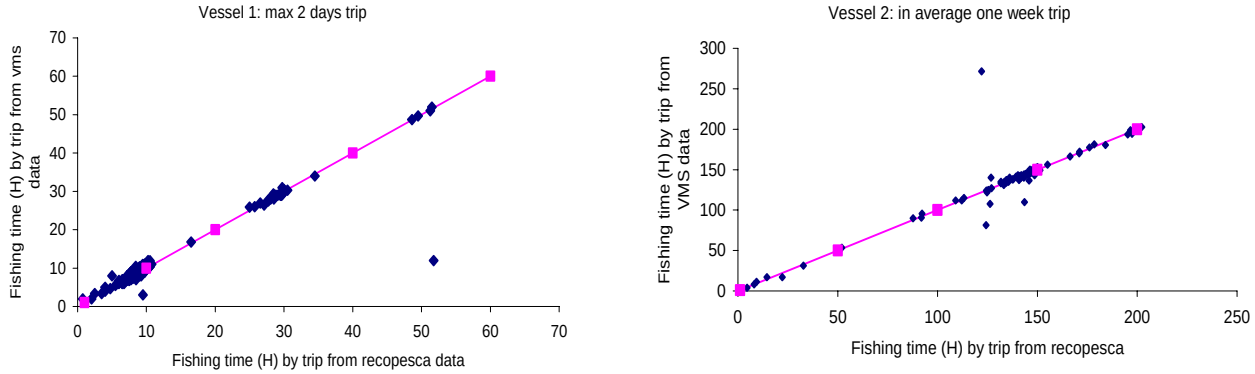


Figure 3.8. Data from the same boat comparing the fishing time by trip estimated from VMS and Recopesca data.

Conclusions

The workshop identified a number of pertinent issues.

Data availability is not consistent across differing nations:

- Ifremer have access to VMS data at a 1 hourly time interval while other nations have access to 2 hourly data. The improved temporal resolution of the Ifremer data would greatly reduce the error in identifying true vessel track locations.
- Logbooks are the only source of gear code information available to Cefas and Marlab. Ifremer have access to fishing calendars for each vessel. In cases where there is no link between a VMS location and a logbook entry then the VMS location cannot be used. For the UK and Scottish data a significant number of VMS locations relate to vessels carrying out non-fishing activity.

Speed rules for identification of fishing activity:

- Currently developed rules are different for each nation and reflect an understanding of national fleet behaviour. Broad patterns of density of activity are achieved using all methods. It is not currently possible to integrate the outputs from the different methods. Further work on refining these rules in order to standardise outputs could form part of future work within the Lot2 programme (MARE/2008/10 Lot 2, Development of tools for logbook and VMS data analysis).

Spatial and temporal resolution of output

- Analysis of data at differing temporal resolution showed that the generation of surfaces of time-spent fishing might not be greatly affected by the temporal resolution of the input data although may be affected by the spatial resolution of the generated results. The use of VMS to identify accurate fishing tracks requires higher temporal resolution data and, for local scale studies, may benefit from the use of a spline fitting algorithm to 'join-the-dots' rather than using straight lines.
- Tracks are often used to determine the proportion of a cell impacted by fishing. Further analysis is required, but it may be possible to determine a conversion factor so that an estimate of area impacted can be derived from the time spent fishing within a cell.
- Workshop participants identified the benefit in agreeing to a common grid resolution for use in future studies. Currently, output resolution range from 1' to 10'. The minimum resolution will be influenced by the temporal resolution of the data, as sub-1 hour data would support a finer spatial resolution of output. Recommendations on this issue may come from the EU Data Collection Regulations.

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Appendix 1

Agenda for Lot 7 VMS meeting, Cefas Lowestoft. April 6 & 7th 2009

Day 1: Summary of recent work in national labs on VMS

14:30 Arrivals & coffee

14:40 Recap of Lot7 project: joint data collection between the fishing sector and the scientific community in the North Sea - Chris Darby

14:50 Deliverables for VMS section of project and what we want to achieve in the meeting - Andy South

15:00 Summary of recent VMS work in national labs:

15:00	Cefas	Andy South
15:15	IMARES	Niels Hintzen
15:30	Marine Scotland	Neil Campbell
15:45	IFREMER	Emilie Leblond, Martial Laurans

16:00 Coffee

16:15 Discussion of VMS approaches & recommendations for report.
Will different methods have a major effect on results?

Day 2: Application of VMS analysis to the case study of proposed UK Dogger Bank SAC

09:00	Recap on day 1	
09:15	The Dogger Bank case study - JNCC	Charlotte Johnstone
09:30	UK fishing activity on the Dogger Bank.	Andy South
10:00	Dutch fishing activity on the Dogger Bank.	Niels Hintzen.

10:30 coffee

10:30 Discussion of potential effects of UK Dogger Bank Natura2000 proposal

12:00 Develop outline for report and meeting summary

12:30 Lunch

15:30 meeting close

Attendees:

Chris Darby, Cefas
Andy South, Cefas
Janette Lee, Cefas
Emilie LeBlond, IFREMER
Martial Laurans, IFREMER
Neil Campbell, MARLAB
Niels Hintzen, IMARES
Charlotte Johnston, JNCC (Day 2 only)

2.5.3 Case Study: Fishing activity within proposed UK Natura 2000 area on Dogger Bank

Report 6 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea. Reference: SI2.464218

Janette Lee, Andy South, Chris Darby & Peter Robinson (Cefas)**,** Niels Hintzen (Imares)**,** May 2009

Introduction

Historically, the spatial distribution of fishing effort and hence commercial catch per unit effort (CPUE) has been difficult to quantify based on logbook or other data. Logbook effort (hours fished) is only recorded at the International Council for the Exploration of the Sea (ICES) rectangle level, and this is often too coarse for accurate spatial delineation of the fishing effort directed within fishing grounds. Vessel Monitoring System (VMS) data provides the potential for more resolved and accurate determination of the spatial distribution of fishing effort; however, the analysis of such data is still in its early stages of development.

Within the LOT 7 EU funded project "Joint data collection between the fishing sector and the scientific community in the North Sea" a collaborative study of VMS data was agreed with the North Sea Regional Advisory Council (NSRAC). The project was designed to improve scientific and user understanding of the analysis process conducted when mapping the spatial distribution of fishing activities and to demonstrate how such analysis could aid the NSRAC in the provision of spatially pertinent advice. It was agreed during discussions that the project would develop standardized methods for estimating effort from VMS data and to undertake an example study.

At the 2008 Brussels meeting of the NSRAC Demersal Working Group the latest UK draft proposal for offshore Natura 2000 sites, part of the 2008-09 offshore Special Areas of Conservation (SAC) consultation, was presented by the Joint Nature Conservation Committee (JNCC, the UK agency which advises on nature conservation for UK offshore waters). The Natura Directives aim to stop biodiversity loss within the European Union by protecting natural habitats and species. JNCC has proposed two Natura 2000 offshore SAC for consultation in 2009. One of these is on the Dogger Bank which has been proposed for the conservation of 'Sandbanks slightly covered by seawater all the time' and 'Harbour porpoise'. Consultation between the Lot 7 Project team and the NSRAC Spatial Planning Group Chair identified the Dogger Bank SAC as a suitable case study the fits the goals of the Lot 7 VMS analysis project.

VMS Analysis protocols

A workshop was held at Cefas, Lowestoft to bring together scientists from across Europe in order to evaluate existing methods, and begin the development of standardised protocols, for estimating fishing effort from VMS data and to discuss the analysis required for the Dogger Bank case study. Representatives from Imares (Netherlands), Ifremer (France), Cefas and Marine Scotland were present. The UK Joint Nature Conservation Committee (JNCC) presented and then participated in discussions concerning the proposed restriction of fishing activities within the Dogger Bank SAC; a study to which the standardised protocols developed by the LOT 7 project team could be applied. The protocols developed at the meeting and applied in the analysis of VMS and catch data are

described elsewhere, this report details the results application and interpretation of the information extracted.

Summary

Figure 1 shows the ICES rectangles that intersect the proposed SAC. Four rectangles (39F1, 39F2, 38F1 and 38F2) cover the majority of the area with a further seven rectangles (40F1, 40F2, 40F3, 39F3, 38F3, 37F1, 37F2) contributing smaller proportions. Landings data from these rectangles are used in the species composition and value analysis, and VMS data are used to give a more detailed picture of vessel fishing activity.

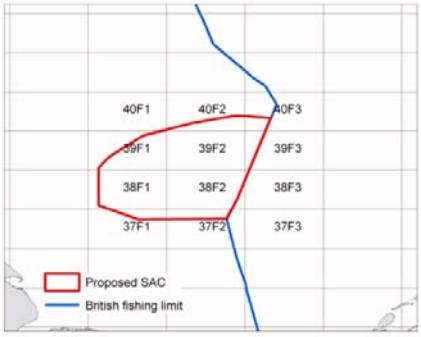

Figure 1. ICES rectangles intersecting the proposed SAC.

An initial analysis of patterns of fishing activity indicated that the majority of fishing effort deployed within this area was by Danish, Dutch and UK vessels. Unfortunately Danish analysts were not available within the project team for an analysis of their VMS, landings and value data and therefore only an analysis was conducted of their VMS data as part of 'other nations' VMS data recorded within UK waters. The main focus of this report is therefore a detailed analysis of UK and Dutch vessel activity within ICES regions IVb and IVc with particular focus on activity inside the proposed SAC area. Analysis is based upon EU logbook and VMS data for the years 2006 and 2007.

UK vessel activity within proposed SAC

Analysis of UK data for 2006 established that 21 beam trawlers, 6 otter trawlers and 3 Danish seine netters fished within the proposed SAC; in 2007, 23 beam trawlers, 8 otter trawlers and 2 Danish seine netters were active in the area. The total annual hours of fishing within the proposed SAC was estimated to be approximately 4700 for beam trawlers in both years, 400 and 1800 for otter trawlers in 2006 and 2007 and 1200 and 1000 for Danish seine netters. This represents approximately 11% of the beam trawl effort, 4% and 14% of the otter trawl effort and 94% and 79% of the Danish seine effort when compared with the total fishing effort of these vessels within ICES areas IVb & IVc. Maps derived from VMS data show that the beam trawl effort within the proposed SAC is greatest between April and September. Highest concentrations of otter trawl activity are noted around the periphery of the proposed SAC and again occur between April and September. The Danish seine effort occurs almost entirely within the proposed SAC area during the months of April to September with a small amount of activity being evident in the final quarter of 2007.

Analysis of the value of landings by UK vessels fishing within the four main ICES rectangles inside the SAC identified total catches, during the years 2006 and 2007, achieved 1.5 and 2.0 million pounds. Catch was dominated by flatfish (plaice, lemon sole, brill and turbot). Landings from the

remaining six adjacent rectangles that the SAC covers to a lesser degree and which may be included within the Dogger Bank SAC of other nations achieved an additional 4 million pounds in both years and were also dominated by flatfish but in addition comprised species (anglers, hake and nephrops) not usually associated with sand banks; illustrating the diversity of habitats available within the region.

The percentage of the revenue that the area represents for the UK fleets differs by gear type. Otter trawlers would be the least affected, with the four core rectangles representing <3% of their total revenue from ICES areas IVb and IVc in 2006 and 2007. Beam trawler catches from the core rectangles represented 5% and 7% of the IVb and IVc total revenue. UK vessels, using this gear type, would therefore be affected to a limited degree if forced to move to adjacent areas. Vessels fishing with Danish seine gear, although few in number, would have almost all (76% in 2006, 90% in 2007) of their revenue removed if they had not been permitted access to the four core rectangles and would therefore suffer the greatest disruption to income.

If the six adjacent areas are included within the SAC the percentage of revenue lost increases and could total 10% for the UK otter trawlers, 20% of the beam trawlers and 100% of the Danish seine netters.

Netherlands Vessels

Analysis of logbook and VMS data for Netherlands vessels in 2006 and 2007 showed that 24 beam trawlers and 2 otter trawlers fished in the proposed SAC. The total hours in two years of fishing within the proposed SAC was estimated to be 3380 for beam trawlers and 180 for otter trawlers. This represents less than 1% of the trawl effort when compared with the total fishing effort of these vessel types within ICES areas IVb & IVc. Only 2 vessels spend more than 5% of their effort within the SAC.

Maps derived from VMS data show that the beam trawl effort within the proposed SAC occurs throughout the year although little activity is evident between January and March. Most activity occurs around the periphery of the proposed SAC although between April and June there is an increase in activity within the SAC. Concentrations of otter trawl activity are low throughout the year and, when present, are noted around the periphery of the proposed SAC.

Analysis of the value of landings by Netherlands vessels fishing within the proposed SAC identified total catches, during the years 2006 and 2007 which achieved 0.88 and 2.1 million euros. Catch was dominated by flatfish (plaice, sole and turbot). The total value from the proposed SAC compared to that recorded in IVb,c was a low percentage; 0.8% in 2006 and 1.9% in 2007. Otter trawls recorded catch values of 29,400 euros in 2006 and 103,800 euro within the SAC in 2007, beam trawlers 0.85 and 2.0 million euros.

Danish Vessels

Analysis of UK recorded VMS data for Danish vessels for 2006 established that 18 gill netters, 64 otter trawlers and 11 Danish Danish seine netters fished within the proposed SAC; in 2007, 15 gill netters, 65 otter trawlers and 7 Danish seine netters were active in the area. Danish otter trawls showed the highest levels of activity in 2006 and 2007 with 16,700 and 7,600 hours fished respectively within the proposed SAC. Gill netters fished 1,600 hours in 2006 and 600 in 2007 and Danish seine netters 4,000 and 2,700 hours. The proportion of the Danish effort relative to the total for IVb and IVc, the species landed and their value was not available to the study.

Detailed analysis of UK activity

UK vessel activity from logbooks

UK Logbook data were extracted for the ICES regions IVb and IVc, which include the proposed SAC. The activity of UK vessels declaring landings within the eleven rectangles is shown in Table 1. These figures include activity in the areas outside of the proposed SAC. Most activity can be attributed to beam trawls, with some otter trawling and Danish seine netting. The majority of vessels for all gears are > 15m length and therefore provide information via the VMS.

Table 1. Proportion of fishing activity by UK vessels covered by VMS data.

	UK logbook activity days		**% of activity by vessels >15 m covered by VMS**	
	2006	**2007**	**2006**	**2007**
Otter trawls	221	432	94	100
Danish Seines	124	76	100	100
Beam trawls	1015	876	100	100

A summary of the fishing activity with ICES regions IVb and IVc and within the proposed SAC is provided in Table 2. More than half of the beam trawlers fishing within ICES regions IVb and IVc carry out some fishing activity within the proposed SAC area whereas only a small proportion (<5%) of otter trawlers fish inside the SAC. In contrast, nearly all of the activity by the (small number of) vessels employing Danish seines is carried out within the boundary of the proposed SAC. The majority of the fishing effort in terms of hours fished comes from the beam trawlers which contribute on average 77% of the total fishing hours in ICES regions IVb and IVc for the gears types under investigation and 69% of the effort within the SAC. Otter trawls represent 20% of the total fishing hours within ICES regions IVb and IVc and 15% of the effort within the SAC. Danish seines contribute the remaining 3% of effort within ICES regions IVb and IVc but represent 16% of the activity within the SAC.

Table 2. Fishing activity by UK vessels fishing within ICES regions IVb and IVc.

	Number of vessels in ICES regions IVb & IVc	**Number of vessels in proposed SAC**	**Proportion of vessels fishing within proposed SAC**	**Hours of activity by these vessels within ICES regions IVb & IVc**	**Hours of activity by these vessels in proposed SAC**	**Proportion of activity within proposed SAC**
Beam 2006	41	21	51	45,706	4,784	10
Beam 2007	34	23	68	37,933	4,726	12
Otter 2006	146	6	4	9,442	375	4
Otter 2007	153	8	5	12,670	1,787	14
Seine 2006	3	3	100	1,278	1,205	94
Seine 2007	2	2	100	1,267	1,000	79

Spatial distribution of activity from VMS

VMS data for the same area were extracted cleaned and processed. VMS locations sampled at 2-hour frequency and with a speed of between 1 and 6 knots were taken to represent 2 hours of fishing activity (as per the methodology described in the support methods document). Figures 2 to 4 show estimated hours of fishing activity within grid cells of 0.05 degrees (200 cells per ICES rectangle). The activity maps have been generated for quarterly data to show variation in patterns of activity throughout the year.

