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Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB)

23–27 April 2007

Dublin, Ireland

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1 Executive Summary

The ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB) met in Dublin, Ireland from 23–27 April 2007 to address six Terms of Reference. The main outcomes related to the ToRs are detailed below.

Key Findings

Impacts of *Crangon* shrimp beam trawling in the North Sea (Section 11)

- Research and development should be supported to develop new technical measures to further reduce discarding in the *C. crangon* fisheries below current levels.
- Any new technical measure, which utilises electrical stimulation of species as an integral part of its operations, should be accompanied by thorough and rigorous evaluations as to its potential environmental impact at the earliest stage.
- The protocol used by WGFTFB to evaluate the efficacy of technical measures in the Crangon fishery be considered as a template / guidance with respect to conducting similar evaluations in other fisheries.
- PGCCDDBS to facilitate that catch / discard sampling be initiated and maintained in all North Sea *Crangon crangon* fisheries in-line with the EU data collection regulations.

For the attention of: **WGECO, AMAWAGC, PGCCDDBS, EU DG FISH**

Species Separation in demersal trawls (Section 12)

- Vital needs exist for species separation in demersal fish trawls.
- Varying degrees of species separation can be accomplished through modification of gear or fishing practice, but preventing loss of target species remains a challenge in some cases.
- Species separation is difficult in cases where species are similar in size and shape, as in flatfish.
- Separation should occur as early as possible in the capture process; avoid encounter with unwanted species; prevent contact with the trawl at early stages of the capture process; encourage and guide escape when inside the trawl; and exclude and release fish while the trawl is still at fishing depth.
- Substantial areas for further research have been identified regarding fish behaviour, and testing of various stimuli in all phases of demersal trawls.
- Understanding the effect of non-visual stimuli requires additional forms of instrumentation.

Technical issues relating to the Mediterranean (Section 13)

- WGFTFB will explore the possibilities to develop scientific collaboration with the General Fisheries Commission for the Mediterranean (GFCM) on fishing technology in the Mediterranean fisheries with focus on the following aspects: Consolidation of the network of Mediterranean gear technologists; harmonisation of the legislation related to fishing gear in the Mediterranean; and creation of a selectivity database for Mediterranean data.
- Survival studies need to be extended to cover other Mediterranean fisheries with the implementation of a standardised methodology. Studies should be done for other fishing gears and key-species (i.e. hake, red mullet, etc.).
- Specific characteristics of Mediterranean fishing gear in conjunction should be considered in the preparation of the FAO fishing gear classification (Section 14), as many Mediterranean fishing gear experts indicates that such given the myriad of fishing gears used in the Mediterranean area.

- With reference to GFCM/ATSELMED-2 recommendations, the working group suggests to standardize fishing terminology used in scientific papers on fishing gear and techniques in order to allow easy comparison of obtained results from different Mediterranean areas.
- Considering the GFCM resolution GFCM/31/2007/3 on 40 mm square-mesh codends in trawl fisheries exploiting demersal resources and taking into account the conclusions of the GFCM-ATSELMED-2 (Barcelona, 2–4 April 2007), the WGFTFB encouraged the promotion of research programmes on different fishing technology aspects including the impact of implementing 40 mm square-mesh in the Mediterranean trawl fisheries.

For the attention of: **FAO-GFCM**

Gear Classification (Section 14)

- The Gear Classification work is ongoing and the final draft is due to be completed by early 2008.

Advice to Assessment Working Group's (Section 15)

WGFTFB has continued to collate and report on fisheries information that may be relevant for stock assessment working groups. The information collated during 2007 included the following:

- The overall picture from the questionnaires in 2007 is that the strong signals on fuel cost and reduced days from last year are not as apparent as fleets seemed to have adapted to these. The trend is now one of many small-scale changes and initiatives, with a lot of evidence of fishermen trying out new fisheries.
- The effects of technological creep are still evident in many fisheries; with vessels becoming more efficient and targeted in their approach e.g. the use of new instrumentation on nets and in navigation have been introduced, notably for door altitude and for control of purse seines.
- The concept of "negative" technological creep reported last year is still evident e.g. shift from beam trawling to less catch efficient but more fuel-efficient methods.
- In a number of fisheries there is some evidence of limited voluntary uptake of Technical conservation measures. Motives for uptake are mixed, including days at sea, national regulations, improved quality and local pressure but the overall impacts are probably still small.
- Ghost fishing remains a problem in a number of areas although mitigation measures (e.g. retrieval surveys) are in place in some fisheries.

For the attention of: **AMAWGC, WGNSSK, WGNSDS, WGSSDS, WGHMM, WGBFAS, AFWG, WGMHSA, WGNPBW, HAWG, WGDEEP, WGECO, WGMME.**

Bottom Trawling Impacts (Section 16)

- WGFTFB recognise the need to develop a plan to be proactive in its role in the Ecosystem Approach to Fisheries that should concentrate on the environmentally responsible fishing of all gears.
- WGFTFB propose to hold a joint workshop in 2008 with WGECO to discuss the efficacy of Technical Measures on a wider ecological scale.

For the attention of: **FTC, ACE, ACFM, and WGECO**

2 Directive

The directive of the WGFTFB is to initiate and review investigations of scientists and technologists concerned with all aspects of the design, planning and testing of fishing gears used in abundance estimation, selective fishing gears used in bycatch and discard reduction; and benign environmentally fishing gears and methods used to reduce impact on bottom habitats and other non-target ecosystem components, including behavioural, statistical and capture topics.

The Working Group's activities shall focus on all measurements and observations pertaining to both scientific and commercial fishing gears, design and statistical methods and operations including benthic impacts, vessels and behaviour of fish in relation to fishing operations. The Working Group shall provide advice on application of these techniques to aquatic ecologists, assessment biologists, fishery managers and industry.

3 Introduction

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Venue: Dublin, Ireland
Date: 23–27 April 2007

3.1 Terms of Reference

The ICES/FAO Working Group on Fishing Technology and Fish Behaviour [WGFTFB] (Chair: Dominic Rihan, Ireland) will met in Dublin, Ireland, from 23–27 April 2007.

Terms of Reference

a) Further develop the WGECO review and the state of knowledge concerning *Crangon* shrimp beam trawling and its impacts on benthic habitats and the wider marine ecosystem in the North Sea. (Request from WGCRAN):

   i) Review the efficacy of recently introduced (2003) technical measures introduced into the North Sea *C. crangon* fishery (Sieve nets / grids) aimed at reducing discarding of juvenile whitefish

   ii) Evaluate the potential impacts upon target (*C. crangon*) and non-target species if electric shrimp beam trawling were to become widely adopted as a fishing method in the North Sea

Conveners: Andy Revill (UK)

b) A WGFTFB topic group will be formed to consider the "Application of fish behaviour for species separation in demersal fish trawls". The topic group will have the following terms of reference:

iii) Identify recent behavioural and gear research into the separation of groundfish species in demersal trawl gears;

iv) Identify basic principles, strategies and effectiveness of groundfish species separation techniques such as separator panels, grids and footrope modifications;

Convenors Pingguo He, (USA) and Mike Pol (USA)

c) A WGFTFB topic group of experts will be formed to consider technical issues relating to Mediterranean fisheries. The group will have the following terms of reference:

i) Open dialogue with appropriate Mediterranean management bodies i.e. FAO-GFCM to identify appropriate areas of collaboration

ii) To review, for the non-EU Mediterranean countries, the technical aspects of their fisheries, following the pattern of the report on Turkish fisheries compiled at the 2006 WGFTFB meeting and using, for example, output from the COPEMED project;

iii) And then to extend, for both EU and non-EU Mediterranean fisheries, available technical information on the fishing gears and practices [see for the EU countries: Technical Report SGMED-STECF SEC (2004) 772], in particular:

- To review recent research;
- To identify the main technical problems of the Mediterranean fisheries and the gaps in knowledge needed to solve them;
- To propose, where possible, technical solutions aimed to manage better the fishery resources and to reduce the impact on the marine ecosystem;
- Publish a report on the findings from the above points.