Maps of beam trawl activity in the North Sea (Figure 2) showed concentrations in ICES region IVc in the early months of the year with an increase in activity within the proposed SAC between April and September. Patterns of activity are similar in 2006 and 2007. Otter trawl activity by UK vessels (Figure 3) is most concentrated in the area to the west of in ICES region IVb with another broad swathe of less intense activity to the east of the proposed SAC. Activity within the SAC is concentrated around the boundary in particular to the south and southeast between April and September. The Danish seine activity (Figure 4) falls almost entirely within the proposed SAC and occurs between April and September.

Some vessels fished within in SAC in 2006 but not in 2007 and vice versa. Although more than 20 vessels engaged in some beam trawl activity within the SAC approximately half of those vessels spent a very small proportion of their fishing time in the area with no vessel spending more than 35% of their time there. Similarly the otter trawl effort within the SAC comprises activity from between 6 and 8 vessels however only two vessels in 2006 and three vessels in 2007 spent in excess of 15% of their time within the area. By contrast the vessels fishing Danish seines, although few in number, fish this year almost exclusively within the proposed SAC area with one vessel showing 100% of activity within the SAC in both 2006 and 2007.

There was little overlap in the gears being fished by vessels within ICES regions IVb and IVc although some vessels did fish different gears at different times of the year. Three of the beam trawlers fishing within the SAC in 2006 carried out some otter trawling activity within ICES regions IVb and IVc between the months of July and December. In 2007 four of the beam trawlers engaged in some level of otter trawl activity. Two of the otter trawlers fishing within the SAC in 2006 carried out some beam trawling activity within ICES regions IVb and IVc between January and June and one vessel employed nephrops trawl gear in December. In 2007, four of the vessels fishing otter trawls within the SAC were also engaged in beam trawling within ICES regions IVb and IVc during the year and one engaged in some nephrops trawling activity in September, November and December. Only one of the vessels fishing Danish seines within the SAC fished an alternative gear within ICES regions IVb and IVc during 2006 and 2007 using nephrops trawl gear (TBN) in January and between March and May.

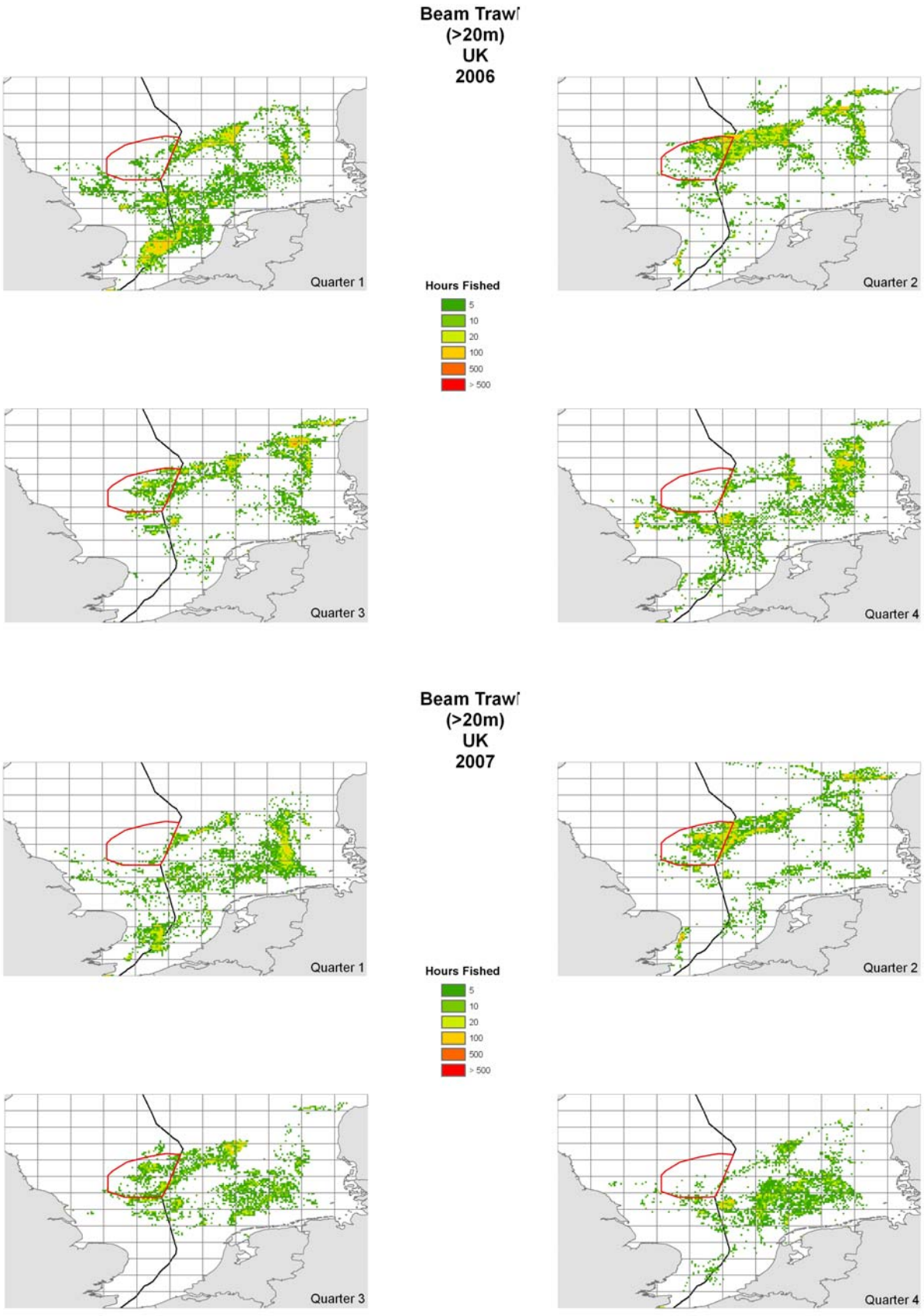

Figure 2. UK beam trawl activity for 2006 and 2007 estimated from VMS.

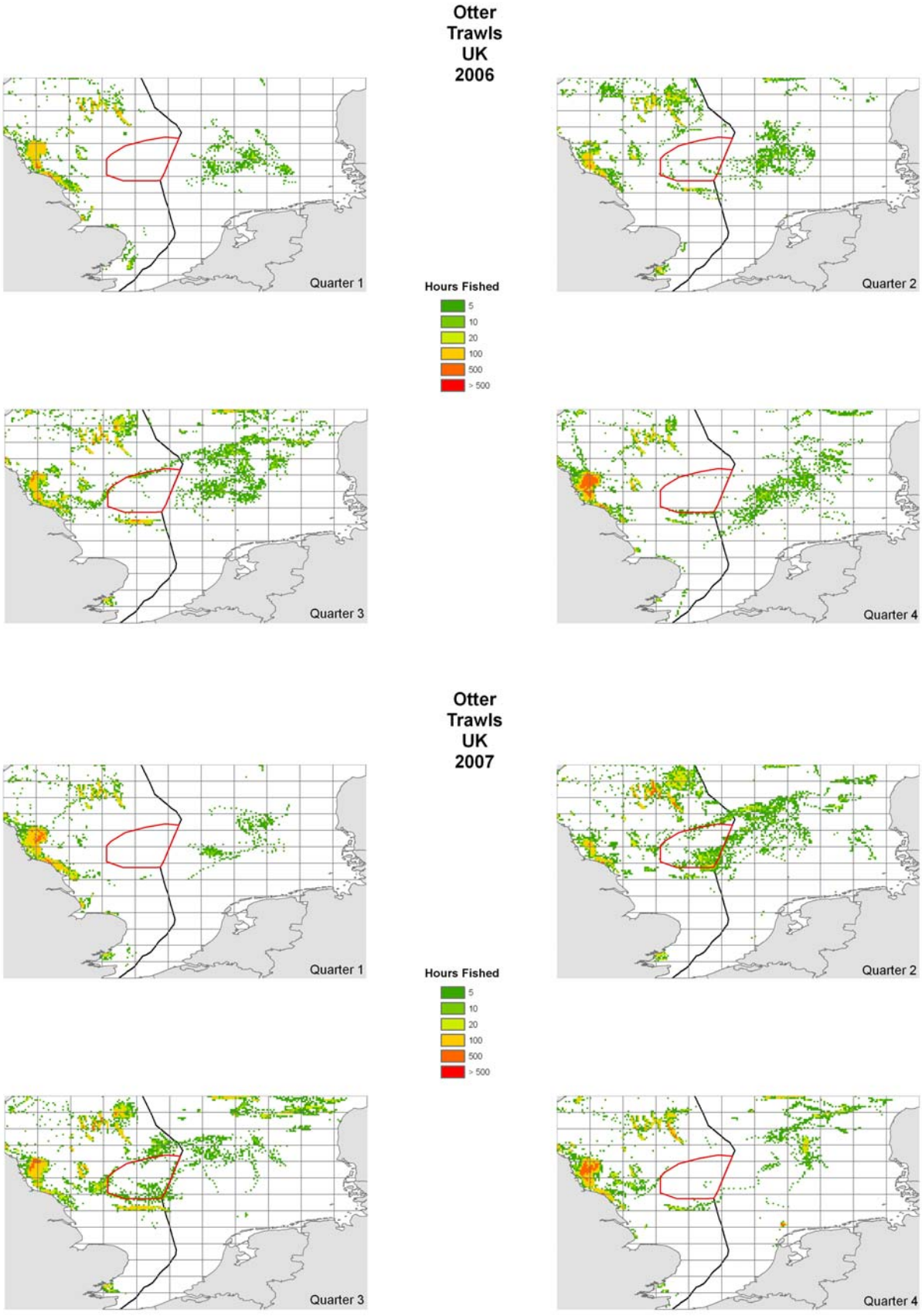

Figure 3. UK otter trawl activity for 2006 and 2007 estimated from VMS.

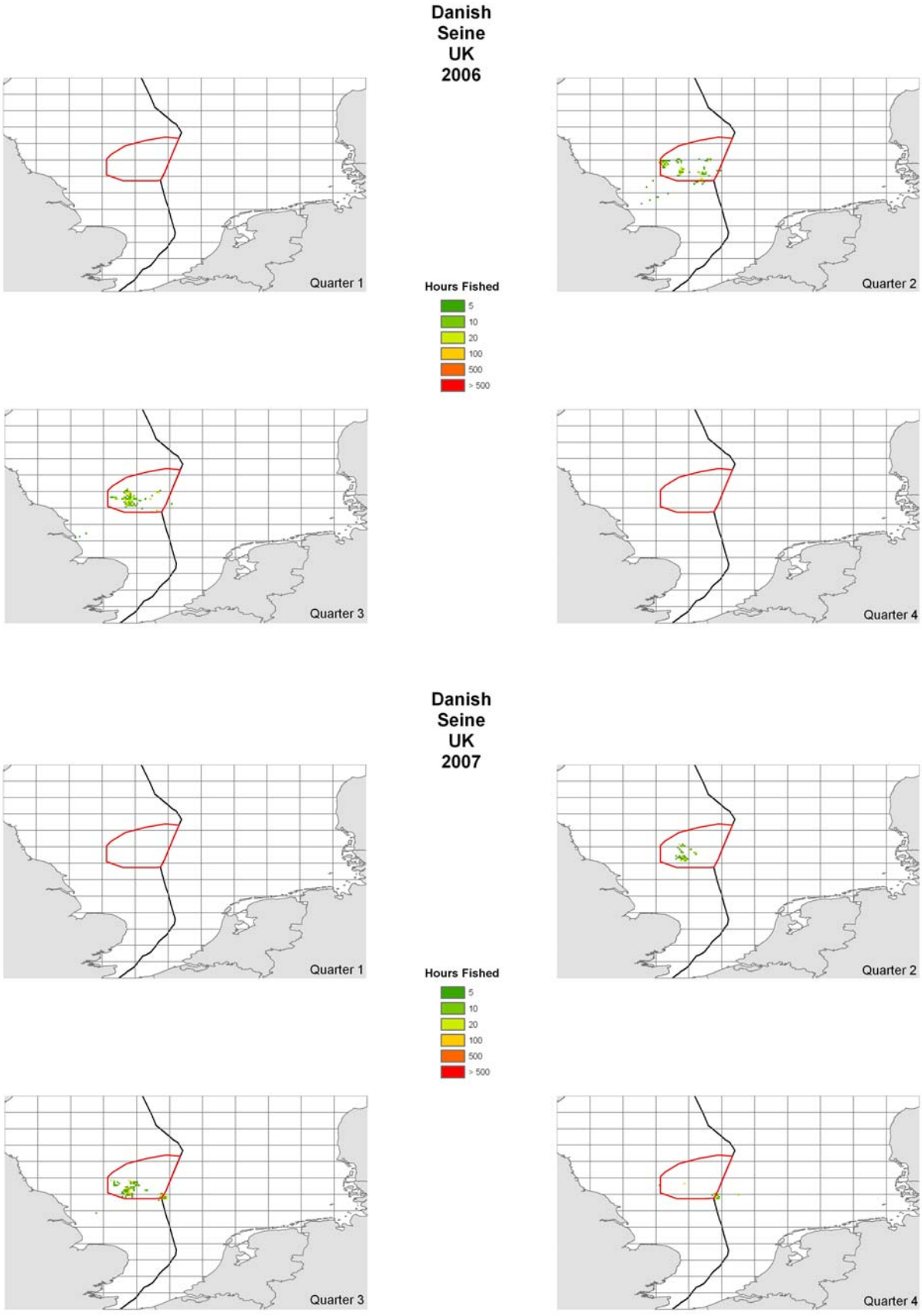

Figure 4. UK Danish seine activity for 2006 and 2007 estimated from VMS.

Landings within ICES regions IVb and IVc

Tables 3 - 6 present the summaries of the value of the landings by gear and species for the three classes of UK vessels fishing within the SAC while Table 7 lists the species codes used.

Table 3 presents the total value of the landings for each category of vessel by rectangle for the two years and the totals for the main core area and the adjacent rectangles. Total landings from the main area of the SAC achieved first sale values of 1.5 million pounds in 2007 and 2 million pounds in 2007. The majority of the revenue was achieved by beam trawls (~77%, £1.2m in 2006 and £1.6m in 2007), otter trawls and Danish seine comprised between 8 and 15% each (£0.16m to £0.3m).

Adjacent rectangles, parts of which are enclosed within the proposed UK SAC, realised just over 4 million pounds in both years with and similar proportions in 2006 but a higher proportion of otter trawling (35%) in 2007.

A comparison with the revenue achieved from the remainder of ICES areas IVb and IVc is presented in Table 4. The values achieved from the rectangles contained within the SAC represent 2% of the UK otter trawl landings in 2007, 7% of the beam trawl revenue and 76% of the Danish seine landings. Corresponding percentages for 2006 were (1% otter, 5% beam and 90% seine). Clearly this are represents the main area for Danish seine fishing in the southern and central North Sea. If the main and adjacent ICES rectangles are collated in the valuation the revenue comprises 10% of the otter, 19% of the beam and 100% of the seine revenue in 2007 and 5%, 21% and 98% in 2006.

Tables 5 and 6 present the break down of landings value by species for the core ICES rectangles and the main and adjacent rectangles for landings values greater than £1000. The two sets of data illustrate that for both years the main rectangle landings are dominated by flatfish (plaice, turbot, brill, sole, dab and lemon sole). The adjacent rectangles have differing compositions with cod, nephrops and skates having greater prominence to the south and megrim, hake and anglerfish increasing to the north and east, species which are not generally associated with the sandbanks that the SAC is designed to conserve.

Total landings values for eight of these species were mapped for each ICES rectangle and are shown in Figures 5 (2006) and 6 (2007).

Table 3. Total first sale value of landings from UK vessels fishing within the ICES rectangles contained in, and adjacent to, the UK proposed SAC.

2007	38F1	38F2	39F1	39F2	Main
All	£301,919	£902,101	£43,384	£808,096	£2,055,500
Otter	£71,651	£211,274	£26,740	£6,923	£316,588
Seine	£143,076	£9,862	£8,792		£161,730
Beam	£87,192	£680,965	£7,852	£801,173	£1,577,182

2007	37F1	37F2	38F3	39F3	40F2	40F3	Adjacent	All
All	£559,282	£1,349,795	£354,089	£1,245,086	£259,423	£574,089	£4,341,764	£6,397,264
Otter	£354,890	£535,047	£30,717	£135,418	£191,112	£254,187	£1,501,371	£1,817,959
Seine	£29,818	£21,009					£50,827	£212,557
Beam	£174,574	£793,739	£323,372	£1,109,668	£68,311	£319,902	£2,789,566	£4,366,748

2006	38F1	38F2	39F1	39F2	Main
All	£234,700	£376,249	£102,942	£815,757	£1,529,648
Otter	£12,872	£15,856	£74,514	£66,328	£169,570
Seine	£169,945	£17,377	£4,813	£7,653	£199,788
Beam	£51,883	£343,016	£23,615	£741,776	£1,160,290

2006	37F1	37F2	38F3	39F3	40F2	40F3	Adjacent	All
All	£667,463	£468,966	£218,299	£1,800,585	£144,061	£854,850	£4,154,224	£5,683,872
Otter	£368,029	£102,057	£18,442	£7,773	£42,872	£6,047	£545,220	£714,790
Seine		£18,147					£18,147	£217,935
Beam	£299,434	£348,762	£199,857	£1,792,812	£101,189	£848,803	£3,590,857	£4,751,147

Table 4. Total first sale value of landings from UK vessels fishing within the combined ICES rectangles contained in, and adjacent to, the UK proposed SAC and ICES Divisions IVb and IVc.

2007	All	Main	Adjacent	4b, 4c	All	Main	Adjacent
All	£6,397,264	£2,055,500	£4,341,764	£41,856,446	15%	5%	10%
Otter	£1,817,959	£316,588	£1,501,371	£18,107,383	10%	2%	8%
Seine	£212,557	£161,730	£50,827	£213,058	100%	76%	24%
Beam	£4,366,748	£1,577,182	£2,789,566	£23,536,005	19%	7%	12%

2006	All	Main	Adjacent	4b, 4c	All	Main	Adjacent
All	£5,683,872	£1,529,648	£4,154,224	£37,338,605	15%	4%	11%
Otter	£714,790	£169,570	£545,220	£14,031,451	5%	1%	4%
Seine	£217,935	£199,788	£18,147	£222,532	98%	90%	8%
Beam	£4,751,147	£1,160,290	£3,590,857	£23,084,622	21%	5%	16%

Table 5. The "Top 30" individual species landings values of commercial species recorded by UK England & Wales vessels in 2007 from the four ICES rectangles containing the majority of the UK proposed Natura 2000 site and the six adjacent rectangles.

2007	Main				
Species	38F1	38F2	39F1	39F2	Total
PLE	£247,892	£590,047	£23,566	£540,614	£1,402,119
TUR	£11,771	£134,261	£3,216	£62,879	£212,127
LEM	£18,235	£58,260	£9,625	£125,217	£211,337
SOL	£1,723	£72,282	£67	£17,539	£91,611
DAB	£5,758	£34,550	£930	£36,470	£77,708
ANF	£4,157	£1,692	£886	£10,527	£17,262
BLL	£954	£1,472	£721	£5,447	£8,594
COD	£2,901	£1,190	£1,538	£1,359	£6,988
CRE	£303	£2,046	£36	£4,255	£6,640
HAD	£1,719	£114	£1,187	£102	£3,122
SQC	£267	£1,234	£228	£1,085	£2,814
SAN	£2,715	£0	£0	£0	£2,715
GUX	£347	£1,125	£67	£465	£2,004
DGS	£833	£850	£14	£177	£1,874
HAL	£1,008	£68	£296	£30	£1,402
JOD	£13	£658	£12	£152	£835
GRO	£96	£250	£3	£367	£716
HKE	£160	£95	£145	£309	£709
WHG	£375	£56	£184	£92	£707
CRA	£57	£137	£0	£443	£637
SKA	£180	£389	£46	£10	£625
NEP	£65	£4	£433	£1	£503
WHE	£53	£216	£53	£144	£466
MAC	£0	£370	£0	£0	£370
GUR	£8	£223	£0	£47	£278
GUG	£55	£86	£0	£126	£267
MUR	£63	£114	£17	£29	£223
JAX	£39	£179	£0	£0	£218
LBE	£85	£49	£13	£50	£197
WIT	£52	£2	£54	£0	£108
All spp	£301,919	£902,101	£43,384	£808,096	£2,055,500

2007	Adjacent						
Species	37F1	37F2	38F3	39F3	40F2	40F3	Total
PLE	£229,178	£637,604	£224,562	£820,786	£60,958	£322,761	£2,295,849
LEM	£39,217	£36,999	£12,389	£95,691	£157,704	£152,132	£494,132
TUR	£33,629	£192,113	£47,503	£171,784	£8,563	£40,391	£493,983
NEP	£111,255	£225,587	£211	£0	£1,703	£324	£339,080
SOL	£18,971	£168,102	£44,628	£35,580	£161	£4,883	£272,325
DAB	£12,232	£29,830	£14,979	£90,952	£2,431	£19,951	£170,375
COD	£56,355	£16,155	£2,147	£3,592	£1,025	£2,824	£82,098
ANF	£5,981	£3,514	£689	£7,782	£10,363	£12,231	£40,560
BLL	£6,113	£10,495	£3,056	£8,619	£300	£6,348	£34,931
SKA	£14,369	£8,411	£748	£32	£0	£1	£23,561
HAL	£2,533	£1,251	£125	£239	£6,936	£3,270	£14,354
SQC	£6,179	£2,563	£456	£2,071	£280	£1,132	£12,681
HAD	£4,604	£692	£6	£25	£1,799	£1,172	£8,298
WHE	£335	£3,972	£997	£1,804	£58	£272	£7,438
LBE	£6,205	£277	£277	£40	£4	£5	£6,808
WHG	£3,010	£2,017	£63	£187	£835	£571	£6,683
LEZ	£14	£0	£4	£1	£4,381	£1,199	£5,599
MAC	£2,793	£2,468	£6	£0	£0	£0	£5,267
CRE	£1,006	£1,990	£282	£1,409	£46	£525	£5,258
DGS	£1,867	£917	£116	£192	£59	£928	£4,079
GUX	£393	£1,219	£325	£922	£24	£84	£2,967
MUR	£1,796	£897	£4	£77	£26	£56	£2,856
HKE	£123	£59	£76	£1,039	£191	£987	£2,475
WIT	£22	£107	£2	£1	£1,138	£900	£2,170
GRO	£152	£551	£68	£487	£155	£305	£1,718
JOD	£85	£569	£100	£550	£54	£129	£1,487
GUR	£40	£338	£92	£603	£1	£87	£1,161
LIN	£456	£110	£17	£44	£67	£148	£842
GUG	£74	£536	£12	£90	£0	£63	£775
POK	£61	£15	£1	£41	£66	£169	£353
All spp	£559,282	£1,349,795	£354,089	£1,245,086	£259,423	£574,089	£4,341,764

Total	
Species	Value
PLE	£3,697,968
TUR	£706,110
LEM	£705,469
SOL	£363,936
NEP	£339,583
DAB	£248,083
COD	£89,086
ANF	£57,822
BLL	£43,525
SKA	£24,186
HAL	£15,756
SQC	£15,495
CRE	£11,898
HAD	£11,420
WHE	£7,904
WHG	£7,390
LBE	£7,005
DGS	£5,953
LEZ	£5,674
MAC	£5,637
GUX	£4,971
HKE	£3,184
MUR	£3,079
SAN	£2,715
GRO	£2,434
JOD	£2,322
WIT	£2,278
GUR	£1,439
GUG	£1,042
LIN	£904
All spp	£6,397,264

Table 6. The "Top 30" individual species landings values of commercial species recorded by UK England & Wales vessels in 2006 from the four ICES rectangles containing the majority of the UK proposed Natura 2000 site and the six adjacent rectangles.

2006	Main				
Species	38F1	38F2	39F1	39F2	Total
PLE	£190,911	£265,632	£27,907	£499,277	£983,727
LEM	£12,848	£19,615	£29,935	£157,148	£219,546
TUR	£6,049	£35,518	£3,748	£52,735	£98,050
SOL	£4,685	£38,724	£595	£30,274	£74,278
DAB	£1,707	£8,020	£934	£26,697	£37,358
NEP	£1,452	£0	£31,662	£16	£33,130
WHE	£719	£1,577	£244	£14,547	£17,087
BLL	£719	£2,334	£416	£13,502	£16,971
ANF	£1,029	£1,272	£1,774	£8,760	£12,835
SAN	£8,357	£0	£0	£0	£8,357
COD	£1,490	£1,092	£745	£2,361	£5,688
HAD	£1,149	£32	£1,486	£907	£3,574
DGS	£1,377	£196	£1	£1,726	£3,300
WHG	£546	£73	£1,339	£313	£2,271
SQC	£652	£342	£243	£953	£2,190
CRE	£172	£465	£198	£1,204	£2,039
LEZ	£100	£0	£797	£639	£1,536
HAL	£95	£69	£668	£516	£1,348
SKH	£0	£0	£0	£1,167	£1,167
SKA	£373	£92	£12	£653	£1,130
GRO	£33	£193	£61	£774	£1,061
GUX	£48	£424	£3	£463	£938
HKE	£46	£105	£64	£535	£750
JOD	£31	£89	£29	£295	£444
GUR	£1	£165	£0	£31	£197
LBE	£0	£169	£0	£6	£175
LIN	£8	£14	£13	£56	£91
MUR	£69	£6	£5	£6	£86
WIT	£3	£0	£44	£20	£67
POK	£0	£3	£0	£54	£57
All spp	£234,700	£376,249	£102,942	£815,757	£1,529,648

2006	Adjacent						
Species	37F1	37F2	38F3	39F3	40F2	40F3	Total
PLE	£153,584	£204,157	£140,632	£1,269,235	£71,242	£541,354	£2,380,204
LEM	£32,801	£13,622	£9,560	£123,136	£47,352	£150,625	£377,096
TUR	£33,381	£35,247	£29,104	£186,013	£7,337	£58,838	£349,920
SOL	£106,664	£89,477	£21,791	£66,259	£393	£11,611	£296,195
NEP	£182,950	£74,162	£3	£22	£571	£2	£257,710
DAB	£7,134	£9,486	£9,183	£100,168	£1,962	£31,569	£159,502
BLL	£25,367	£9,217	£2,880	£19,325	£4,202	£21,895	£82,886
COD	£32,779	£12,537	£1,660	£5,018	£1,160	£4,656	£57,810
WHE	£6,578	£8,119	£1,722	£17,996	£3,614	£18,519	£56,548
SAN	£33,153	£0	£0	£0	£0	£0	£33,153
ANF	£7,233	£1,325	£590	£7,329	£1,837	£10,690	£29,004
DGS	£17,637	£1,383	£16	£97	£92	£114	£19,339
SKA	£11,858	£3,709	£42	£421	£0	£18	£16,048
SQC	£3,582	£1,863	£142	£676	£40	£286	£6,589
WHG	£2,598	£978	£181	£167	£143	£957	£5,024
HAL	£2,584	£802	£77	£283	£620	£401	£4,767
LBE	£3,752	£277	£2	£32	£0	£9	£4,072
CRE	£476	£715	£240	£841	£66	£522	£2,860
HKE	£47	£46	£136	£947	£99	£854	£2,129
GRO	£162	£129	£58	£725	£139	£910	£2,123
GUX	£316	£251	£51	£728	£297	£309	£1,952
HAD	£866	£113	£4	£47	£426	£146	£1,602
LEZ	£29	£8	£0	£9	£1,355	£22	£1,423
GUR	£430	£341	£5	£265	£10	£20	£1,071
MUR	£819	£129	£0	£2	£0	£5	£955
GUG	£48	£278	£22	£216	£0	£166	£730
WIT	£21	£4	£0	£0	£628	£23	£676
LIN	£244	£60	£17	£100	£32	£164	£617
JOD	£4	£70	£107	£369	£0	£58	£608
FLE	£16	£304	£32	£9	£0	£0	£361
All spp	£667,463	£468,966	£218,299	£1,800,585	£144,061	£854,850	£4,154,224

Total	
Species	Value
PLE	£3,363,931
LEM	£596,642
TUR	£447,970
SOL	£370,473
NEP	£290,840
DAB	£196,860
BLL	£99,857
WHE	£73,635
COD	£63,498
ANF	£41,839
SAN	£41,510
DGS	£22,639
SKA	£17,178
SQC	£8,779
WHG	£7,295
HAL	£6,115
HAD	£5,176
CRE	£4,899
LBE	£4,247
GRO	£3,184
LEZ	£2,959
GUX	£2,890
HKE	£2,879
GUR	£1,268
SKH	£1,198
JOD	£1,052
MUR	£1,041
GUG	£781
WIT	£743
LIN	£708
All spp	£5,683,872

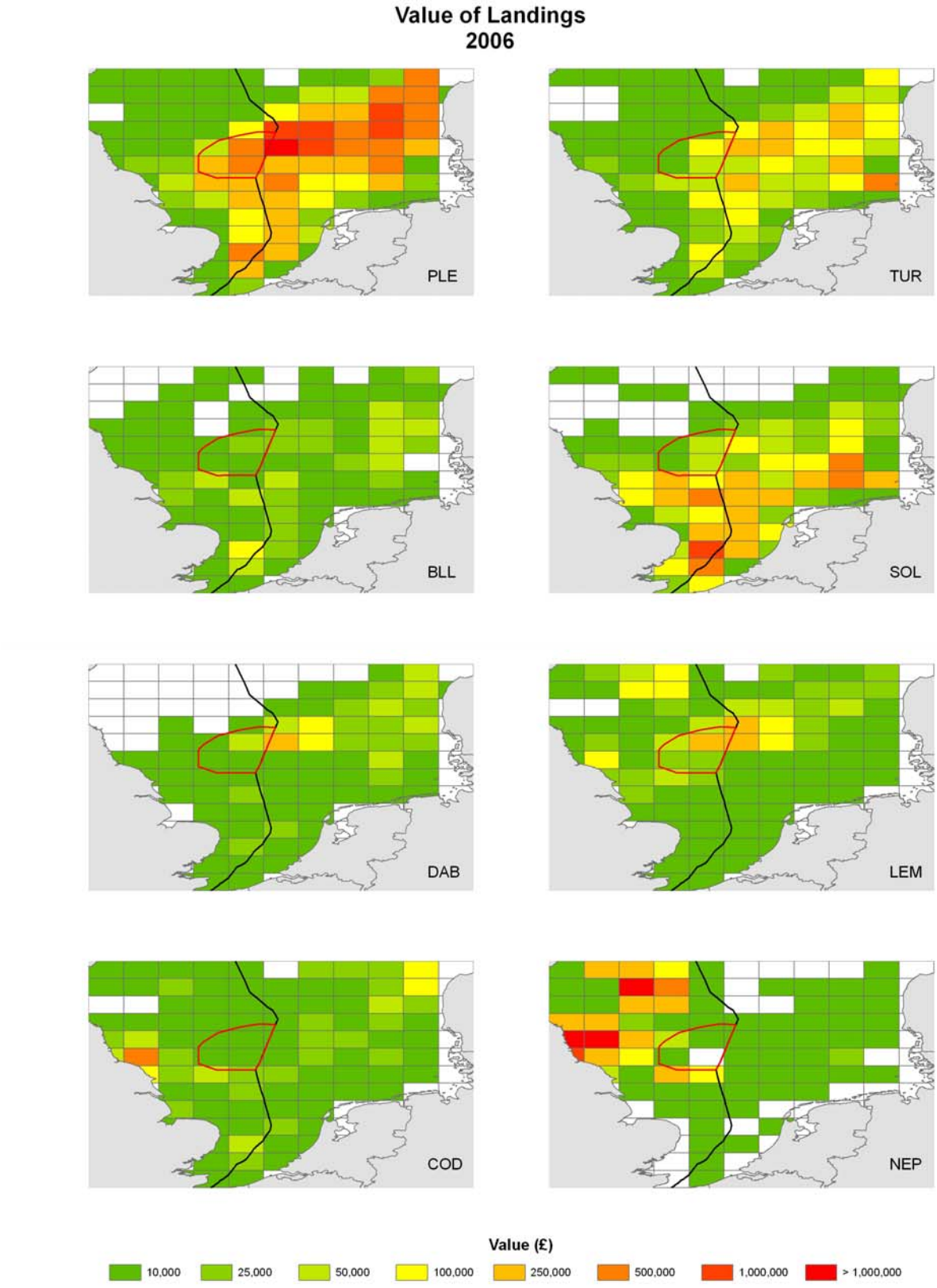

Figure 5. Value of UK landings by species, 2006.