Conveners: Antonello Sala (Italy), Jacques Sacchi (France,) and Enric Massuti (Spain)

d) The Topic Group on Definitions and classifications of fishing gear categories will continue to work by correspondence following an agreed Action Plan timetable and report to the WGFTFB in 2007 to:

i) Present a draft FAO/ICES fishing gear classification based on the structure of gear definitions agreed during the 2006 WGFTFB and;

ii) In consultation with management bodies and by reviewing current initiatives, identify which gear parameters that should be monitored to provide better estimates of commercial CPUE

Conveners: John Willy Valdermarsen (IMR, Bergen), Wilfried Thiele (FAO, Italy)

e) Term of Reference on "Incorporation of Fishing Technology Issues/Expertise into Management Advice." Based on the questionnaire exercise carried out in 2005/06 into developments in fleet dynamics etc, WGFTFB recommends that the topic group continue to carry out this survey on an annual basis.

Conveners: Dave Reid, FRS, Scotland, Norman Graham, MI, Ireland, Dominic Rihan, BIM, Ireland

3.2 Participants

A full list of participants is given in Annex 1.

3.3 Explanatory note on meeting and report structure

The approach adopted in 2004 of addressing specific ToR's was adopted for the 2007 meeting. Individual conveners were appointed during 2006 to oversee and facilitate work by correspondence throughout the year. The Chair asked the convener of each ToR to prepare a working document, reviewing the current state of the art, summarising the principal findings, identifying gaps in the knowledge where consultation with other experts was required and recommending future research needs.

Two days were allocated for the conveners and members of the individual Topic Groups to meet, finalise their reports and findings, and produce a presentation to the WG and prepare a final report for inclusion in the FTFB report. The **summaries and recommendations** for the working documents for each ToR were reviewed by WGFTFB and were accepted, rejected or modified accordingly to **reflect the views of the WGFTFB**. However, the contents of these working documents do not necessarily reflect the opinion of the WGFTFB. In addition to the presentation of the review report, where appropriate, each convener was asked to select a small number (~3) of individual presentations based on specific research programmes. The abstracts are included in this report, together with the authors' names and affiliations. Although discussion relating to the **individual presentations** was encouraged and some of the comments are included in the text of this report, the contents of the individual abstracts were NOT discussed fully by the group, and as such they **do not necessarily reflect the views of the WGFTFB**.

The Chair outlined that were possible this format will be adopted for the next three years.

4 WGFTFB advice and requests during 2006–2007

4.1 Overview

During 2006/2007, WGFTFB dealt with the following requests for advice:

- EU request on Electric Beam Trawling.
- WGMHSA request for fisheries based advice in relation to the stocks under the remit of this Working Group.
- WGCRAN request to evaluate the potential impacts upon target and non-target species if electric shrimp beam trawling were adopted as a method and also the efficacy of technical measures introduced into the North Sea *C. crangon* fisheries in the North Sea.
- SGMIXMAN request to "*to explore extensions of mixed fisheries analysis by incorporating fleet dynamics*".
- Attendance at AMAWGC meeting.

4.1.1 EU Request on Electric Beam Trawling

In November 2005, ICES received a request from the European Commission Directorate General for Fisheries and Maritime Affairs regarding the then current regulation that banned the use of fishing techniques that use electrical stimulus for fish capture and specifically dealing with a request from Netherlands regarding the use of an electric beam trawl system. The Chair of WGFTB was asked to formulate a multi-disciplinary ad *hoc* Expert Group to consider the request. This Expert Group reported back to ACFM in May 2006.

This advice was adopted by ACFM and forwarded to the EU. The EU's Scientific, Technical and Economic Committee for Fisheries (STECF) then assessed it further in November 2006 with further input from WGFTFB. STECF largely concurred with the WGFTFB advice and concluded:

> "*Although the development of this technology should not be halted, there are a number of issues that need to be resolved before any derogation can be granted".*

As it transpired, however, the EU ultimately rejected this assessment and introduced a derogation to allow electric beam trawling on a restrictive basis under Annex III (4) of Council Regulation (EC) No. 41/2006.

4.1.2 Request from WGMHSA

Members of WGFTFB attended the WGMHSA meeting in Galway in September 2006 at the request of the Chair of WGMHSA. A report and presentation on fisheries based advice relating to the stocks under the remit of this WG were presented covering the following issues:

- Fleet Dynamics
- Technology Creep
- Selectivity
- Sources of Unaccounted Mortality
- Ecosystem Effects
- Pelagic Survey Trawl Issues.

This was felt to be a useful exercise and WGFTFB remain open to attendance at other WG meetings if requested to do so to provide similar information.

4.1.3 WGCRAN

Two requests from WGCRAN were received directly and these are dealt with in Section 11. WGFTFB also assisted WGECO respond to a request from WGCRAN:

> *"To review and report on the impacts of Crangon beam trawling on benthic habitats and the marine ecosystem in the North Sea".*

This request was dealt with at the WGECO meeting in April 2007, with input from WGFTFB and the main findings of this report and the comments of WGFTFB are summarised in Section 11.

4.1.4 Request from SGMIXMAN

The Chair of WGFTFB participated in the Study Group on Mixed Management (SGMIXMAN) meeting in January 2007 at the request of the Chair, specifically to:

> *"Explore extensions of mixed fisheries analysis by incorporating fleet dynamics".*

The Study Group identified a number of areas where the work of gear technologists could assist in the implementation of fleet/fishery approaches, particularly in the relation to the following:

- Definition of Effort and Measurement of Catchability.
- Fleet Dynamics and Fleet Descriptors.
- Technical Creep.
- Unaccounted Fishing Mortality.

4.1.5 Other Requests

The Chair of WGFTFB attended the AMAWGC meeting in February 2007 and discussed the relevance of the fisheries advice that WGFTFB provided to the Assessment Working Groups in 2006. Generally the AWG Chairs found the information useful and in an appropriate format, although there was a need for better quantification of the information provided. It was agreed WGFTFB would continue with the provision of this information. The issue of the

measurement of effort and catchability was also raised as a matter of mutual interest, and a commitment was given that WGFTFB would attempt to investigate this area in the future. (See Section 19.1.4).

5 Report from Study group on survey trawl standardisation (SGSTS)

The Study Group on Survey Trawl Standardisation (SGSTS) met in Galway, Ireland from the 18–20 April. It was the intention of the group to compile and extend the material presented into the 2005 and 2006 reports to provide an ICES Cooperative Research Report on Survey Trawl Standardisation and would emphasise those gears currently in use by the majority of the ICES member countries in their bottom trawl surveys. Following the 2007 meeting, however, it has been decided to produce two CRR reports one on general survey trawl issues and the other specifically on the GOV. At the 2007 meeting, tasks were assigned to individual members of the Study Group and a timetable for the production of the CRRs agreed. This was presented at plenary to WGFTFB.

6 Report on GACAPOT and SGPOT

6.1 International Technical Workshop on Gadoid Capture by Pots (GACAPOT)

Michael Pol

An International Technical Workshop on Gadoid Capture by Pots (Gacapot) was held on 4 November 2006 in Gloucester, Massachusetts hosted by Massachusetts Division of Marine Fisheries, University of New Hampshire and Marine Institute, Newfoundland. The workshop focused on determining basic principles for potting gadoid species by examining the current state of research on gadoid capture in pots and assessing the direction of future research for improving catch rates. There were fifty attendees from 16 countries on five continents (Asia, Australia, Europe, North and South America) and included a mixture of researchers, harvesters, gear manufacturers and students.

The main conclusions presented were based on Pol's observations alone, and have not been formally concluded by the conveners. His main conclusions from the workshop were as follows:

a) Research of pots is still in the early stages and a lot of basic testing of pot characteristics needs to be done e.g. on entrance size, shape, orientation; currents; others – colour, contrast, and seasonality.

b) Catches might be simply related to abundance, and it is difficult to establish what the local species density is.

c) Increasing pot volume appears to increase catch. The behavioural reason for this is unclear, although the effect could be density-related.

d) An optimization exercise could help define the catch rates necessary for practical use.

e) Plume orientation with entrance is vital, and can be achieved through floating, setting practice, or multiple entrances.

f) Pot design (volume and floating, adding a leader) would benefit from tank/engineering exercises.

g) Alternate, additional stimuli appear to have some promise although it is not clear exactly what stimuli are most effective.

h) There is a need to understand the feeding behaviour of the target species, including detection threshold and reaction thresholds.

i) Observation of cod is extremely valuable and inexpensive; laboratory experiments are also useful. Observations could also help to establish rather easily whether familiarity or novelty is a factor in capture in pots.

Proceedings from this report will be published shortly.

6.2 Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT)

Bjarti Thomson

Overview

SGPOT was proposed by the topic group on "Alternative fishing gears" that met at the FTFB meeting in 2005 and 2006. SGPOT had its first meeting on 21–22 April 2007 in Dublin, Ireland prior to the FTFB meeting at which it was decided to work on the first two ToRs.

The meeting was attended by 24 participants representing 12 countries, and the work was facilitated by the following presentations:

- Summary of GACAPOT meeting, Gloucester Nov. 2006 (Mike Pol).
- Canadian fish pot research (Alain Fréchet and Philip Walsh).
- Russian pot fisheries and research (Oleg Lapshin).
- Commercial pot fisheries around the world (Bjarti Thomsen).
- Pots as survey gear (David Stokes and Robert Bunn).
- Fishing consideration and survey design (Peter Munro).
- Pot entry patterns in relation to environmental variables (Peter Munro).
- Recent pot research by IFREMER (Jacques Sacchi).
- Pot studies in the Baltic (Sven Gunnnar Lunnery).

The group acknowledged that pots are widely used for crustaceans, but landings from fish pots are limited. However in a few areas pots are very important and account for more than 50% of total fish landings. The group developed a table describing existing commercial pot fisheries worldwide that will be finalised in the final report of the Study Group.With regard to stock assessment, pots are the primary gear for abundance indices of many crustaceans. Pots have the potential to be precise and accurate, through large sample sizes and low variances at fine spatial resolution, and can be used where other gears are unusable e.g. rough gound. The group identified factors that inhibit the use of pots as survey gear and recognized the need for additional research on the functioning of pots. One example is the question of the effective fishing area when used in abundance estimates. Text on the assessment use of pots has been prepared.

The group discussed research needs to improve efficiency. The conclusions of GACAPOT (Section 6.1) seem to be broadly applicable for all pots. The fish capture process in pots involves a complex process that includes interaction of attraction to the pot, encouraging ingress and restriction of egress. The group acknowledged the need to understand basic fish behaviour and biology in relation to fish pots. Attraction and consumption of bait by fish is known to involve multiple sensory modalities and multiple behavioural thresholds. Laboratory experiments on basic fish behaviour and biology can serve to isolate processes that are confounded in situ. The group identified a range of issues that need to be addressed.SGPOT will work by correspondence and meet at the WGFTFB meeting 2008.

General Discussion

The importance of collaboration with the fish behaviour group was noted, as being vital to maximise the catching effort of the pots and further research on behaviour was required to improve the catching efficiency for fish species. The point was also raised as to whether SGPOT had considered gear conflicts. The example was given of the Georges Bank fishery, where there was well-documented evidence of conflict between fixed and mobile gears. The Chair of SGPOT agreed this was an important issue and stated the group would consider this at their next meeting, along with other ecosystem effects related to pot fisheries.

7 Report from Study Group on Unaccounted Fishing Mortality

7.1 List of Participants

Philip MacMullen (Chair)	SFIA	UK
Mike Breen	FRS	UK-Scotland
Alain Frechet	MLI	Canada
Olafur Ingolfsson	IMR	Iceland
John Simmonds	FRS	UK-Scotland
Irene Huse	IMR	Norway
Dominic Rihan	BIM	Ireland

SGUFM met on 24 and 26 April 2007 with the following terms of reference:

a) To consider issues relating to the sources of fishing mortality other than those that can be accounted for by the reported catch;

b) To report on the current knowledge of unaccounted mortality; and

c) To review and make recommendations on methods used to estimate escape mortality from towed fishing gears.

Within these, two specific requests for information had been received:

1) AMAWGC requested that SGUFM recommend a strategy and detailed proposals for unaccounted mortality in North Atlantic mackerel, specifically that related to slippage;

2) AMAWGC requested that SGUFM conduct a critical review of methods for incorporating UFM data in stock assessments, with particular reference to the approach used by project Survival.

7.2 North Atlantic Mackerel sub-group

The sub-group were given research progress reports from John Simmonds and Irene Huse. The information included a detailed analysis of most currently available sources of data on mortality and experimental work on the survival of fish that were caught and released (slipped). Mortality data had been used in a series of Bayesian models to estimate the likely level of fishing mortality relative to the currently accepted figures. Data integrity seemed generally high and the estimates from different sources had a coherence that lent them further credibility. The estimates are, as yet, unpublished.

The survival experiments were still at an early stage. They had dealt only with fish caught by purse seine but had established control methodologies that could be applied more widely. Data from the control populations indicated that bias was low and further trials were scheduled for later in 2007. It was noted that this work had a very high cost. Extending it to other fleets and fishing methods would carry a considerable cost burden.

Work had also recently been carried out in Norway to test if sample catches taken with automatic trolling equipment could be used to give representative weight-samples of mackerel

before carrying out a full pursing operation. Initial results suggest the correlation was good between samples taken from the two gears.

Irish fishermen have been testing flexible grid systems with a bar spacing of 50mm placed in the brailer sections of pelagic trawls for size selection of mackerel and horse mackerel. Given the difficulties in assessing fish escapement from large pelagic trawls, observations had been gathered to provide information on the rigging of the grids and also on the behaviour of the fish towards them. Initial indications had been positive in that fish had been observed actively escaping through the grids in large numbers but there was no information available on the mortality of escaping fish. Further research into these grids is planned for later this autumn but the measurement of survival rates remains a problem and may need to be addressed through cooperative research with other countries with expertise in this area.

The group concluded that, on the evidence to date, it was doubtful that technical measures alone would ever prevent slipping totally, and this is really a control and enforcement issue. While there is no doubt the presence of observers will reduce slipping, it will never totally stop the practice if the market so dictates. In addition, particularly on large freezer vessels it is difficult for observers to fully determine whether slipping has taken place. It is recommended that the Norwegian experiments to try to sample the fishery using low impact gears, should be explored in other pelagic fisheries. Alternatively, measures to encourage fishermen to carry out short test hauls to ascertain whether the fish are of the right size should be considered.

After discussion the sub-group noted and agreed the following:

- A requirement for comprehensive discard monitoring was due to be introduced for all fisheries prosecuting this stock,
- Further data on slipping maybe available from Scottish, Dutch, German and Irish sources,
- High grading was almost certainly underestimated, particularly for those fleets where quota entitlements were relatively low,
- Size selection of fish continued to be relatively poor, resulting in potentially avoidable slippage. Pre-catch sampling could be improved and there was scope to look further at the use of size-selecting grids and the mortality implications of their deployment,
- Slippage as a result of mixed catches of mackerel and scad was significant because of limits on bycatch,
- Survival trials were currently being funded entirely by Norway but there was a strong case for cooperative research supported by an international funding base. This should extend the existing Norwegian programme to include other fishing methods and practices along with the evaluation of novel technical conservation measures,
- Tagging survival studies provided critically important data and should be extended,
- Existing modelling results should be available in the public domain, and
- There was a continuing need to derive better data on mortality from all sources.

The sub-group further noted that there was a need for a more robust management regime. This should provide or strengthen:

- Observer coverage;
- Monitoring of landings;
- Rigorous scrutiny of data to detect sources of bias; and
- General monitoring and enforcement.

Failure to address this fundamental need would seriously undermine and progress in other areas.

7.3 Inclusion of UFM Data in Stock Assessments

On 22 February 2007, the Chair of SGUFM (M Breen, UK) gave a presentation to AMAWGC summarising the work of SGUFM and highlighting results from an international project investigating the mortality of gadoids escaping from trawls (Project Survival) (Breen et al, 2007). One output from Project Survival was a proposed method for including UFM data (in particular discard and escape mortality) in stock assessment analysis. A case study was presented, which applied these methods to the ICES stock assessment of North Sea Haddock to assess the potential effect upon the perceived total fishing mortality (F). Following the resulting discussion in AMAWGC, it was decided that SGUFM would undertake a critical review of these methods (as proposed by Project Survival and based upon Breen and Cook, 2002) to assess the validity of the model and its assumptions.

A Review Group (M Breen, UK; A Frechét, Canada; and Ó Ingólfsson, Iceland) met as part of SGUFM on 24 and the 25 April, 2007 in Dublin. The Terms of Reference for this Review Group was:

To conduct a critical review of methods for incorporating UFM data in stock assessments, with particular reference to the approach used by Project Survival.

This report is a summary of this review and its recommendations.