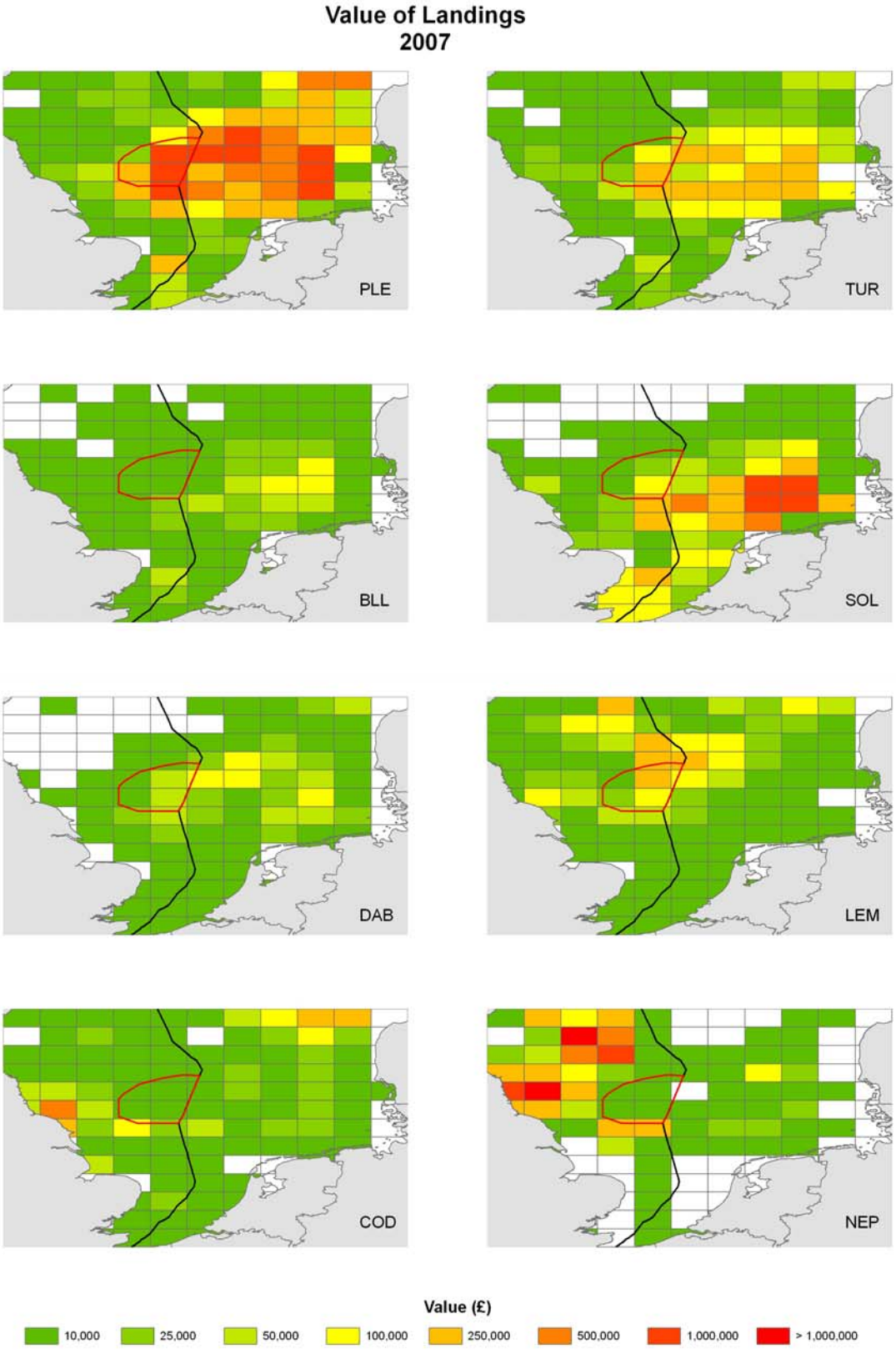

Figure 6. Value of UK landings by species, 2007.

Table 7. Species landings codes used within Tables 5 and 6.

Code	Species
PLE	Plaice
TUR	Turbot
NEP	Nephrops
LEM	Lemon sole
SOL	Sole
DAB	Dab
COD	Cod
ANF	Anglerfish
BLL	Brill
SKA	Skate and rays
SKH	Sharks
SQC	Squid
CRE	Crab
HAD	Haddock
LBE	Lobster
WHG	Whiting
MAC	Mackerel
HAL	Hallibut
WHE	Whelk
DGS	Spurdog
GUX	Gurnard and latchet
MUR	Mullet red
SAN	Sandeel
JOD	John Dory
LEZ	Megrim
GRO	Other mixed demersal

Detailed analysis of Danish activity, based on UK VMS records

Table 8 shows the main gears and fishing activity by the Danish fleet based on an analysis of UK recorded VMS data. In 2006, 18 gill netters, 64 otter trawlers and 11 Danish Danish seine netters fished within the proposed SAC; in 2007, 15 gill netters, 65 otter trawlers and 7 Danish seine netters were active in the area. Danish otter trawls showed the highest levels of activity in 2006 and 2007 with more effort allocated in 2006 than in 2007 by all gear types.

Table 8. Activity of Danish vessels fishing within the proposed SAC within UK waters.

	2006		2007	
	Hours	Vessels	Hours	Vessels
Gillnets	1,587	18	643	15
Otter trawls	16,722	64	7,610	65
Danish seines	3,963	11	2,664	7

The maps in Figure 7 show the pattern of activity for gillnets, otter trawls and Danish seines from the Danish fleet. Otter trawl activity is distributed to the west and south of the SAC, although there is activity throughout the area. The activity is considered to be characteristic of the sandeel industrial fishery. VMS data from UK waters on Danish gill netters indicates activity spread across IVb and IVc with no particular concentration within the SAC. In contrast the Danish Danish seine activity is almost exclusively within the SAC showing a similar spatial allegiance to that of the UK vessels fishing with this gear type.

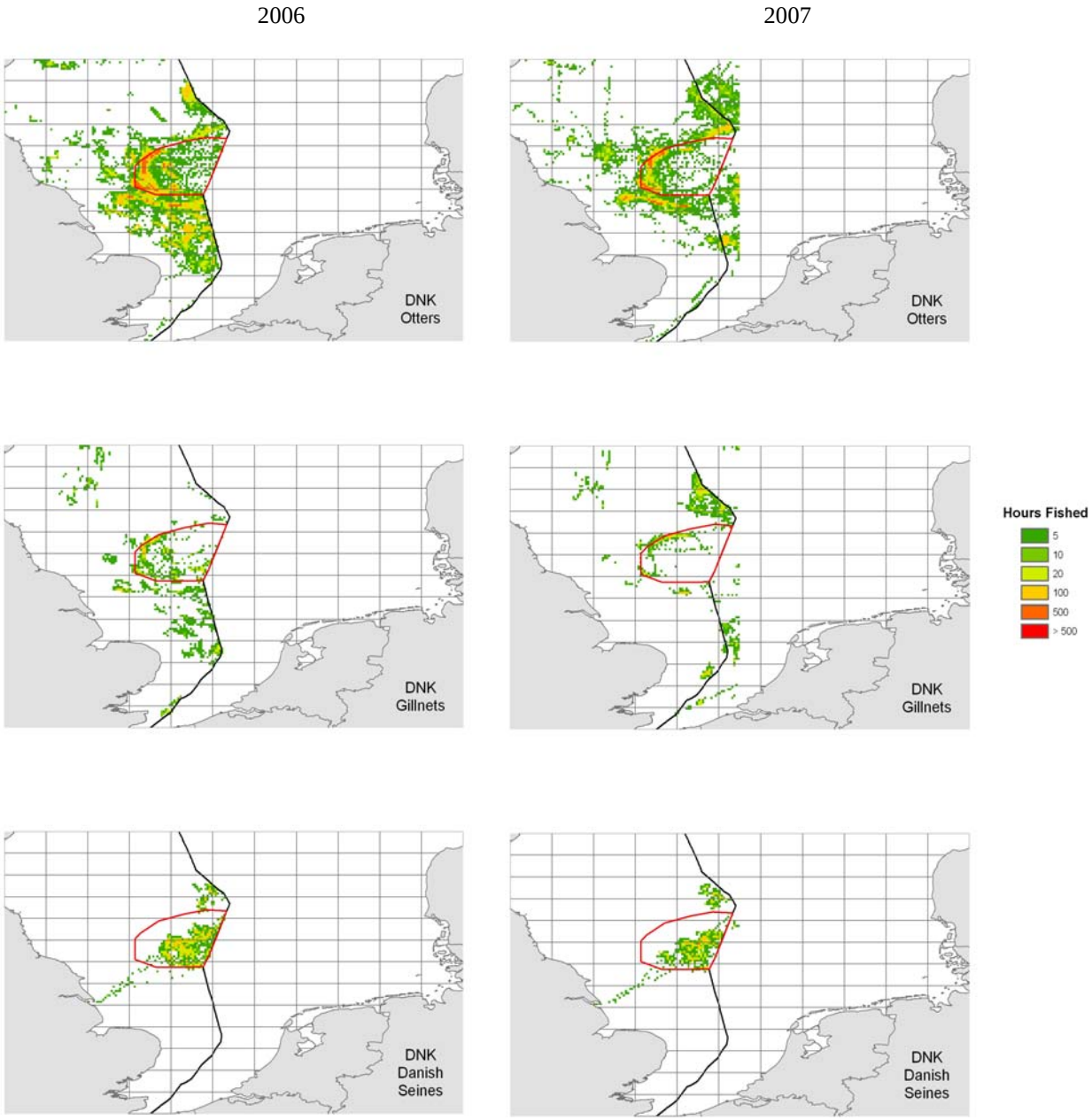

Figure 7. Fishing activity for Danish vessels for 2006 and 2007 estimated from VMS.

Detailed analysis of Netherlands activity

Methods

Logbook data were extracted for the ICES regions IVb and IVc, which include the proposed SAC. VMS data for the same area were extracted cleaned and processed. VMS locations sampled at 2-hour frequency within a speed range depending on the type of gear used represent hours of fishing. Hours of fishing depend on the total effort allocated by the fisheries, distributed over the number of VMS records where vessels are fishing. Since routines have only been developed for the gear types otter trawl, shrimp beam trawl and beam trawl to distinguish fishing activities from steaming, effort allocations to VMS records can only be accomplished for these gear types. However, as only two VMS records with one other gear type (Scottish seine) have been recorded in the SAC area, the omission made by not accounting for other gear types is not significant. Values for landings are obtained from auction data, provided by the Dutch Ministry. These data are aggregated and averaged on a monthly basis. Catches obtained from logbook data are multiplied with the average monthly price of the species to compute landings value.

Results

The total number of vessels within the proposed SAC area is limited. Only two types of gears can be distinguished, otter trawls and beam trawls. During 2006 and 2007, 2 otter trawls and 24 beam trawls fished within the proposed SAC area (Table 9). The total effort allocated in ICES regions IVb and IVc by the otter trawlers is 34,895 hours of which 178 hours (0.51%) were spent within the proposed SAC. The beam trawler activity was 543,319 hours within ICES regions IVb and IVc with 3,384 hours (0.62%) spent within the proposed SAC. A spatial overview of allocated effort in 2006 and 2007 by quarter for these otter and beam vessels is given in Figures 8 and 9.

Table 9. NLD vessels fishing within proposed SAC.

	Number of vessels fishing in proposed SAC, 2006-2007	**Effort within SAC, hours fished 2006-2007 (hours fished)**	**Proportion of effort in ICES areas IVb & IVc (%)**
Otter trawls	2	178	0.51
Beam trawls	24	3384	0.62

The largest fishery in terms of effort in ICES areas IVb & IVc is the large beam trawl fishery. The shrimp trawl fishery is considerably smaller, followed by the otter trawling effort which is only 5% of the total effort allocated by these three types of fisheries (Table 10). Note however that as only these three gear types have been investigated, in reality these figures might be different for IVb&c. An overview of the effort allocated by vessel within and without the proposed SAC area is provided as Table 11.

Table 10. Proportion of effort in ICES IVb and IVc (NLD vessels) within proposed SAC.

	Effort in ICES areas IVb & IVc (hours fished)	**Proportion of all fishery activity (%)**
Otter trawls	34,895	5.0
Beam trawls	543,319	77.4
Shrimp trawls	123,518	17.6

The values of the landings are based upon monthly averaged prices obtained from auction data. The effort allocated by the otter boards and beam trawling can be expressed in a monetary value when merged with monthly averaged prices (Table 12). From the species caught by these fisheries, both in 2006 and 2007, the top 3 species by value are represented by sole (*Solea solea*), plaice (*Pleuronectes platessa*) and turbot (*Psetta maxima*) (Table 13). However, these values compared to the values outside the proposed SAC are small. Hence, based upon these analyses, the major part of the catch value is taken outside the proposed SAC area. Figures 10 and 11 represent the spatial distribution of landings value per ICES rectangle for eight main commercial species for 2006 and 2007. These figures indicate where effort, expressed as a value measure, has been allocated in these years. Only 26 of the 131 (20%) vessels fish inside the SAC and of these vessels only 2 spend more than 5% of their effort within the SAC.

Table 11. Proportion of effort in ICES IVb and IVc (individual NLD vessels) within proposed SAC.

Vessel	Effort in SAC	Effort outside SAC	% in SAC		Vessel	Effort in SAC	Effort outside SAC	% in SAC		Vessel	Effort in SAC	Effort outside SAC	% in SAC
1		7622			45	142	6500	2.1		89		7604	
2		7307			46		7			90		5543	
3		6568			47		8845			91	58	1613	3.5
4		6887			48		8603			92		6918	
5		4221			49		6263			93	15	7756	0.2
6		3724			50		7346			94		856	
7		6642			51		1317			95		7532	
8	113	6565	1.7		52		1986			96		4368	
9		5323			53		5522			97		5870	
10	119	6777	1.7		54		2			98	67	7576	0.9
11	79	4681	1.7		55		7632			99		5172	
12	57	6787	0.8		56		5265			100		7729	
13		6600			57		5752			101		3226	
14		6744			58		3308			102		7006	
15		634			59		7027			103		6636	
16		7296			60	2	7534			104		3554	
17	515	6458	7.4		61	232	6845	3.3		105		2888	
18		7033			62	179	7220	2.4		106		480	
19		7509			63		2518			107		1998	
20		7409			64	109	6504	1.6		108		4111	
21		7918			65		4337			109		5402	
22		8248			66	46	7011	0.7		110		3051	
23		3620			67		6801			111		3081	
24		6445			68	133	7043	1.8		112		3573	
25		2297			69		7076			113		594	
26		728			70		6608			114		5192	
27		3694			71	22	5938	0.4		115		1376	
28		933			72		7353			116		4336	
29		895			73	497	7203	6.5		117		2723	
30		10472			74	288	6647	4.2		118		1353	
31		8549			75		6628			119		3289	
32		5568			76		1306			120		8145	
33		7063			77		5696			121		870	
34		7438			78	15	7623	0.2		122		4031	
35	2	9986			79		5583			123		2152	
36		6299			80		7213			124		4315	
37		9268			81		7001			125		2312	
38		6667			82		4092			126		4144	
39	36	6722	0.5		83		7593			127		4923	
40	157	7206	2.1		84		7146			128		3651	
41	24	7547	0.3		85	120	4018	2.9		129		2499	
42	270	8389	3.1		86		7077			130		1577	
43		4085			87		5963			131		6080	
44	265	6608	3.9		88		2684						

Table 12. Proportion of catch (NLD vessels) within proposed SAC.