Introduction

Traditional stock assessments assume that all fish passing through a towed fishing gear survive. Moreover, few attempts have been made to develop methods to incorporate escape mortality data in stock assessments (ICES, 2000; Suuronen, 2005). If escape mortality is high there may be important implications for current assessments, since they will tend to underestimate total fishing mortality and stock size. Furthermore, such assessments may result in biased estimates of biological reference points and misleading calculations on the benefits of changes in technical measures, for example increasing codend mesh size (Breen and Cook, 2002[1]).

Project Survival proposed a method, based on the Mesnil-Cook model; to include length based estimates of mortality and selectivity (for both discards and escapees) in stock assessment models (Breen at al, 2007[2]). An important advantage of the Mesnil-Cook approach is that adjustments are made to the input catch data and so can be applied to any of the current stock assessment models (e.g. VPA, SVPA and XSA). In this case study, this method was used to include estimates of escape mortality for haddock in an XSA stock assessment modelling exercise.

Methodological Approach

This method modifies the "catch data" for a stock assessment using a correction factor based on a probability function (the Mesnil-Cook model; Figure 1) combining the likelihood of

1 **Breen, M. and Cook, R. (2002).** Inclusion of Discard and Escape Mortality Estimates in Stock Assessment Models and its likely impact on Fisheries Management. *ICES CM* 2002/V: 27, 15pp.

2 Breen, M., Huse, I., Ingolfsson, O.A., Madsen, N. and Soldal, A.V. (2007). SURVIVAL: An assessment of mortality in fish escaping from trawl codends and its use in fisheries management. EU Contract Q5RS-2002-01603 Final Report.

retention in the codend and the probability of discarding on deck, with mortality functions defined by field observations from Project Survival. Length related functions are converted to age based functions using simple matrix transformations, with respect to each year of the stock assessment; where the reference for each year is a raised age-length key generated from both fishery dependent (market sampling) and independent (survey) data. The probability functions for retention of fish in the codend were derived on an annual basis from Ferro and Madsen (unpublished) where it was assumed that the fleet was using technical measures equivalent to the minimum legal requirement for that year. From this, partitioned selectivity functions were estimated for each year based on the partitioned selectivity functions defined by Project Survival (Breen et al, 2007; Madsen et al, submitted).

Summary of SGUFM Review and Recommendations

The Review Group concluded that:

- The proposed model for incorporating UFM data into stock assessments was basically sound although its efficacy in projecting all UFM depends critically upon being able to represent all age groups in the catch data,
- Reconstruction of age-length keys, using both fishery dependent and independent data for each year and age class, would remove potential bias from the transformation of length- to age-based probability functions,
- Assumptions on the extent to which experimentally derived selectivity data reflect fleet scale selectivity need to be tested – current work at FRS will support this process,
- Experimentally derived data on mesh selection at the different phases of trawl deployment (towing, haulback and at the surface) are required to substantiate assumptions made in this respect,
- Further work is also needed to confirm assumptions made as to the survival of fish escaping during the three deployment phases, particularly whilst at the surface,
- The historic significance of escape mortality (F_E) should be assessed by retrospective analyses,
- Given the high potential significance of surface escape mortality within overall fishing mortality, further experimental work should be carried out in order to substantiate input data and improve confidence in the inferred impacts upon F, and
- Partitioned mortality should be projected with respect to stock abundance for all age groups, not merely presented as a probability function.

8 WKNEPHSEL

8.1 Overview

It has been noted that in many instances there are analytical problems associated with modelling *Nephrops* size selection. Additionally, recent experiments have shown that on many occasions, the selection profiles of *Nephrops* do not conform to standard selection models e.g. logistic functions. As a consequence of this, data from individual hauls are disregarded from analysis to determine mean selection profiles. It was therefore identified the need to develop new analytical methods to parameterise *Nephrops* selection profiles that can be used for management purposes.

In order to address these issues A Workshop on *Nephrops* Selection was held in FRS, Aberdeen, UK, from 6–8 February 2007 with the following Terms of Reference:

a) Update information on the selectivity of *Nephrops* gears suitable for use in assessments and stock predictions;

b) Collate selectivity data relevant to current *Nephrops* fisheries using regional or geographic grouping, if appropriate;

c) Develop models of retention as a function of length taking account of other significant variables related to gear design, catch and environmental factors, for *Nephrops* and, where possible, bycatch species.

A total of 15 participants attended.

- Data from approximately 56 different data sets from nine countries and seven areas were collated on a haul-by-haul basis. The proportions of *Nephrops* retained in the test codend, relative to those retained in the test and control codends combined, were plotted against carapace length.
- Parametric analysis of the data provided was difficult given the mixture of experiment types. A non-parametric analysis based on smoothers was therefore used and the relationship between the standard errors and the gear explanatory variables was modelled using a linear mixed model.
- The effects of various parameters on L50 and SR derived from a logistic model were further investigated by linear regression for the covered codend data. Parametric analysis is more powerful than the smoother-based analysis used in the meta-analysis but realistically we can only apply it to covered codend data.
- The meta analysis carried out shows at length classes 20, 25, 30, 35, and 40 mm, three variables – mesh size, mesh shape and the presence / absence of a lifting bag – had highly significant effects on *Nephrops* selection.
- The analysis perhaps surprisingly showed twine thickness not to be a significant factor except in one specific data set. It is felt though that twine thickness remains a gear parameter that should be considered further given its implicit effect on selectivity.
- The analysis showed a significant effect of the strengthening or lifting bag on *Nephrops* selection but this result should be considered with caution. Further studies should be carried out to confirm these models predictions but also to assess whether their use is necessary from a strength and safety perspective.
- The data set on *Nephrops* selection should be explored further, particularly to investigate the robustness of the results to different modelling assumptions e.g. Bayesian techniques and to identify if there are fundamental differences between models for the square and diamond mesh codend data when analysed independently.
- There is considerable amount of catch comparison data for both *Nephrops* and whitefish selectivity in *Nephrops* trawls and this data should be further analysed by SGCOMP.
- The potential for improving *Nephrops* size selection by the use of other selective devices such as the French flexi-grid should be considered.
- Under WGFTFB a similar workshop be held to consider whitefish selectivity data from *Nephrops* fisheries.
- The modelling approach used to examine what population effects might result when implementing gear changes should be repeated with other fisheries to fully assess its value and accuracy

The full report of this workshop will be available shortly.

General Discussion

The general comment was made that just because a variable was not found to be significant in this analysis does not mean that there is not an effect and this should be remembered in considering the results. The point was also made that it would be useful to collate information from this workshop on how experiments should be structured in the future to ensure that there

is consistency amongst data from individual countries and allowing meta-analysis to be more valuable as differences in data make these types of analysis often misleading.

It was pointed out that the data on twine thickness was unbalanced, which made analysis difficult and members of WGFTFB were requested to provide any selectivity data specifically on twine thickness in *Nephrops* fisheries. With respect to cover bags it was stated that the rigging was important when considering selectivity and this should be taken into account.

On the management side, although there may not be a reason to continue to look at *Nephrops* selection from a biological perspective, there is a still a need to improve the selectivity for whitefish bycatch in *Nephrops* fisheries given that problems still exist. Therefore research into ways of improving selectivity in *Nephrops* trawls should concentrate on the selection of bycatch species, except in cases where a specific *Nephrops* discard problem is identified by Stock Assessment Working Groups. *Nephrops* selectivity experiments should be more targeted in the future to deal with specific problems in fisheries.

9 WGFTFB Website and mailing list status and future

9.1.1 General overview

Up till now, the FTFB website and mailing list has followed the FTFB Chair. At the 2006 WGFTFB meeting is was agreed this was not a good approach, as the workload for the Chair and IT department of the institute involved in maintaining the website are too high but since then no other options have been found. Therefore the FTFB website (www.wgftfb.org) is now being hosted by BIM. The new site is still under construction but will be fully operational within the next couple of months. A site description will be posted on the site in due course. Comments from the membership have been requested.

The WGTFB mailing list needs updating and the Chair will try to do this over the course of 2007.

10 WWF Smart Gear Competition

Dr Andy Revill, CEFAS, UK presented information about the 2007 'Smart Gear' competition. Initiated by WWF in 2005, the competition now attracted a wide range of sponsors. It aimed to inspire innovative, practical, cost-effective ideas that enabled fishermen to 'fish smarter' – better targeting their intended catch whilst reducing bycatch. There had been 83 entrants in 2006. Previous years' winners had been a magnetic shark deterrent for longlining and a means of reducing cetacean bycatch by adjusting fishing depth. These concepts and runner-up award winners had been subjected to very rigorous scrutiny and were now being adopted in fisheries around the world.

11 ToR a): Impacts of *Crangon* shrimp beam trawling in the North Sea

11.1 General overview and presentation of principal findings

This ToR was received as a direct request from WGCRAN. The justification given by WGCRAN was as follows:

"The C. crangon fishery may become a focus of further attention in the future, particularly in relation to its discarding practices, impacts upon benthic communities, technological innovations (i.e. electric shrimp beam trawl), the efficacy of existing technical measures, economic performance, and the sustainability of stocks. This attention may arise directly from the current process of MSC (Marine Stewardship Council) certification that is now underway, renewed NGO activity and interest, licensing of fisheries activities within the Wadden Sea

Marine Protected Areas, etc. It is for this reason that we have made some recommendations to other ICES working groups". ICES WGCRAN 2006.

An overview of the topic was given at plenary to the FTFB at the start of 2007 meeting. The full report from the topic group is given in Annex 3.

11.1.1 Terms of Reference (ToR) (requests from the WGCRAN):

a) WGCRAN recommend that the WG Ecosystem Effects of Fishing Activities provide a summary review of the state of knowledge concerning *Crangon* shrimp beam trawling and its impacts upon benthic habitats and the wider marine ecosystem in the North Sea. *(This ToR has been addressed by WGECO but is included here as it is closely linked to the remaining ToR which are addressed by the WGFTFB below)*

b) WGCRAN recommend that the ICES-FAO WGFTFB review the efficacy of recently introduced (2003) technical measures introduced into the North Sea C. *crangon* fishery (Sieve nets / grids) aimed at reducing discarding of juvenile whitefish

c) WGCRAN recommend that the ICES-FAO WGFTFB evaluate the potential impacts upon target (*C. crangon*) and non-target species if electric shrimp beam trawling were to become widely adopted as a fishing method in the North Sea

11.1.2 Assessment of efficacy of the technical measures

Assuming comparable levels of compliance and gear performance the results from this UK study can be extrapolated to other member states. The prevalence of group 0 fish on the fishing grounds, suggests that many small fish, in the size range for which the sieves are least effective, are still caught by shrimp beam trawlers in European waters. This is compounded by the exemptions granted in the relevant national legislation, applying to the main EU brown shrimp fleets of Germany and The Netherlands which state that no selection device is required for up to half of the year.

Overall, the legislation reduces the undesirable capture of unwanted marine organisms and, as such, is consistent with the requirements of the precautionary principle and ecosystem-approach as defined in EU legislation. It is particularly effective at reducing bycatch levels of cod and relatively larger fish of all species (>10 cm in length), but less so at reducing 0 group plaice, which make up the largest component of the bycatch. The legislation has had a positive effect, and it represents the best available solution, but it does not sufficiently address the bycatch issue in the *Crangon* fishery.

The above is a summary of: T. L. Catchpole, A. S. Revill, J. Innes and S. Pascoe (2007). Evaluating the efficacy of technical measures – A case study of selection device legislation in the UK Crangon crangon (brown shrimp) fishery, (In preparation).

11.1.3 Evaluating the potential ecosystem impacts of the electric shrimp beam trawling

We are unable at present to give an evaluation of the likely impacts that might arise if electric-shrimp beam trawling were to become widely adopted as a method used to harvest *C. crangon*. However, work in this field is progressing and accompanies the development of the technology. Such work is presently being undertaken at the Belgian Fisheries Research Institute (IVLO) in Oostende and the University of Gent.

We include an appendix (appendix A), which describes the concerns recently reported on by ICES in respect of the development of the Dutch electro-fishing beam trawl for flatfish. While we recognise that the electro-fishing flatfish beam trawl and the electric-shrimp beam trawl differ widely in design, the ecological concerns are likely to be similar and workers in this field should take account of such concerns at the earliest opportunity.

We add one note of caution, in that electric fishing for shrimp in China has been recently banned as this fishing method proved difficult to regulate and resulted in stock over-fishing and unacceptable environmental impacts.

11.1.4 List of Participants

Andy Revill (Chair)	CEFAS	UK
Tom Catchpole	CEFAS	UK
Bob van Marlen	IMARES	Netherlands
Jochen Depesetele	ILVO	Belgium
Harald Wienbeck	BFAFI	Germany
Bart Verschueren	ILVO	Belgium

11.1.5 Conclusions

1) The ICES-FAO WGFTFB acknowledges the principal findings of the WGECO (2007) report (ToR e) on the 'Ecosystem impacts of *C. crangon* fisheries' which indicates that the two main impacts of these fisheries are:

   i) The removal of the target species (*C. crangon*).

   ii) The discarding of unwanted fish bycatch.

2) The ICES-FAO WGFTFB concludes that the ecosystem impact of *primary concern* is the discarding of unwanted fish bycatch. The core purpose of the *C. crangon* directed fishery is the removal of *C. crangon* itself, however long terms trends do not indicate any stock decline or over-exploitation of *C. crangon* stocks at current levels of fishing effort. As such the ICES-FAO WGFTFB considers the removal of *C. crangon* to be a necessary and unavoidable consequence of this fishery and therefore not of primary concern.

3) Based on a study of the UK fishery and assuming that the findings from this study can be applied to the remaining North Sea *C. crangon* fishery, the ICES-FAO WGFTFB conclude that the current technical measures (sieve nets) legislated for use in 2003 in the *C. crangon* fisheries appear to function as intended and do reduce the bycatch of unwanted fish species in these fisheries.

4) The ICES-FAO WGFTFB concludes that the existing technical measures used in these fisheries are the most effective gear-modifications available at present for reducing the bycatch of unwanted fish species in these fisheries. However, the ICES-FAO WGFTFB conclude that these existing technical measures are only partially effective in reducing discards of unwanted fish species, and that there is a clear need to develop further measures to reduce discarding in these fisheries beyond existing levels (i.e. new gears, spatial / temporal measures etc).

5) The ICES-FAO WGFTFB conclude that technical developments with on-board catch processing and deck sorting equipment (i.e. rotary riddles with constant running water) may improve discard survival rates, but that scientific studies are required to confirm this.

6) The ICES-FAO WGFTFB concludes that the protocol used to evaluate the efficacy of these technical measures in the *C. crangon* fisheries is both holistic and effective. The same protocol can potentially be used elsewhere in other fisheries to conduct similar evaluations on the efficacy of technical measures.

7) The ICES-FAO WGFTFB support the research and development of new measures which could be used to effectively harvest *C. crangon* while reducing discards of unwanted species beyond current levels. The ICES-FAO WGFTFB concludes that the electric-shrimp beam trawl may be one such technical measure, but as yet it is in too early a stage of development to be able to evaluate its potential effects on the ecosystem or its fishing efficiency.

8) The ICES-FAO WGFTFB concludes that any new technical measure, which utilises electrical stimulation as a component, should be accompanied by thorough and rigorous evaluations as to their potential environmental impact and fishing efficiency at the earliest stage possible.

11.1.6 Recommendations

1) The ICES-FAO WGFTFB recommends that research and development be supported to develop new technical measures to further reduce discarding in the *C. crangon* fisheries beyond current levels.

2) The ICES-FAO WGFTFB recommends that any new technical measure, which utilises electrical stimulation of species as an integral part of its operations, should be accompanied by thorough and rigorous evaluations as to its potential environmental impact at the earliest stage.

3) The ICES-FAO WGFTFB recommends that the protocol used to evaluate the efficacy of technical measures in the Crangon fishery be considered as a template / guidance with respect to conducting similar evaluations in other fisheries.

4) The ICES-FAO WGFTFB recommend to the ICES PGCCDDBS to facilitate that catch / discard sampling be initiated and maintained in all North Sea *Crangon crangon* fisheries in-line with the EU data collection regulations.

11.2 Review and report on the impacts of Crangon shrimp beam trawling on benthic habitats and the marine ecosystem in the North Sea

J. Depestele [on behalf of ICES - Working Group on Ecosystem Effects of Fisheries (WGECO)]

Summary

This review was completed by the ICES Working Group on "Ecosystem Effects of Fisheries" (WGECO) in Copenhagen in 2007 (ICES, 2007). WGECO has provided an overview of the most recent information on shrimp beam trawl fisheries in the North Sea. The impact of the North Sea shrimp beam trawl fisheries was examined on a comprehensive list of ecosystem components, including *Crangon*.