	Value of catch within proposed SAC, euros		**Percentage of total catch**	
	2006	2007	2006	2007
Otter trawls	29,480	103,804	0.25	0.59
Beam trawls	846,952	2,014,520	0.56	1.31

Table 13. Catch value by species (NLD vessels) within proposed SAC.

	2006		**2007**	
Position	**Main Species caught within SAC**	**Value of landings within SAC in euros**	**Main Species caught within SAC**	**Value of landings within SAC in euros**
1	SOL	341,047	SOL	997,140
2	PLE	313,259	PLE	651,374
3	TUR	76,275	TUR	211,064
4	LEM	49,057	LEM	71,247
5	BLL	22,140	DAB	37,605
6	DAB	20,721	BLL	31,711
7	COD	11,600	NEP	27,707
8	NEP	7,379	COD	20,010
9	GUU	6,353	SRX	16,449
10	SRX	5,396	GUU	13,699

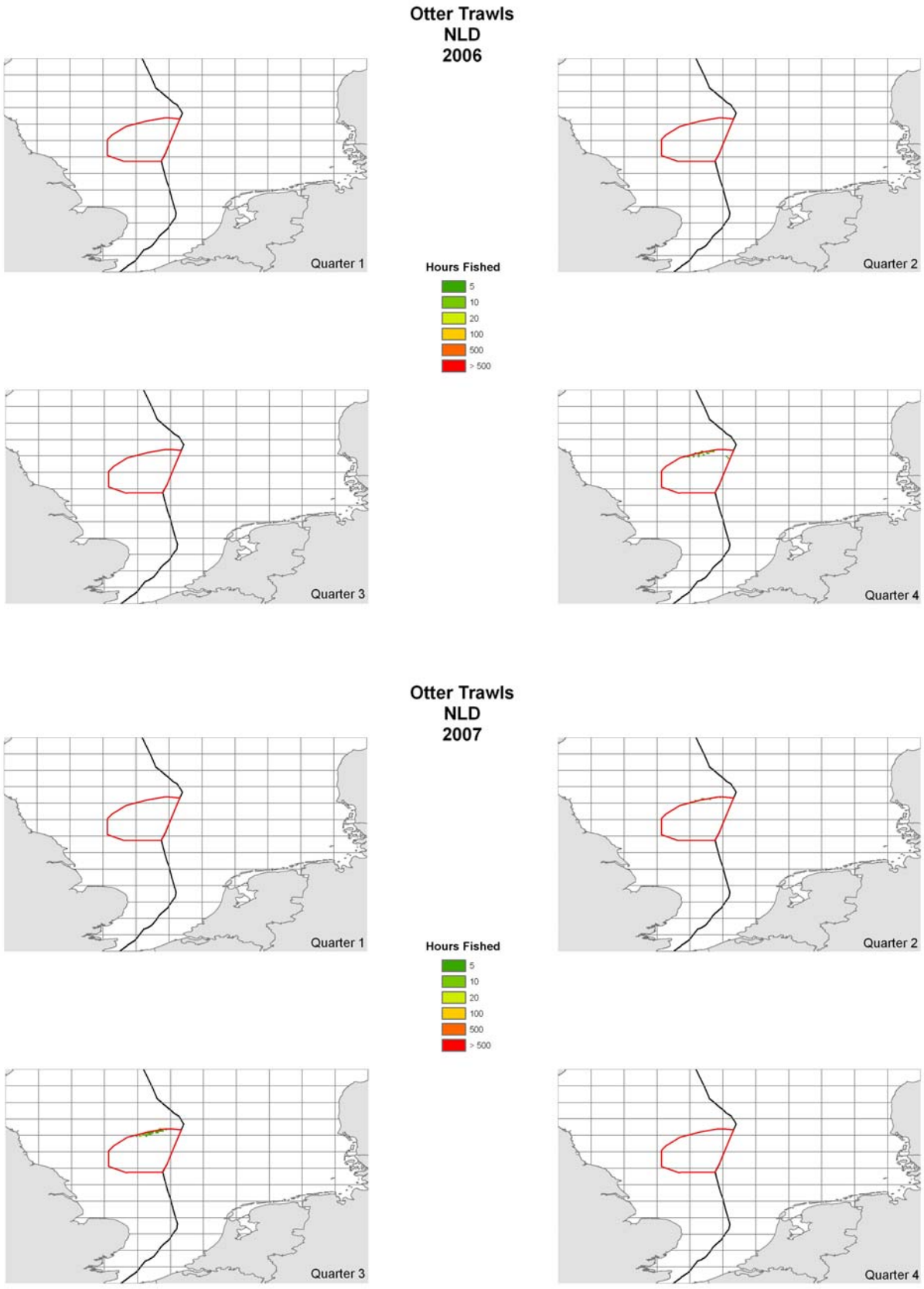

Figure 8. Netherlands otter trawl activity (2006-7) for vessels operating within the proposed SAC.

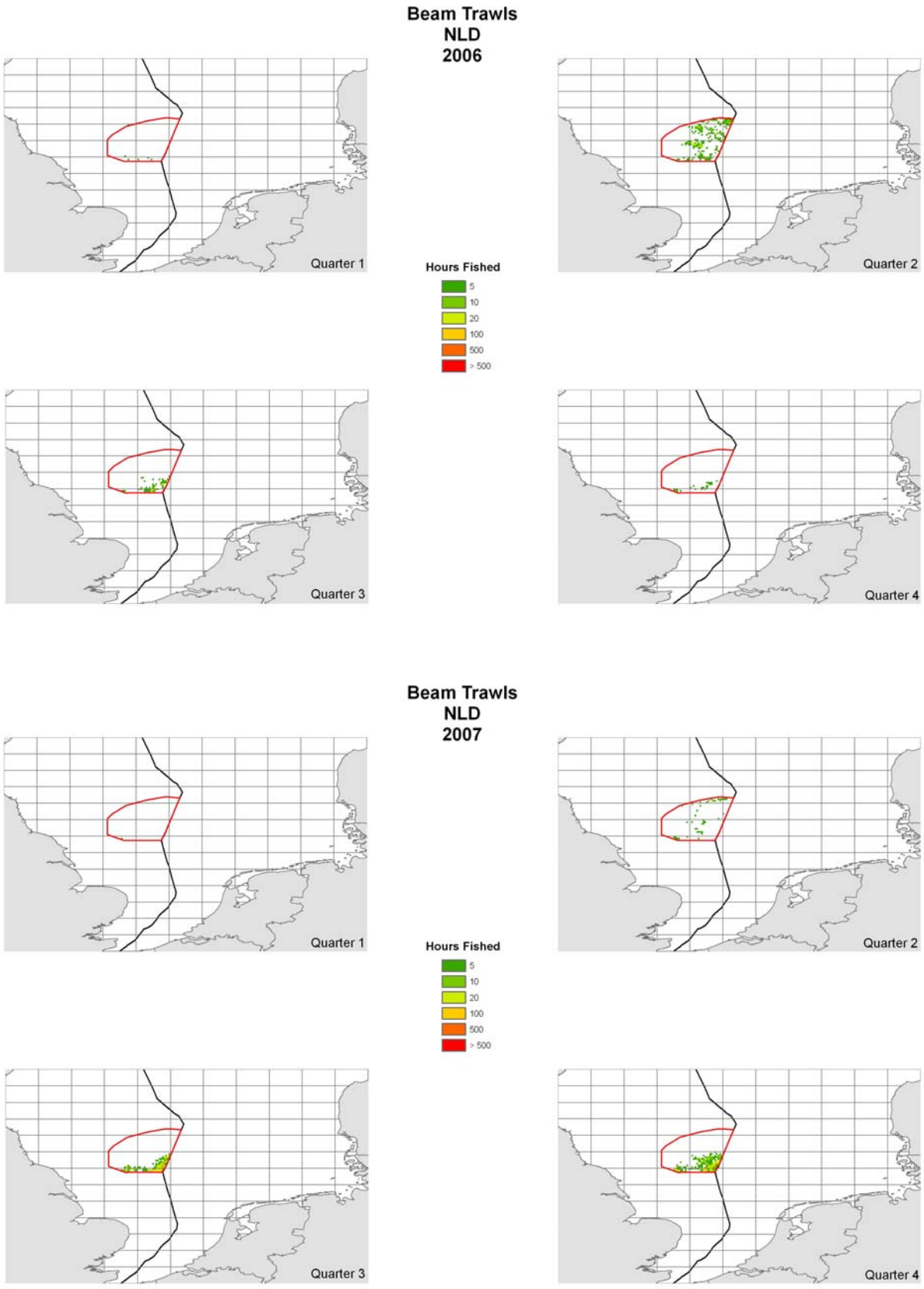

Figure 9. Netherlands beam trawl activity (2006-7) for vessels operating within the proposed SAC.

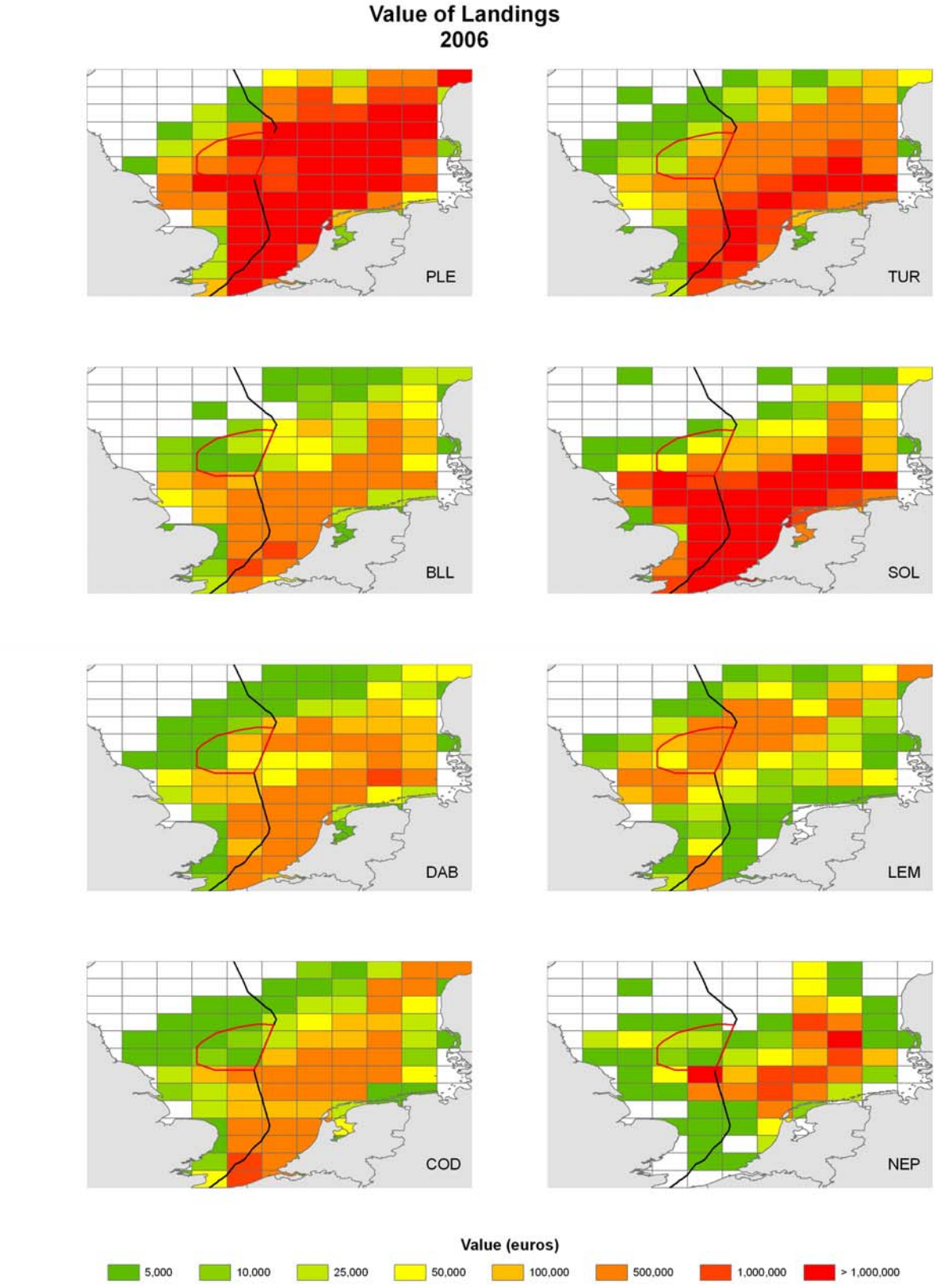

Figure 10. Value of NLD landings by species, 2006.

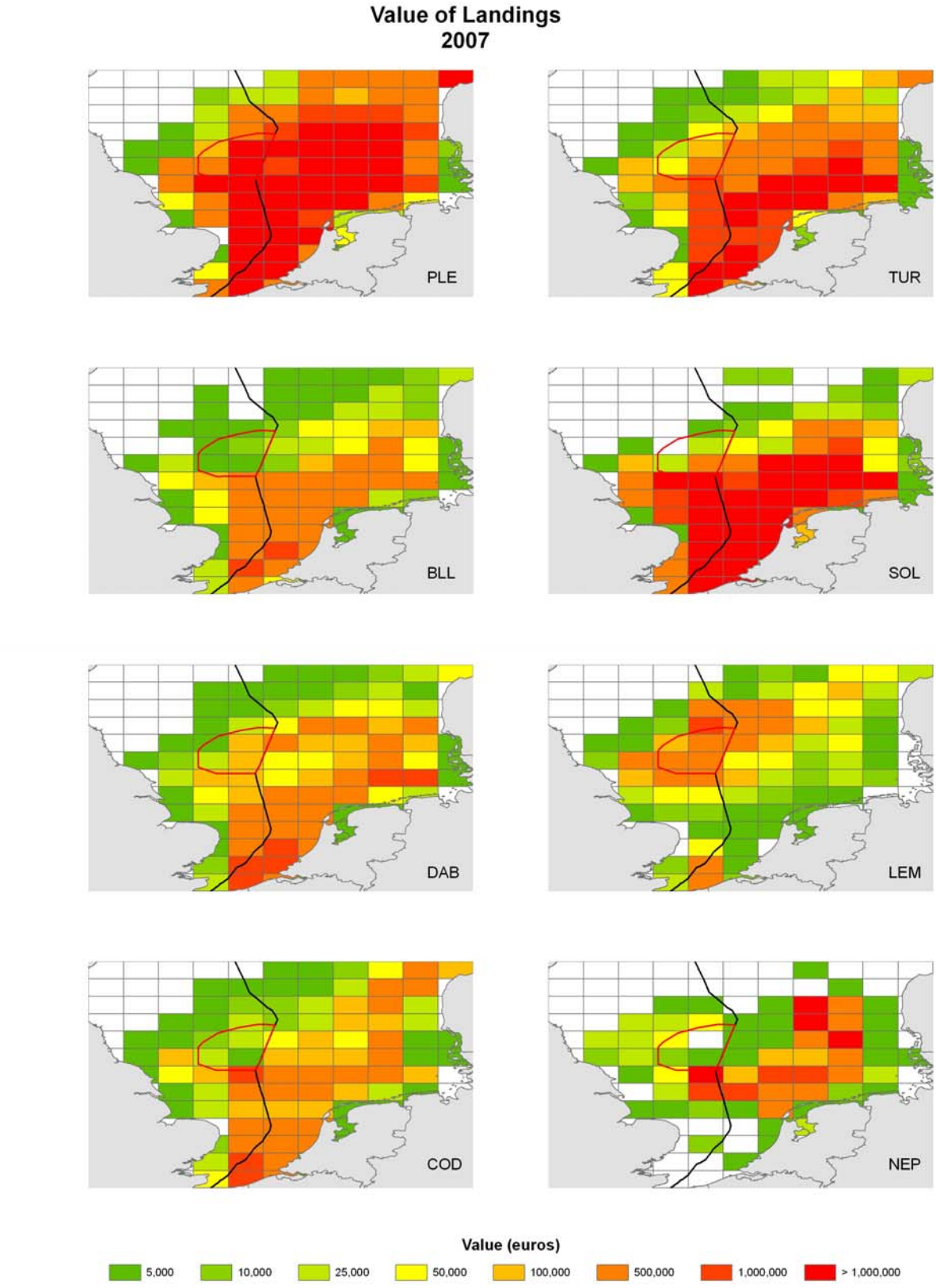

Figure 11. Value of NLD landings by species, 2007

3. SUMMARY

The studies conducted within the Cooperation to Develop Fisheries Information from the North Sea (CoDFINS) project have been undertaken within the European Commission studies and Pilot projects for carrying out the common fisheries policy Lot 7: *Joint data collection between the fishing sector and the scientific community in the North Sea* specified in the Call for Tenders FISH/2006/15 "*Studies and Pilot projects for carrying out the common fisheries policy*".