As few specific studies on the environmental impact of the North Sea shrimp fisheries have been conducted, the WGECO assessment is based on very limited information or inferred from shrimp beam trawling studies from other areas. Overall, it was concluded that the removal of shrimp from the ecosystem was likely to be the most important ecological impact as they are an important prey item for birds, fish and other invertebrates, and structure the population dynamics of their prey. The size selective removal of *Crangon* by a fishery potentially represents an alteration in the natural pattern of predation and so may impact the structure and functioning of coastal areas of the North Sea. The use of small meshed shrimp beam trawls result in a considerable amount of bycatch of juvenile commercial fish in the North Sea. These unwanted bycatches have been identified as a major cause for concern. Several management measures have been developed and implemented or are being developed to reduce bycatch. Their efficacy is being evaluated in this report. Discarded bycatch may represent a significant food resource to birds in localized areas. The effects over the whole North Sea is unknown.

Discussion

The author was asked to explain what is meant by impacts on local or on North Sea scale. He replied that the key role of *Crangon crangon* is minor when the North Sea is considered as whole, but when the focus is on the impacts of shrimp beam trawl fisheries for a smaller spatial scale, e.g. Wash estuary, North Frisia, etc. the impacts are expected to be substantial by shrimp removal and bycatch of fish species. The density of gadoid predators for instance affects shrimp stock abundance in North Frisia. Shrimp beam trawl fisheries might affect the structure and functioning of this regional area by the removal of *C. crangon* as a key ecosystem component.

12 ToR b): Species Separation in demersal trawls

Conveners: Pingguo He (USA) and Mike Pol (USA)

12.1 General overview and presentation of principal findings

The topic group met on 24 and 26 of April, 2007 in Dublin, Ireland. Twenty-three WGFTFB members participated the topic group meeting:

12.1.1 Terms of Reference

- Identify recent behavioural and gear research into the separation of ground fish species in demersal trawl gears;
- Identify basic principles, strategies, and effectiveness of groundfish separation techniques;

12.1.2 List of Participants

Pingguo He (Co-Chair)	Univ. of New Hampshire	USA
Michael Pol (Co-Chair)	Mass. Div. Of Marine Fish.	USA
Arill Engås	IMR	Norway
Benoît Vincent	IFREMER	France
Bent Herrmann	DIFRES	Denmark
Daniel Valentinsson	IMR	Sweden
Dave Reid	FRS	UK-Scotland
David Chosid	Mass. Div of Fisheries	USA
Eduardo Grimaldo	Norwegian Coll. Of Science	Norway
Ken Arkley	SFIA	UK
Kristian Zachariassen	FFL	Faroe Islands
Ludvig Krag	DIFRES	Denmark
Mathias Paschen	Univ. of Rostock	Germany
Emma Jones	FRS	UK-Scotland
Ólafur Ingólfsson	IMR	Iceland
Oleg Lapshin	VNIRO	Russia
Emmet Jackson	BIM	Ireland
Jose Alio	INIA	Venezuela
Paulo Fonseca	INIAP/IPIMAR	Portugal
Rikke Petri Frandsen	DIFRES	Denmark
Irene Huse	IMR	Norway
Waldemar Moderhak	SFI	Poland

Defining scope

The group defined the scope and limited the topic to species separation in demersal fish trawls and fish behaviour applicable to species separation in demersal trawls. Behaviour of demersal fish species in crustacean trawls and reducing crustacean and other non-fish bycatch in demersal fish trawls are considered to better understand related demersal fish species behaviour.

Presentations on surveying recent actives in fish behaviour and species separation applicable to demersal fish trawls

The topic group received nine oral presentations on species separation and fish behaviour. The presentations and discussions provided a wide range of species separation issues and aspects in various trawl designs from different parts of the world. Talks on crustacean species and midwater trawls were accepted because they demonstrated recent research on techniques that could be transferred to fish species separation. The titles, including three presentations at the plenary are listed below:

- P. He, USA, "A rope separator trawl to reduce cod bycatch in the Gulf of Maine multispecies fishery."
- M. Pol, USA, "Sharpening a blunt instrument: Species separation in demersal otter trawls in Massachusetts, USA"
- E. Grimaldo, Norway, "Evaluation of the escape of fish at towing depths, during haul back, and at the surface for a diamond-mesh codend, a codend with exit windows and a codend fitted with a sorting grid."
- I. Huse, Norway, "How to avoid catches of red king crab in a cod trawl."
- E. Jones, Scotland, "A review of recent FRS Marine Laboratory work on species separation."
- B. Vincent, France, "Species separation in *Nephrops* Fishery in Bay of Biscay."
- M. Paschen, Germany, "Model tests of various cod end constructions - the key for an explanation of selectivity characterisation"
- J. Alio, Venezuela, "Using differences in behaviour of shrimp and fishes to reduce bycatch in Venezuelan shrimp fisheries."
- P. Fonseca, Portugal, "Indirect evidence of differences in fish and crustacean species behaviour elicited by the use of bycatch reduction devices."
- P. He, USA, "Fish behaviour and species separation in multispecies trawls."
- K. Zachariassen, Faroe Islands, "Sorting grids in large blue-whiting trawls"
- R. Imron, Indonesia, "Proposal on research and engineering appropriate BRDs for developing eco-friendly trawls in Indonesia."

Participant surveys

The group surveyed recent projects related to the topic from its members and found the following research related to the topic:

- Large mesh haddock trawl for the Georges Bank haddock fishery - University of Rhode Island, USS
- Separator panel tests and behavioural observations – University of New Hampshire US
- Horizontal separator panel haddock trawl – Gulf of Maine Research Institute, US
- Horizontal separator panel haddock trawl – University of Massachusetts Dartmouth, US
- Grid devices to separate cod and flounders – University of New Hampshire US
- Separation of cod and haddock with groundgear modifications – DIFRES, Denmark
- Separation of two flatfish species – FPI, Canada
- Species separation using light and a panel - Iceland

Other research was surveyed from the WGFTFB National Reports.

- Selectivity of eel in trawls in the Baltic – Germany, 2006
- Laboratory studies of flatfish selectivity and herding behaviour: potential implications for trawl capture efficiency – C. Ryer, USA, 2006

- The effect of light intensity on the availability of walleye pollock to the survey gear.- S. Kotwicki, USA, 2006
- Project Necessity – Denmark, 2005
- Inclined separator panel – C. Glass, USA, 2005
- Development and Testing of a Selective Flatfish Trawl – R. Hannah, USA, 2005

Identifying principles and strategies for separating species and reducing unwanted bycatches and discards

The groups identified the following principles, in the order of preference, to separate species and to reduce bycatch and discard mortalities:

- Avoid encounter with unwanted species
- Prevent contact with the trawl at early stages of capture processes
- Encourage and guide escape when inside the trawl
- Exclude and release fish while the trawl is still at fishing depth

Strategies to separate species and to reduce bycatch and discards

The group identified a number of strategies to separate species and to reduce bycatch and discards.

12.1.3 Main Findings

- Vital needs exist for species separation in demersal fish trawls.
- Varying degrees of species separation can be accomplished through modification of gear or fishing practice, but preventing loss of target species remains a challenge in some cases.
- Species separation is difficult in cases where species are similar in size and shape, as in flatfish.
- Substantially more work on separation of crustaceans from fish has been conducted compared to separation of fish species.

The group concluded that separation should occur as early as possible in the capture process and developed the following principles:

- Avoid encounter with unwanted species
- Prevent contact with the trawl at early stages of capture processes
- Encourage and guide escape when inside the trawl
- Exclude and release fish while the trawl is still at fishing depth
- Strategies for employing these principles were developed, based on known research efforts and potential future areas of exploration. Substantial areas for further research were identified regarding fish behaviour, and testing of various stimuli in all phases of demersal trawls.
- Understanding the effect of non-visual stimuli requires additional forms of instrumentation.

12.1.4 Recommendations and future plans

1) The group request that the topic group reconvene for one day at the annual meeting in 2008 to complete and review the final product. Work by correspondence will be conducted during the intervening year as described below.
2) The group requests input from the WG in general on the best final product that would be relevant to researchers, harvesters, and fishery managers.
3) Suggestions for the final product include:
    - An appendix to the WGFTFB annual report.
    - An FAO document designed for harvesters worldwide.