The programme has successfully facilitated collaboration between representatives from fishers' organisations and scientific fisheries institutes in the resolution of fisheries issues of importance to the North Sea Regional Advisory Council (NSRAC).

A series studies which covered the themes of the Lot 7 Studies and Pilot projects for carrying out the common fisheries policy Terms of Reference were outlined by the project team, discussed and agreed with the NSRAC Executive Committee and its Demersal Working Group. Meetings were then organised within the project framework and at NSRAC meetings to refine the studies and carry out and present and discuss the analyses. The group has:

- Reviewed the published information, listed studies that can be used as examples and provided suggestions for self sampling data gathering programmes that can be applied by fishers.

- Reviewed the information that can be gathered from collaborative surveys currently taking place in the North Sea. Data collected from a series of coordinated commercial surveys, designed by fishers, can provide the information required to improve stock assessments, especially at the oldest ages where catch rates in surveys are low. The basis for such a coordinated survey is already in place because several countries are already conducting surveys that could, over time, and with minor modifications to sampling protocols and design be combined to provide an industry survey series. The expertise and experience is already available, but setting up of such a survey will require input from more countries to give greater coverage and could be encouraged by EU funding of industry projects. The study group has helped to begin this process already, by collaborating to provide input into the design of a new North Sea wide gadoid survey that has been funded and incorporated within the UK Fisheries Science Partnership programme; the first fishing survey was conducted in 2009. The survey results can be used to link together indices from surveys conducted in other areas in a combined analysis.

- Analysed catch rates from commercial surveys being conducted currently in the North Sea to address fishers concerns about the quality of research survey catch rates. Two studies have demonstrated that indices derived from soft and hard substrate have similar dynamics and that there is coherence between commercial data and research surveys at young ages. However, the studies both raised concerns about low catch rates at older ages in research surveys resulting in noise in stock assessments. Information from the collaborative surveys described previously would resolve this.

- Within studies examining the utility of VMS data the study group reviewed the methods applied by analysts from each member state to process satellite monitoring data and extract fishing information. The team complied a common protocol for the standardisation of approaches for use in common projects, the first time this has been carried out. The analysis methods were applied to VMS data on fishers' spatial movements and gear use within an area of the North Sea that may be designated as a potential Natura 2000 conservation area by the UK. A report was prepared at the request of the North Sea RAC and presented to its Demersal Working Group, providing them with information on usage of the area by gear country and also the species catches by weight and value. The NSRAC highlighted the value of the information provided by the group to its future advice and discussions with managers as to the use of the area of seabed.

Study results were presented to and have been used by: the NSRAC Executive Committee and the NSRAC Demersal Working Group at its tri-annual meetings; directly to the industry to highlight the information contained within data and to provide guidance on alternative sources and ways in which it can be collected; the ICES North Sea Working Group.

The CoDFINS project is considered to have been have been challenging and important lessons learned in two main areas. Firstly the targeting of data collation and analysis at areas of research that are current to the NSRAC in a rapidly changing biological system and political environment. Second the process of working within the temporal framework of the NSRAC which has only a few meetings each year at which work plans can be proposed, revised and results discussed.

Project development followed the protocol designed into the work plan at the start of the project with successful completion of the design and implementation phase. However, significant delays in the progress of the scheduled work have been a feature from the start, resulting from three main factors:

- Assembling the participants together at an initial meeting and scheduling the work for the subsequent analysis proved problematic. The well documented, recent problems in the fisheries of the North Sea compounded with the changes to the timing of the ICES advice schedule from October to June, following a request from the Commission, resulted in the participants (scientific and industry) having to commit to a substantial unforeseen workload at short notice to the time of the year at which the project was initially due to occur, following discussions with the Commission, the project start date was therefore rescheduled.

- A second factor which has complicated progress for two of the projects has been logistical stresses resulting from the unscheduled retirement and resignation of key project members from their institute. The team members were essential to one, and key to a second of the projects which were agreed with the NSRAC. The problems associated with each project are described later within the individual project descriptions. The first project could not be completed without the key analyst and the time allocated to it was diverted to an new task that met the Lot 7 Terms of Reference. Following a further delay,

the second project was reassigned and shared between two alternative project managers who successfully completed the work.

- The third aspect which has delayed the work of the project team but not altered the characteristics of the projects was the logistic difficulties in dealing with the NSRAC which meets infrequently during the year and has a numerous issues to cover at its meetings. The scheduling of the NSRAC meetings has a formal structure which needed to be considered in the timing of discussions and the presentation of results and this had not been factored into the original timing of the project.

The logistical difficulties have resulted in important lessons being learned by the Project Team whom consider that the project has been successful in achieving its aim of facilitating collaboration between representatives from fishers' organisations and scientific fisheries institutes in the resolution of fisheries issues of importance to the North Sea Regional Advisory Council (NSRAC), albeit at a slower pace than originally envisaged possible.

Annex 1 Report for Meeting 1 of the CoDFINS project

Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea
Reference: SI2.464218

Report of Meeting 1

Summary

The first meeting of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea occurred on the12/13 of November 2007 at Millbank, London. The meeting Agenda is presented in Appendix 2 of this report.

A series of presentations illustrating potential areas research of that could form the basis for work packages linked to five Lot 7 tasks were given by the scientific participants and discussed as to their potential for providing the NSRAC with information that would contribute to improved management of the North Sea fisheries.

Five areas of collaborative research that address issues that are considered of to be of current significance to the North Sea RAC were discussed:

1) Consultation with fishers to establish gear specifications currently used within the North Sea fisheries — Task 1
2) Industry science collaborative surveys of stock dynamics — Task 3
3) Fishers participation on research surveys — Task 3
4) Spatial mapping of catch rates by fisheries based on the analysis of logbook and VMS data. — Task 4
5) Analysis of information collected on board fishing vessels to ground-truth fishing patterns derived from VMS datasets. — Task 4,5

There are close associations between the objectives of areas (2) & (3) and (4) & (5) and therefore three potential project proposals were outlined for further development. Groups of participants that were interested in participating within each of the three areas were tasked with writing proposals that will be go forward as the design phase proposal to be submitted to the North Sea RAC the next available meeting. Following discussions with the North Sea RAC secretariat it was agreed that the most appropriate forum would be the North Sea RAC Executive Committee meeting that will take pace on the 20th of February.

1. Introduction

The first meeting of Lot 7: *"Joint data collection between the fishing sector and the scientific community in the North Sea"* occurred on the12/13 of November 2007 at Millbank, London. The meeting was called to initiate discussions for the design phase of the project. The objective of the design phase as specified in the Lot 7 tender documentation is given below:

Design Phase

During the first 6-month phase of the study (Design Phase), the Project Team will meet to select a series of case study stocks (fleets and fisheries) from within the North Sea and the Eastern Channel. Data availability and methods of analysis will be considered and a work programme for the subsequent 12-month period developed (Implementation Phase). The work programme will include a detailed breakdown of how the remaining project resources will be allocated, time frames, objectives and deliverables defined to ensure tasks specified in the Implementation Phase are delivered. A draft report of the work programme will be presented to the Commission in month 5. The work programme will then be modified as necessary on the basis of feedback from the Commission and stakeholders. A final report describing the work programme for the Implementation Phase will be completed by the end of month 6.

2. Project administration issues

Chris Darby outlined the difficulties in communicating with the project participants and finding a suitable time slot to bring all of the parties together during the previous six months. This had resulted mainly from communication problems arising from changes to staff allocated to the project and the increasingly heavy workload of scientists working within North Sea stock management in 2007.

The problems encountered had resulted in a delayed start to the project by six months. Project participants had previously confirmed by e-mail that they wished to continue with the study as previously outlined, following the delay, and it was agreed that the co-ordinator would explain to the Commission the reasons for a delay to the start of the project and request and extension of the time frame for completion. A suggestion for the project timetable is presented in Figure 1.

3. Presentations of example research areas

In order to develop themes for collaborative projects a series of presentations were made by the participants from each of the scientific institutions covering areas of research that they were undertaking which could be expanded to encompass a North Sea wide project on a scale that is reasonable to the budget and experience available to the project members. Discussions on the merits or difficulties associated with each of the projects followed and suggestions for pilot studies formulated around each of the proposals that were considered suitable. Abstracts of the presentations are provided in Appendix 2 of this report.

4. Potential candidate projects

The project objectives require that during the design phase the participants identify pilot cooperative projects and fisheries/areas where they can be implemented. Following the presentations and discussions on participants research experience a series of concept proposals were put forward and refined related to meet the Lot 7 terms of reference tasks 1, 3 and 4 as described below:

Task 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).

Fishing gear surveys - There was general agreement as to the merits of an analysis of the regional variation in specification, setup and consequently selectivity of fishing gear types. It was considered that surveys (questionnaires) of fishers behavious conducted at ports using techniques similar to those described by in the Scottish studies (Annex 2 presentation 5) could be carried out by each of the participants and used to provide the information required for Task 1. Discussions covered the species, gears and time of year/season that could be used within any pilot exercise.

Task 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.

It was considered that, given the time and limited budget available to the project that a full experimental study for this task was beyond the resources of the project. The group experience that its members have of combined collaborative projects of this format would be gathered together in the form of a report providing guidance on the design and implementation of such studies.

Task 3

Design and implementation of pilot projects regarding the participation of fishermen in ongoing scientific surveys on board research vessels.

Collaborative fishing survey work is being carried out by fishers and scientists within a number of countries and with a variety of objectives; for example Annex 2 presentations 1 & 2 involved monitoring the dynamics of local stock concentrations using commercial boats and gears. If coordinated internationally and integrated across the whole of the North Sea the analysis would be far more powerful and more valuable to the management of North Sea fish stocks. The surveys could potentially provide an industry stock survey at limited cost to each individual country. Comparisons between the indices of abundance obtained from differing gear types

and on a variety of substrates would allow comparisons with the current survey series used for the assessment of the North Sea stocks, which, fishers consider are not representative of the local stock dynamics. Developing surveys using fisher's knowledge has been successful in a number of countries and this project would seek to incorporate fishers' knowledge into the design of surveys that could be used to provide information on stock dynamics for improving assessment science.

Tasks 4 and 5

Spatial and temporal analysis of VMS data

One of the main difficulties associated with the utilisation of commercial catch per unit effort (CPUE) series for the calibration of stock assessments is the definition of directed fishing effort. In some studies VMS (Vessel Monitoring System) position fixes (every two hours) obtained from satellite tracking have been used as a source from which time on fishing grounds, speed and course can be derived. It has been argued that there is sufficient information within the data to define the development of each fishing trip in terms of the area fished and if direction and speed estimates are considered representative of fishing behavior, the fishing and non-fishing periods. However, in the groups experience there has been no systematic study of the sensitivity of the inferences made about fishing patterns, to the length of time between satellite position reports. Are two hourly reporting rates sufficient to make accurate statements about fishing behavior?

It is proposed that an analysis of VMS data from an example fishery at a variety of temporal reporting rates be carried out in order to test the sensitivity of management advice to the underlying data. Crosschecking of VMS track records with other data such as electronic logbooks and on board navigation instruments will be used to validate analytical results. The outcomes of the testing will provide insights into the understanding of the fishing system and activity of the fleet and feed directly into the NSRAC request for a mapping of fishers information for use in spatial management of fisheries.

Further work, action

Groups of participants that were interested in participating within each of the potential study areas were tasked with writing proposals that will be go forward as the design phase proposal for research to be submitted to the North Sea RAC the next available meeting. Given the proximity of the Xmas and new Years break it was decided that this work would be carried out in January and February 2008.

Following discussions with the North Sea RAC secretariat it was agreed that the most appropriate forum for presentation and discussion of the design phase report would be the North Sea RAC Executive Committee meeting that will take pace on the 20th of February.

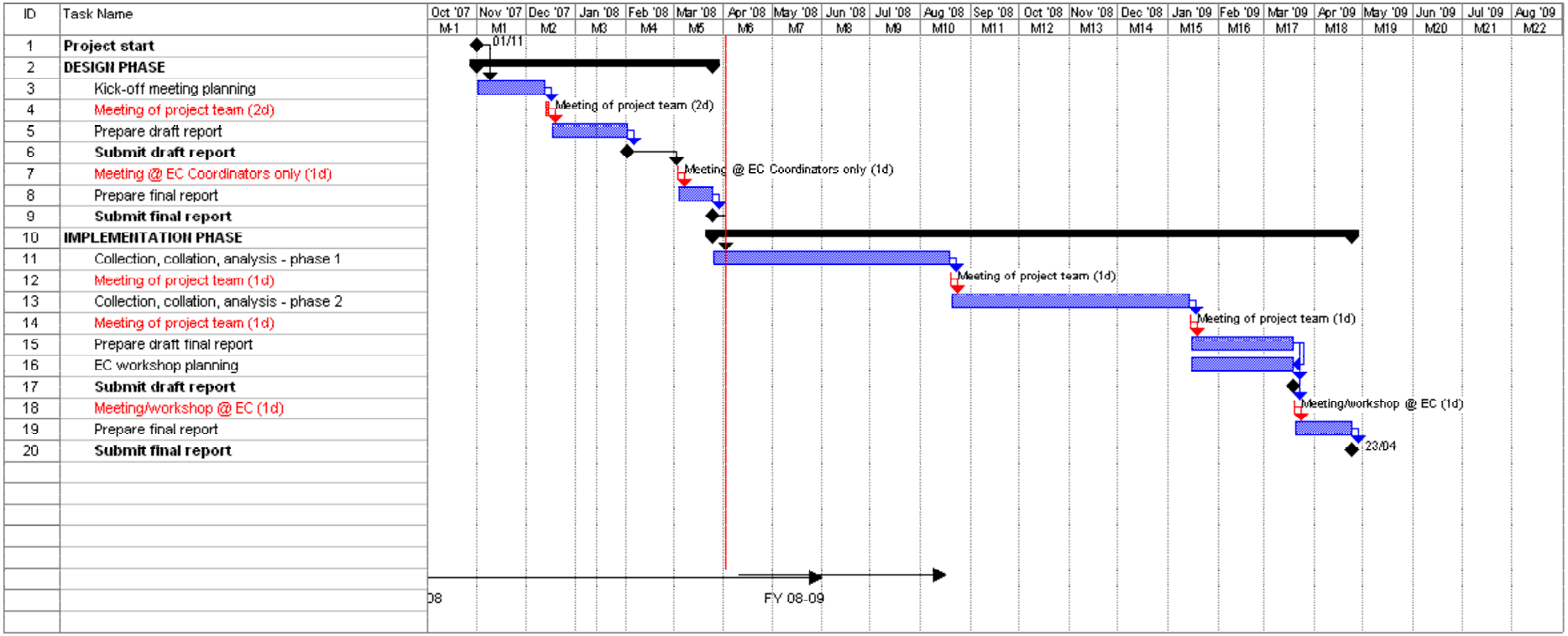

Figure 1 A suggested time table incorporating a revised for Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea

Appendix 1 - Presentations of example research areas

REX (Kai Wieland from DIFRES Denmark)

Collaborative fishing survey work being carried out between Danish fishers and scientists under the REX project. This was aimed at recording the differences in the spatial, age and size distribution of cod caught by gill, trawl and seine nets on a variety of hard and soft substrates in the North Sea around Denmark. The IBTS international research surveys are undertaken with a conventional bottom trawl on soft ground, but fishers considered that these surveys were not representative of the local stock dynamics. The projects eventual aim was to incorporate fishers' knowledge into the design of surveys that could be used to provide information on stock dynamics for improving assessment science and possibly spatially explicit management of cod.