- An ICES Cooperative Research Report.
- A peer-reviewed journal article.

12.2 Individual presentations

12.2.1 A Rope separation haddock trawl to reduce cod separation in demersal otter trawl

P. He

Abstract

This paper describes the design and test of a trawl targeting haddock. The key feature of the new trawl is the use of ropes, instead of netting, for the horizontal separator and a large escape exit in the lower belly. The trawl intended to retain haddock (*Melanogrammus aeglefinus*) and pollack (*Pollachius virens*) while releasing cod (*Gadus morhua*), flounder species and other bottom dwelling species. Substantial increases in haddock and pollack biomass in Gulf of Maine, and much slower increases in cod and yellowtail flounder (*Limanda ferruginea*) stocks require development and use of such trawls to reduce fishing pressure on cod and yellowtail flounder. The research involved flume tank tests, underwater observations and comparative fishing trials using the alternating tow method. Results showed that commercial catch rates of haddock (218 kg/hr) could be obtained using the new rope haddock trawl. The new trawl reduced cod catch by 61%, with an associated reduction in haddock of 16%, both in numbers. Catch of flounders was virtually eliminated in the new trawl. There was also substantial reduction in other commercial and discard species such as dogfish (*Squalus acanthias*), wolffish (*Anarhichas lupus*), lobsters *(Homarus americanus*), and skates (*Raja spp*). On average, 85% of all catch in numbers were haddock when using the new trawl compared with 52% when using the commercial (control) trawl. Underwater video observations of the gear proved that the shape of the rope separator panel was similar to what was seen in the flume tank and met design specifications. Fish behavioural observations revealed that the rope panel enhanced species separation by allowing haddock to swim up and cod to swim down the rope panel.

Discussion

The question was raised as to why ropes had been used instead of netting panels and the author replied that was to prevent meshing of species such as dogfish, which had proved problematic in previous experiments. They had also had much better separation of haddock with the rope panels and also observed haddock swimming up through the ropes, which would not have been possible with a net panel.

It was also pointed that there were no problem of damage and maintenance of the rope panels and no problems were observed when shooting or hauling, except on one specific haul when a rope burst.

Concern was raised that the ropes may restrict the horizontal spread of the trawl, particularly given that fishermen use different towing speeds, door spreads and doors depending on trawl design and vessel characteristics. It was suggested that the ropes may have to be rigged on an individual vessel/trawl basis and this would reduce commercial acceptance. The author replied that the rigging of the ropes had been extensively tested in the Flume Tank in Newfoundland and no distortion of the trawl had been seen.

The question was raised as to whether any acoustic measurements had been taken given that there could be noise effects and vibrations from the ropes that may affect fish behaviour. This

concern was acknowledged and need for such study was stressed by the author but not restricted just to these experiments.

12.2.2 Sharpening a blunt instrument: Species separation in dermersal otter trawls in Massachusetts, USA

M. Pol

Abstract

Species are separated in demersal otter trawls through a variety of strategies. Past and current research in Massachusetts has focused on developing otter trawl nets that separate species at the trawl mouth by understanding the behaviour of target fish species. The raised footrope trawl, developed to separate silver hake (*Merluccius bilinearis)* from flatfish and other bottom-affinitive species, is designed so that the fishing line is approx. 0.5 m off-bottom with an opening of 1.5 m. The Ribas and topless trawls, developed to separate Atlantic cod (*Gadus morhua)* are two-seam low opening (2.0 m approx.) that are designed to have the fishing line near the bottom and have the top half of the nets modified. The Ribas net has large (205 mm) square mesh and the topless net has the top half of the net largely removed; both designs allow *G. morhua* to escape by ascending. The Five Point trawl is a "sweepless" raised footrope trawl that captures haddock (*Melanogrammus aeglefinus)* and passes over *G. morhua* by rigging the fishing line to be 1.5 m off-bottom with an opening of approx. 8 m. Preliminary data indicate that the three nets effectively separate species. The three nets are based on our understanding of the behaviour of the target and bycatch species. Flatfish, homarids, and lophids are usually restricted to the sea floor up to 2.0 m or less. *G. morhua* and *M. bilinearis* are between 0.5 to 2.0 m off bottom. Haddock are from 1.0 to 10 m (or greater) off-bottom.

Discussion

The question was raised as to whether diurnal or seasonal variation had been consideration with respect to separation of species. The author replied this was one issue that needed to be considered and stated that the data existed and would be analysed at a later stage. The importance for gear monitoring in this type of experiments was stressed.

12.2.3 Evaluation of the escape of fish at towing depths, during haul back and at the surface for a diamond-mesh codend, a codend with exit windows and a codend fitted with a sorting grid

E.Grimaldo, R. Larsen, M.Sistiaga*

Abstract

The first part of an experiment with the aim of evaluating the capacity of different selection systems to sort out fish at depth was carried out in December 2006. Two codends were evaluated: a 155 mm diamond mesh codend, a 135 mm diamond codend fitted with a 55 mm sorting grid. A square mesh cover was fitted to a "Multisampler" in order to collect fish escapees at three different phases of the trawling process: at depth, during haul back and at the surface.

The selectivity estimates did not show evidence of a better selectivity between the codend fitted with the sorting grid and the 155 mm diamond mesh codend. There was however considerable differences in the percentages of escaping fish, at depth, during haul back and at surface. The codend fitted with the sorting grid released 74% of all cod escapees at depth, and 22% of them at surface. In contrast, the 155 mm diamond codend released only 55% and 42% at depth and at surface respectively. For haddock, the sorting grid released 95% of all escapees at depth, and 3.4% at surface. The 155 mm diamond codend released only 74% at depth and

25% at surface. Fish which escape during the haul back and at surface were not likely to survive because of the rapid decompression movement from fishing depth (in this case around 300 m) to the surface, and also because at surface fish were exposed to predation by birds.

Discussions are made having in mind that all fishery managements base their technical gear regulations on the assumption that juvenile fish (from commercially important species) survive escape. Therefore, it is generally expected that the selective devices let the unwanted (non-target) bycatch fish escape at the fishing depth (i.e. here the sea bed) in a gentle manner to ensure their survival and future recruitment. (Full report provided in Annex 4).

Discussion

It was felt that the larger mesh size used in the diamond mesh codends with the grid could explain the differences observed in selection patterns. The importance of releasing the fish at depth to avoid the high mortalities of the surface escapees during haul back was also stressed, although currently there was only limited information on release rates during haul back and associated mortalities. Further research on this topic was recommended.

13 ToR c): Technical issues relating to the Mediterranean

Conveners: Antonello Sala (Italy), Jacques Sacchi (France) and Enric Massutí (Spain)

13.1 General overview and presentation of principal findings

This ToR was initially proposed by Antonello Sala (National Research Council – Institute of Marine Sciences, Ancona, IT) at the 2006 FTFB meeting in Izmir. An overview of the topic was given at plenary to the FTFB at the start of 2007 meeting by Antonello Sala.

13.1.1 Terms of Reference

1) Open dialogue with appropriate Mediterranean management bodies *i.e.* FAO-GFCM to identify appropriate areas of collaboration;

2) To review, for the non-EU Mediterranean countries, the technical aspects of their fisheries, following the pattern of the report on Turkish fisheries compiled at the 2006 WGFTFB meeting and using, for example, output from the FAO/GFCM/COPEMED project; and

3) Then to extend, for both EU and non-EU Mediterranean fisheries, available technical information on the fishing gears and practices [see for the EU countries: Technical Report SGMED-STECF SEC (2004) 772], in particular to:

- Review recent research;
- Identify the main technical problems of the Mediterranean fisheries and the gaps in knowledge needed to solve them;
- Propose, where possible, technical solutions aimed to manage better the fishery resources and to reduce the impact on the marine ecosystem;
- Publish a report on the findings from the above points.

13.1.2 Summary overview

The Group met during the afternoon of 24 and morning of 26 April 2007 in Dublin, chaired by Jacques Sacchi, Antonello Sala and Enric Massutí. A total of 9 Mediterranean scientists participated to this Topic Group, along with a GFCM representative.