Fisheries Science Partnership (Chris Darby from Cefas, England)

Collaborative fishing surveys are also being carried out within the Fisheries Science Partnership in England. A series of industry science collaborative fishing surveys are funded by the UK Government to provide information from commercial fishing catches on key stocks to supplement data sources traditionally used in ICES assessments. In particular a time series of surveys of NE coast of England cod had been carried out to 2003 to 2007 in order to provide year-on-year comparative information on distribution, relative abundance and size/age composition of cod, and to obtain additional information on distribution, relative abundance and size/age composition of whiting and haddock off the NE coast.

Other countries are also carrying out Industry Science partnership surveys in the North Sea which if co-ordinated and used within a combined analysis could potentially provide an industry stock survey at limited cost as the surveys are already funded within other programs.

Spatial mapping (Eaun Dunn NSRAC)

The North Sea Regional Advisory Council are seeking to be pro-active by mapping fishing areas in the North Sea. The initiative is driven mainly by the assumption that Marine Spatial Planning will affect the way fisheries operate and are managed. To begin the provision of necessary information, the NSRAC recommended a proposal to 'undertake collection of fishers' knowledge and supporting data required to map priority fishing areas in the North Sea'. The outcome of a workshop held on 7-8th February 2006, attended by invited fishing and scientific representatives from 7 Member States, confirmed that the NSRAC's original proposal is not feasible at the present time because the sector is not comfortable with proactively collecting and disseminating fishers' knowledge, although they are happy to use this knowledge to validate maps based on data derived from other sources. This reappraised approach arose primarily because of uncertainties and fears related to how and by whom maps may be used, and because of concerns associated with revealing fishermen's commercially confidential knowledge.

Nonetheless, participants felt that it was important to at least make a start, and at the same time to build in appropriate safeguards. The group agreed that mapping currently available ICES catch and effort data, and where possible Vessel Monitoring System (VMS) data, combined for North Sea States, would be useful as a starting point from which to build industry-science working relationships and the specific data and knowledge required for more comprehensive mapping. The group decided to remove the emphasis on 'priority' fishing areas, since defining 'priority' was considered not to be an action of mapping but rather a decision to be made by the NSRAC in the context of addressing specific management challenges.

The purpose, aim, objectives and draft project plan were described. An important feature of the project is the involvement of the fishing industry through the production and validation of these maps.

Collaborative Research with the Industry (Dave Reid FRS, Scotland)

Examples of collaborative projects that have been carried out with the industry were presented. FRS has a series of ongoing data collection programmes in collaboration with various components of the industry. Most directly these include the operation of high resolution positional loggers on vessels in the Nephrops fleet in the Clyde and northern North Sea, and the Scottish pelagic fleet. Some of the pelagic vessels have also granted access to positional information logged in their onboard OLEX navigation systems and these are being used to map historical behavior in order to distinguish directed fishing activity from steaming, pumping and other movement activities that are logged by the monitoring systems. One particular area of interest is the

A number of "tally book" schemes in selected fisheries have also been conducted, where skippers keep detailed diaries of activity. This is passed to the fishers associations, who then transmit in anonymous format for analysis and use in assessment and management advice. A notable example of this is the use of such a scheme in the Anglerfish fishery in the North Sea and Northern Shelf. The resultant CPUE data have been used to re-evaluate the assessments in the light of poor official landings information. In addition to the log book schemes industry science partnership surveys for anglerfish have been carried out in order to provide information from the industry for future assessments.

Information on Commercial Fishing Gear and its Use (Dick Ferro FRS, Scotland)

There is a basic lack of fishery information on what gears are being used to catch fish and the configuration in which they are being applied, which is a major factor in determining the gears selectivity. Gear uptake and frequency of use is affected by management measures, however it is unknown as to what is the level of compliance and consequently what the effect of technical measures on stocks will be.

FRS has carried out a long-standing and ongoing survey of the types of cod end in use in the demersal fisheries, and this has been extended to other details of the gear deployed. The survey work is initially based on approaches for a short questionnaire presented by on board observers. This is followed up at the master's convenience with

a detailed series of questions on gear, tactics and other salient information. The design of the enquiries is in house and the intention would be to harmonise the work with others within the context of this project. Knowledge of how gear types change over time – technology creep, and how this impacts on fleet effort, effective fishing power and selection properties would a valuable resource for the RAC and fishery scientists and managers.

CPUE analysis and electronic log books (Emile LeBlond IFREMER, France)

One key issue in deriving adequate CPUE series that can be used to calibrate stock assessments is improvement of the definition of fishing effort and the linkage between effort and catch levels. In order to address this issue, IFREMER has been analysing VMS (Vessel Monitoring System) data, and has therefore set up a method of cross-checking data with Log-books and sale slips data.

The Vessel Monitoring System (VMS) provides reports of the location of fishing vessels at regular intervals. VMS also monitors the vessel movements and provides data on its speed and course. Currently in France, vessels over 15 metres overall length have to be equipped with electronic devices that automatically send data to the national monitoring centre through a satellite system. VMS provides adequate information to derive the progress of each fishing trip, the fishing grounds visited, the fishing and non-fishing periods, and hence accurate fishing effort variables. By cross-checking VMS track records with other data such as log-books and sale slips, this investigation will contribute to enhance the quality of fishing effort data, but also to link fishing effort with catches at an appropriate scale, and thereby improve the reliability of CPUE series as abundance indicators. Overall, the outcomes of this investigation will provide important insights into the understanding of the fishing system and activity of the fleet.

Achieving the objectives of this investigation is pending the access to VMS data. At the present state, scientists from EU countries have had only limited access to these data. The expectation however is that this access will be facilitated through the collaborative work between scientists and the fishing industry.

Fishers – science surveys combined across areas

To improve data on fishing effort, and in the perspective of an ecosystemic approach to fisheries, IFREMER suggests the use of sensors on fishing gears and aboard vessels of voluntary fishermen. These sensors would record fine-scale information on fishing effort and also environmental parameters, at the scale of the fishing operation. The fishing effort variables being collected could be the length of nets or the number of gears for passive gears (hooks and pots for instance) and the soaking time and depth for passive and active gears. Environmental parameters to be measured could be e.g. salinity or turbidity. This system has been successfully tested on-board 30 French vessels, which could be expanded, through the project, to a selection of EU vessels operating in the North Sea and the Eastern Channel.

Experience from collaborative studies within Holland (Floor Quirijns Imares, Holland)

Experience gained in the Dutch collaborative F-project and in the ICES Study Group on Fisheries Information (ICES 2005) tells us that fishermen still await action from the management in making information on the distribution of catch and effort readily available. The EC-logbook system, although with a crude recording scheme (per day and per ICES-quadrant), seems still under-utilized in assessment work and anyway in communication with the fishery on developments in stock sizes through space and time.

The Commission is seeking greater detail and additional information (e.g. gear choice) from basic recording systems that is not yet properly organized and visible yet. We anyway should mention the linkage between lot 7 and that basic recording system. Finally, what to expect from the electronic logbook system of the EC in development? How will information be generated there and how will it merge with the joint data collection intended here? The electronic logbook system of the EC will be more robust in the end.

Another experience in the F-project is that there are a number of technical, organizational and communicative factors that constrain the participation of fishermen in joint data collection. An important one is that fishermen would like to know from the start about the ultimate processing and use of the information they collect. Just tapping their data recording and promising that they will be informed once the data are processed will not do (see also Table 2 in Johnson and van Densen 2006).

This makes us to believe that task 5 should be covered whatever other task is (primarily) paid attention to. It has to do with the balanced organization of the routing from joint data collection, via data processing into informative graphical displays and their discussion until the ultimate use of the information in stock assessments and management decisions. In this project that organization does not need to be fully accomplished, but serious attention should be paid to the fishermen's view on the data and information flow.

New types of commercial software for catch recording enable a fisherman to evaluate his performance in terms of catching success through space and time in his very own way. Such information of course is very specific. It relates to his fishery confined to his resource area. Also, it is his way of interpreting the information that comes in the form of screen displays.

In the F-project we initially tapped the data stored by fishermen on diskettes for instance, and processed these data into information at the research institute. We discussed the outcome in the form of maps and graphs with them at a later stage. This was information aggregated for the complete fleet of fishermen that participated in the project. Now we discuss individual performance with individual fishermen as well. From these discussions we got the impression that a fisherman having some experience in generating and evaluating information on board is better equipped in the discussion on the outcome of the joint data collection. We got this impression also from a fisherman that developed his own software and generates graphical displays on board. In our view, the potential of this type of capacity building, not necessarily

shaped and controlled by the researcher ‘superior’ in data analysis, should be paid attention to in this project as well. It makes the communication on procedures and on the outcome more effective.

Appendix 2 - Meeting 1 Design Phase

Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea
Reference: SI2.464218

Meeting Agenda,
Room 821, Millbank London

"During the first 6-month phase of the study (Design Phase), the Project Team will meet to select a series of case study stocks (fleets and fisheries) from within the North Sea and the Eastern Channel. Data availability and methods of analysis will be considered and a work programme for the subsequent 12-month period developed (Implementation Phase).

The work programme will include a detailed breakdown of how the remaining project resources will be allocated, time frames, objectives and deliverables defined to ensure tasks specified in the Implementation Phase are delivered.

A draft report of the work programme will be presented to the Commission in month 5. The work programme will then be modified as necessary on the basis of feedback from the Commission and stakeholders. A final report describing the work programme for the Implementation Phase will be completed by the end of month 6."

Attendees

Michael Andersen	DFA	ma@dkfisk.dk
Doug Beveridge	NFFO	dbeveridge@nffo.org.uk
Chris Darby	Cefas	chris.darby@ceras.co.uk
Ewen Dunn	NSRAC	euan.dunn@rspb.org.uk
R Ferro	Marlab	R.Ferro@marlab.ac.uk
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Emilie Leblond	Ifremer	emilie.leblond@ifremer.fr
Mike Park	SWFPA	m.park@btconnect.com
Floor Quirijns	Imares	floor.quirijns@wur.nl
Dave Reid	Marlab	D.Reid@MARLAB.AC.UK
Andy South	Cefas	andy.south@cefas.co.uk
Kai Wieland	Difres	kw@difres.dk

Agenda

Day 1, 12 November 2007;

Room 821; Millbank London 11:00 –17:00.

1. Introduction

2. Project administration issues

3. Lot 7 objectives and timetable

4. Presentation of candidate studies for inclusion in the project bid with a discussion of the merits of each analysis, the potential for collaborative studies and usefulness to management. By Lot 7 task:

    a. Fishing Operations
    b. Self sampling
    c. Collaborative surveys
    d. Log book information
    e. Quality assurance

Day 2, 13 November 2007;

Room 821; Millbank London 9:30 – 15:30/16:00.

5. Summary of Day 1

6. Additional presentations

7. Discussion on the type of projects to include in the submission

8. Further work and actions

9. Next meeting.

Terms of reference

The study, which should be undertaken in consultation with the relevant RAC, shall aim to establishing further cooperation between the fishing sector and the scientific community for the purposes of and improved quality of data and joint fisheries data collection

The study shall involve at least two of the following tasks:

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).

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. Design and implementation of pilot projects regarding the participation of fishermen in ongoing scientific surveys on board research vessels.

4. Design and implementation of schemes to use catch and effort information better for stock assessments and management evaluations. This includes better use of existing logbook information 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 about the marine environment, the fish stocks and the fisheries. If data from self-sampling programmes are available, for instance through an associated project under item 2, their potentials could be explored. The schemes should be evaluated in relation to other available information sources (e.g. scientific surveys, observer data, VMS data etc)

5. Pilot projects to involve stakeholders in quality assurance and assistance to data interpretation in conjunction with analysis of data for stock assessments, evaluations of management measures etc. This can for instance be workshops prior to stock assessment working groups with interactions between stakeholders and researchers regarding data screening and quality.

It is recommended that the relevant RAC is consulted by the tender for the preparation and/or the implementation of the study. An identification of pilot fisheries/areas where the aimed cooperative platforms can be implemented, the type of data through this cooperation can be better achieved and the detailed design component shall be completed within 6 months, while the implementation phase will last up to 12 months.

5. ANNEX 2 CoDFINS proposed projects

Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea

Reference: SI2.464218

Proposed project discussion paper
Submitted to the
North Sea Regional Advisory Council
Executive Committee Meeting
20th February 2008

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Kai Wieland	Difres	kw@difres.dk

OPEN CALL FOR TENDERS: Reference No FISH/2006/15 Studies and Pilot projects for carrying out the common fisheries policy

2.2.7. Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea

Brief description of the study

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 a improved platform for fisheries management while promoting mutual respect and understanding among the two 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.

Background

Historically, collaboration between scientists and the fishing industry operating in the EU has been a sensitive issue surrounded by a general atmosphere of distrust, given the cultural gap which separates both sides.

In recent years, fisheries scientists and the European fishing sector have undertaken steps towards close and successful cooperation through ICES, the Regional Advisory Councils (RAC), national fisheries research institutes and other organisations.

Terms of reference

The study, which should be undertaken in consultation with the relevant RAC, shall aim to establishing further cooperation between the fishing sector and the scientific community for the purposes of and improved quality of data and joint fisheries data collection

The study shall involve at least two of the following tasks:

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).

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. Design and implementation of pilot projects regarding the participation of fishermen in ongoing scientific surveys on board research vessels.

4. Design and implementation of schemes to use catch and effort information better for stock assessments and management evaluations. This includes better use of existing logbook information 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 about the marine environment, the fish stocks and the fisheries. If data from self-sampling programmes are available, for instance through an associated project under item 2, their potentials could be explored. The schemes should be evaluated in relation to other available information sources (e.g. scientific surveys, observer data, VMS data etc)

5. Pilot projects to involve stakeholders in quality assurance and assistance to data interpretation in conjunction with analysis of data for stock assessments, evaluations of management measures etc. This can for instance be workshops prior to stock assessment working groups with interactions between stakeholders and researchers regarding data screening and quality.

It is recommended that the relevant RAC is consulted by the tender for the preparation and/or the implementation of the study. An identification of pilot fisheries/areas where the aimed cooperative platforms can be implemented, the type of data through this cooperation can be better achieved and the detailed design component shall be completed within 6 months, while the implementation phase will last up to 12 months.

Within 16 months of the signature of the contract, the contractor will produce a draft final document, including the main outputs of the implementation of the elements of the design phase. A workshop with the participation of all interested parties: scientists, fishermen, RACs, national administrations and the Commission, will be organised by the contractor in order to present and discuss the results of the implementation phase.

Budget

The maximum budget allocated for this study is € 300.000 covering all expenses, including personnel, transport, overheads and consumables and two meetings in Brussels (preliminary report and presentation/discussion of the draft final report).

Task 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).

Information on Commercial Fishing Gear and its Use

Summary

There is a basic lack of fishery information on what gears are being used to catch fish and the configuration in which they are being applied, which is a major factor in determining the gear's selectivity. Gear uptake and frequency of use are affected by management measures. However, the level of compliance is unknown and consequently it is more difficult to predict what the effect of technical measures will be on stocks.

FRS Marine Laboratory Aberdeen has carried out a long-standing and ongoing survey of the types of codend in use in the demersal fisheries, and this has been extended to other details of the gear deployed. The survey work is initially based on approaches for a short questionnaire presented by on-board observers. This is followed up at the skipper's convenience with a more detailed series of questions on gear and other salient information. The intention is to coordinate the information from several Member States to obtain more comprehensive view of the gear use and compliance for several key international North Sea fisheries. Knowledge of gear variations across regions and gear development over time – technology creep - and how these impact on fleet effort, effective fishing power and selection properties would be a valuable resource for the RAC and fishery scientists and managers.

Aims/Uses

a) To provide data to identify changes in fleet operations and technology (such as developments in gear designs) which may affect the effort exerted by fleets using a range of mobile gears and hence the effort balance between fleets.
b) To provide data to identify the level of compliance with minimum legislation requirements and the changes in the design of a range of mobile fishing gears which may affect size (and species?) selectivity of specific fleets.

The fleets in question are those using otter and beam trawls, pair trawls and seines, multi-rig trawls and Scottish and Danish seines in mesh size ranges from 80mm upwards.

Methods

An initial assessment using information on national databases will be undertaken to determine the significant fleets in the area and the number of vessels involved. A significant fleet can be defined as one taking more than a certain value of catch where the criterion is based on an absolute value or a proportion of the total value of the relevant international fishery. Having identified these fleets the partners participating in this work package will meet to choose the fleets, common to as many participants as possible, which will be targeted to conduct the pilot surveys. The chosen fleets should use different mesh size ranges and/or target species. Each partner will survey at least 2 fleets.

The aim should be to sample 25% of the vessels in these fleets and this sample should attempt to represent the whole range of vessels in terms of size, power, design and gear handling.

The data will be collected by means of forms which will be completed by skippers and researchers in one-to-one meetings which should not take more than 15 minutes. A separate form will be used for the effort and selectivity objectives. The researcher will need to be familiar with the technical aspects of fishing gear and fishing operations. Example forms are given in appendices X and Y but may need to be redesigned specifically for each fleet and the gear types they use.

The surveys for each fleet should be completed within a specified period (e.g. within one / two months) and each form will cover the fishing operation on the most recent trip.

Analytical methods to collate the data for each fleet will be developed to obtain potential variables to describe the aggregated characteristics of fleet effort and selectivity. Consideration will be given to methods of assessing the suitability of the variables for characterizing effort and selectivity.

Task 3 - Design and implementation of pilot projects regarding the participation of fishermen in ongoing scientific surveys on board research vessels.

Project (1) Collation and Analysis of Information from Industry Science Collaborative Surveys

Summary

It is of the greatest importance to the management of the North Sea stocks that fishermen and scientists agree on the basic data that goes into stock assessments so that decisions can be made with greater accord. The benefits include reduced uncertainty and therefore risk to the stock and future yields, reductions in the time taken to arrive at decisions and the costs associated with management. Industry surveys conducted within European Union (EU) Member States have facilitated increased dialogue between fishers, scientists and managers and have been beneficial to furthering rational, sustainable fisheries management at a regional scale. However, collaborative projects have not, so far, been expanded to the extent that they can be utilised to provide information for the management of international fisheries. The project describe here is designed to bring about a collation of information gathered by fishers throughout the North Sea surveys, to document and compare methodologies and results and establish whether an integrated analysis of the data can provide a more prominent position within assessment science for industry/science surveys. An analysis of the potential of the data to identify consistent signals in yearclass strength, especially at the older population ages and to quantify abundance changes on differing substrates will be used to assess the potential for using combined survey information to resolve questions of interest to fishers and scientists.

Introduction

In several EU Member States collaborative industry/science fishing survey programmes are being conducted to collect information on the status and dynamics of locally important fish concentrations. Time-series of survey data collected using formally designed surveys that are based upon fisher's knowledge have been shown to provide valuable information on spatial distribution and by-catch of fish, local mortality rates, recent recruitment trends and catch compositions from mixed fisheries. The information is particularly useful for addressing regional management issues, because it provides valuable information at a finer scale than is usually provided by the research vessel surveys operated by national fisheries laboratories.

However, because the surveys usually only cover small areas of the North Sea, the results generally do not reflect abundance trends across the North Sea as a whole, consequently it is difficult for ICES Working Groups to incorporate such localised abundance indices into their global assessment models. Potentially, if coordinated and integrated across the whole of the North Sea information collected by regional commercial surveys could provide fisher's organisations and fisheries scientists with an extremely powerful information database for analysing the spatial dynamics and temporal trends of North Sea fish stocks and their catches.

This project is aimed at collating information gathered by fishers surveys conducted at a national scale to document links, compare techniques and establish whether an integrated analysis of data can provide a more powerful basis for resolving questions of interest to fishers and scientists.

Methodology

Collaborative fishing surveys are being carried out in the North Sea by fishers and scientists within a number of EU Member States. The surveys generally have common characteristics:

- They utilise commercial boats and gears to conduct formally designed surveys that are based upon fisher's knowledge
- The objectives relate to the monitoring of the dynamics of local stock concentrations primarily for the major commercial species
- Scientific observers are used to provide guidance on the design of the survey, recording and analysis of data – they have scientific validity
- They only cover small areas of the North Sea, therefore the results do not generally reflect abundance trends across the North Sea as a whole.

Although there are common methodologies and objectives across the surveys there has been no international coordination, standardisation or comparison of results. Potentially, if parameters are estimated by integrated analysis across the variety of gear types and methodologies used, a combined analysis could provide the industry with a stock survey that would complement the International Bottom Trawl Survey (IBTS), especially at the older ages at which catch numbers are low.

The project will take a series of phases:

Phase 1 – A collation of information on all industry based North Sea surveys that can be obtained by the project team, on request. Cataloguing and mapping of the spatial extent of the survey, the fishing gears utilised, target and by-catch species. The aim would be to provide the an inventory of industry surveys and a database that can be used as a reference collection for analysts responding to requests for advice from the NSRAC and other management agencies. The collection would form the basis for an expanding library of information.

Phase 2 - Classification of the surveys in order to find links that allow the integration of information within and across areas for species of interest. This will identify surveys series correlations highlighting the potential for integration of information, such as year class abundance, across larger areas.

Phase 3 – Analysis of the data from the surveys. A series of questions related to issues that are relevant to fishers will be formulated and analysis carried out in order to test the utility of the collected data. Recommendations for additional surveys and or modifications to additional surveys would be made from the study in order to provide and enhanced program for future data collection.

Phase 4 – Discussion of results with the industry and final writing

The utility of the collated data sets for answering requests will be dependent on the temporal length of the time series and the spatial extent and gear and species coverage.

Phase	Activity	Time
1	Extraction of data and preparation to required format	1 week
2	Collation data and preparation of report	3 weeks
	Per study	
3	Analysis of data for responses to case study requests and preparation of draft reports	4 weeks
4	Discussion of results with industry and final report	1 week

Suggested exploratory analysis

In order to examine the scales at which the combined data can be used for analysis it is proposed that two studies are initiated that use data for the whole of the North Sea area at a global and fine scale:

3) At the North Sea scale - Can information from commercial fishing surveys using a variety of gears, vessel types, with differing spatial coverage and designs be collated and combined to produce a commercial gear based index of stock trends, particularly with respect to the abundance of older/larger fish? Current IBTS catch rates of older gadoids are low and noisy and supplementing the information with commercial CPUE for these age/size groups may result in a more precise estimation of spawning stock biomass trends.

4) At a regional scale - Do commercial catches from substrate types not covered by the IBTS show the same trend as the current assessment? If the proportion of cod found on rough substrate is non-linearly correlated with abundance the assessment may estimate the biased trends in population size during periods of recovery and decline.

5) Is a substantial proportion of the cod population found on hard substrate? What is the spatial extent of this substrate?

Survey data

Currently the survey data sets available to the group are:

English FSP East Coast cod survey (Cefas)
English FSP Northern North Sea lemon sole and plaice survey (Cefas)
Danish REX project (DIFRES)
Scottish diagnostic fishing on hard bottom and sediment classification in IBTS rectangles with ROXANNE (MARLAB)
Dutch Industry CPUE; time series of sole and plaice catch rates per haul (Imares)

Meetings

- spring 2008: Data compilation
- autumn 2008: Results and interpretation
- spring 2009: Presentation

Task 3 - Design and implementation of pilot projects regarding the participation of fishermen in ongoing scientific surveys on board research vessels.

Project (2) Coordination and feedback meetings for industry observers participating in scientific surveys used for the provision of data to stock assessment groups.

Summary

Industry observers have regularly participated in research surveys collecting information for use in stock assessments - such as the ICES coordinated IBTS surveys. Reports from observers are usually fed back through fishing organizations to interested parties within individual member states but are rarely distributed wider. It is proposed that a co-ordination meeting, held at the beginning of the year, is used to synchronize observer's objectives prior to participation on any surveys and a follow up meeting used to provide a joint report to the North Sea RAC and the scientific survey coordinators.

Methodology

In recent years the fishing surveys carried out annually in the North Sea by fisheries science institutions have regularly carried fishing industry observers who provide feedback to their members and the scientific organizations. Generally the reports have not been used outside of the Member States. The data collected by surveys such as the

ICES International Bottom Trawl Survey (IBTS) is collated into time series that form a major part of the stock assessments and fisher's involvement and feedback should form a valuable part of the quality control of the process.

The IBTS survey group meet annually to discuss issues arising from the surveys carried out in the previous year and to coordinate future programs. It is suggested that during the next survey year industry observers nominated to participate on each Member State's survey are brought together at the start of the year at a coordination meeting to share historic experience agree objectives. Following the surveys the observers would again meet for two or three days, preferably prior to the IBTS coordinators working group, to prepare a report for the RAC and ICES of individual and collective observations.

The report would provide feedback to the North Sea RAC and the scientific survey coordinators and form a template for future observation.

Planning & finance

Travel and subsistence at two meetings for each contributing observer

Task 4 – Design and implementation of schemes to use catch and effort information better for stock assessments and management evaluations. This includes better use of existing logbook information 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 about the marine environment, the fish stocks and the fisheries. If data from self-sampling programmes are available, for instance through an associated project under item 2, their potentials could be explored. The schemes should be evaluated in relation to other available information sources (e.g. scientific surveys, observer data, VMS data etc)

Task 5 – Pilot projects to involve stakeholders in quality assurance and assistance to data interpretation in conjunction with analysis of data for stock assessments, evaluations of management measures etc. This can for instance be workshops prior to stock assessment working groups with interactions between stakeholders and researchers regarding data screening and quality.

Spatial and temporal analysis of VMS data to provide standardised estimates of fishing effort in consultation with the fishing industry (Tasks 4&5)

Summary

VMS data are potentially hugely useful for estimating the spatial distribution of fishing effort, however, raw VMS data alone are of little use because they are just points, and they do not identify whether a vessel was fishing or the fishing gears used. Processing raw VMS data to create useful estimates of effort is not straightforward due to large volumes of data, data quality issues and the use of novel, non-standardised methods. We will bring together scientists from across Europe to start to develop and test standardized protocols for estimating fishing effort from VMS data. These protocols and their outputs will be modified in consultation with the fishing industry, addressing the industries desire to produce maps of fishing activity to feed into proposed spatial planning processes.

Background

Historically, fishing effort and hence commercial catch per unit effort (CPUE) has been difficult to quantify based on logbook or other data. Logbook effort (hours fished) where available is only at the ICES rectangle level, and this is often too course for accurate delineation of the fishing grounds and effort. One of the main difficulties associated with the utilisation of commercial CPUE series for the calibration of stock assessments is the definition of directed fishing effort. VMS provides the potential for more resolved and accurate determination of fishing effort. It can routinely provide position, course and speed at least two hour intervals (e.g. 1 hour for France). From this it should be possible to separate the time at sea into actual fishing activity and steaming/transiting activity. Vessel speed is clearly the most likely candidate for differentiating fishing from other activities, although turning rates have also been used

in this context. The key problem to be addressed is how accurate is a determination of fishing activity based on point observations every two hours. Recent work in other fisheries has suggested that 15 minute intervals represent a good rule of thumb for discriminating fishing. Two hour intervals have the potential for missing some fishing activity.

For the time being, VMS is likely to remain on a two hour polling rate. So the aim of this proposal is to develop standardized methods for estimating effort from these data and to establish, for a small number of pilot fisheries, the accuracy of these estimates.

This testing can be done using either more highly resolved positional data (e.g. from on board GPS loggers) or by obtaining accurate fishing position information for a small number of representative vessels (e.g. by the way of onboard observations). This would require the willing collaboration of the vessel skipper and owners. One other possibility for investigation is to obtain faster polling data from VMS, again for a small number of representative vessels. This is possible via the national monitoring services, but probably not on any large scale.

Due to time and budget limits, data used for the analyses should be readily available, or available with only little effort.

Objectives

6. Developing standard European protocol for estimating fishing effort from VMS data
7. Estimation of the accuracy & precision of estimates of fishing effort from VMS
8. Open discussion with the fishing industry on estimates of fishing effort and the methods used to create them
9. Produced standardized map of fishing effort for selected case studies

The outcome of this work will increase understanding of the spatial distribution of fishing effort and fleets, and will feed directly into the NSRAC request for a mapping of fishers information to inform the spatial management of fisheries.

Analytical approach

Firstly, the representative vessels should be identified. These should be typical of the fleet being examined, and willing to provide access to fishing information or to take a logger on board. Speed/frequency plots or other analytical tools can be used to define “fishing activity” as opposed to steaming or other unidentified activity. This should probably be in “blind” trial. Results can be compared to validation data, the algorithm for identifying activity can be refined and then applied to the same or different vessels. Defining such an algorithm can be seen as an iterative mechanism. It would almost certainly be specific to a given fishery and may also vary in time and space. Once an acceptable algorithm(s) is defined, it can then be used on a larger test set to establish precision and accuracy. The final step would be to apply this to the total set of VMS data from the relevant fleets to provide a time disaggregated map of fishing effort. The maps created in this way, or zoomed in maps of smaller areas, should be discussed with the industry in order to check consistency with reality.

Ideally, candidate fisheries should be reasonably small and homogenous in the first instance. It might be appropriate to try and identify fisheries where analytical assessment was considered unreliable and a CPUE index may be useful to improve that. Another alternative would be to identify fisheries where spatial management is appropriate e.g. in the context of the Real Time Closures currently being run up for the cod fisheries in the northern North Sea.

Case Studies

North Sea beam trawl fleet – IMARES & Cefas
Northern North Sea cod in the mixed demersal fishery – FRS
French North Sea fleet - Ifremer

Planning & finance

Step	Activity	Deadline
1	Extraction of VMS data in preparation for workshop	+ 1 month
2	Extraction of finer resolution reference data in preparation for workshop	+ 3months
3	Drafting standardised protocols for analyzing VMS data to generate estimates of fishing effort including maps	+6 months
4	Estimation of the accuracy & precision of estimates of fishing effort from VMS	+6 months
5	Discussing maps of estimates of fishing effort from VMS and methods with the fishing industry	+6 months
6	Finalising standardised protocols for analyzing VMS data based on responses from the fishing industry and experience of cross – European collaboration	+12 months
7	Production of maps of fishing effort for case studies using standardised methodologies	+12 months

Meetings

- T1: Workshop on data compilation & initial analysis
- T6: Meeting with industry to discuss & refine analyses
- T12: Presentation of final results