13.1.3 Dialogue with appropriate Mediterranean fisheries management bodies.

13.1.3.1 Collaboration with GFCM

Various works on fishing technology were performed in the framework of GFCM since its establishment (selected publications are provided in Annex 5). Recently, in 2004, SAC established a working group on gear Selectivity in the Mediterranean fisheries. This working group met in Sete, France, from 9 to 11 February 2005 and in Barcelona, Spain, from 2 to 4 April 2007. The main conclusions of the 2 meetings are summarized as follows:

1) First meeting (GFCM-ATSELMED, France, 9–11 February 2005):
- Setting a network of technologists involved in the Mediterranean fisheries (GFCM-TECHNOMED). This network was also open to the fishing industry.
- Setting of database on selectivity studies, including all related technical data and parameters available.
- Start to drawing up of a practical guide for selectivity study

2) Second meeting (GFCM-ATSELMED2, Spain, 2–4 April 2007):
- The Workshop confirmed the necessity to standardise the terminology of Mediterranean fishing gears: glossary and catalogue are needed.
- It was considered that selectivity studies require a multi-disciplinary approach, integrating technologists, biologists and economists.
- It was necessary to develop a protocol for the standardisation of selectivity studies, taking into account the GFCM-ATSELMED meeting and the conclusions from the present WS, including technological, biological, ecosystem and economic aspects. The participation of fishing industry (especially fishing gear manufacturers) was also recommended.
- It was also identified the need to monitor the implementation of 40 mm square-mesh codend, taking into account technological, biological, ecosystem and socio-economic aspects.
- In addition to the monitoring of implementation of 40 mm square-mesh codend, the WS suggested to perform research on:
  - i) Effect on discards.
  - ii) Survival rates of escapees from the fishing gear (estimation of unaccounted mortality).
  - iii) Effect of the type of netting material and mounting.
  - iv) Analysis of economic effects.
  - v) Further analyse and compare the effects on the ecosystem.
- The WS pointed out that the knowledge of survival rates in the Mediterranean should be strongly improved, and stressed the need to establish an appropriated methodology to address this issue.
- The WS considered that the implementation of 40 mm square-mesh codend is generally going to have a positive effect for the majority of the studied species and from a biological point of view, the WS stressed that the 40 mm square-mesh codend should be implemented as soon as possible.
- The WS stated that implementation of the 40 mm square-mesh is considered not sufficient to recover fully, highly exploited species. Additional measures are also required.
- The available information on the effect of application of the 40 mm square-mesh codend does not cover the whole Mediterranean. The WS encouraged the development of selectivity studies in more GFCM-GSAs.

13.1.3.2 Review, for both EU and non-EU Mediterranean countries, the technical aspects of their fisheries

There is a large amount of information on fishing technology related to Mediterranean fisheries more or less available, with some documents published but many others remaining as grey literature. Among these documents it is possible to find specific information and publications relating to one or several technical aspects of the fisheries.

The EU Commission provided a comprehensive report in 2003 on the fisheries of 4 EU countries giving in particular the most important technical characteristics of their fisheries, regulations and management recommendations.

For non-EU Mediterranean fisheries, a Turkish technologist team provided a detailed report on the different fishing techniques used in Turkish waters with general description on the gear, practices, and subjects of concern and possibilities of improvement at the FTFB meeting in 2006.

In relation to other non-EU Mediterranean countries, some studies have been developed by FAO/GFCM/COPEMED during recent years, to describe the fisheries of Morocco, Algeria, Tunisia and Libya, in the Western and Central Mediterranean sea (www.faocopemed.org). Information has been inventoried and the fleets and the fishing gears (without detailed of technical description), as well as the main metiers and the target species have been listed.

For both the EU and non-EU Mediterranean fisheries, the convenors will request data from all appropriate countries related to the description of some technical aspects of their fisheries, in particular highlighting gear/fleet/fishery related issues. Specifically Mediterranean countries will be asked to provide information according to standard format report on the following technical aspects of the main gear types used in the country:

- Technical description;
- Species and size selectivity devices;
- Technical gear devices aiming to fuel saving;
- Means of improving catch quality (i.e. technical devices, tactics and strategies)[3].

Also to provide information at vessel level:

- Vessel conception and deck management;
- General characteristics of the fishing vessels (number, LOA, GT, HP, etc);
- Technologies for improving working conditions onboard.

For those aspects, the FAO gear classification/specification will be the relevant reference. Other gears not classified by the FAO should also be described.

And at species level describe:

- Main target species and landings for each gear;
- Ecosystem effect of fishing gears (i.e. physical impact, bycatch, discards, etc.).

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3 **Tactics** are defined as changes during a fishing trip, based on short time reactions (e.g. effort allocation within a trip, gear selection, selection of fishing grounds). **Strategy** is defined as a change over a longer time span (e.g. a complete year).

13.1.4 Research on Mediterranean fishing technology

13.1.4.1 General description of Mediterranean trawl gear design

The different Mediterranean fleets use various types of bottom trawls. They are generally designed more according to fishing practice than to targeted species. However, two main trawl gear categories can be recognized, Mediterranean and "Atlantic" designs. The typical Mediterranean trawls have low vertical openings, essentially using sweeplines and occasionally short bridles. The Atlantic designs have generally a larger vertical opening, sometimes due to the addition of lateral panels. In a few cases larger lateral panels and fork rigs are used to obtain higher vertical opening for targeting midwater species. The fishermen themselves using only basic rules of cutting and mounting generally make up Mediterranean trawls, while the Atlantic-style trawls are made using more advanced net plans.

13.1.4.2 Codend selectivity in bottom trawl

Some works have assessed the codend selectivity for some important species in bottom trawl fisheries, e.g. European hake *(Merluccius merluccius)*, red mullet *(Mullus barbatus),* Norway lobster *Nephrops norvegicus*, pink shrimp *Parapenaeus longirostris,* red shrimp *Aristeus antennatus* (see Annex 5). Besides the size selectivity parameters, some of these studies have also analysed the codend selectivity in relation to catch composition, commercial yields, retention efficiency and discards.

Given the importance of hake and red mullet in the Mediterranean bottom trawl fisheries, the relationship between mesh size, L50, SR and SF was reviewed by several authors, with the main objective to estimate reference selection for different codend mesh size.

Considering that the real processes are more complex, several Mediterranean fisheries scientists during ATSELMED-2 started to explore effects of other parameters (e.g. mesh size, mesh configuration, twine diameter, mounting ratio, etc.) on codend selectivity. This study presents an updated literature review of the Mediterranean bottom trawl selectivity, discusses and summarises the data and the work presented in several papers/reports. Advice on the experimental methodology and data analysis are provided for a better estimation of selection parameters.

The review of the literature was undertaken during 2006 and further technical information on the gear characteristics was subsequently obtained through correspondence with the relevant authors. The scarcity of papers demonstrated the need for this review. In particular, between 1969 and 2007, only 20 and 28 relevant papers were found respectively for red mullet and hake, while only a few others existed for other demersal species. Updating of published literature is on going for these 2 species and needs to be extended to other main commercial species.

13.1.4.3 Multiple size selection devices in towed gears (i.e. square-mesh panels, grids, etc.)

Five recent studies explored the efficiency of sorting grid systems in the western Mediterranean (see Annex 5). These studies have been conducted under both experimental and commercial conditions, and tested different grids with respect to material (rigid, semi-rigid and flexible), mounting (upper and lower surface opened to the codend), surface (50 and 75%) and bar spacing (15 and 20 mm).

Despite the efficiency of sorting grids of 20 mm bar spacing to improve trawl selectivity, which could also present better survival after escapement than other selection devices (square-mesh), the introduction of sorting grids seems to present some disadvantages with respect to others devices, mainly related to saturation effects, wider selection range, more complex

installation, maintenance of optimal angle during the tow (requiring a remote monitoring system) and handling and durability, under commercial and routine fishing operations.

Some experiences with square-mesh panels in the codend have also been made, also showing the efficiency of these devices to improve trawl selectivity. Within the context of the multispecies bottom trawl Mediterranean fishery, however, there is no single solution suitable for all species, and perhaps it is necessary the look multiple selection systems, in order to first sort by type of species and then by size.

13.1.4.4 Survival studies in bottom trawl gear

Except in Turkey, there are no studies investigating the survival rates of fish escaping from trawl codends in the other Mediterranean countries. The first study completed was carried out of Turkish coast of Aegean Sea in 2001 and aimed to investigate the survival rate of red mullet *(Mullus barbatus)* after escaping from a commercial bottom trawl codend. A second study was conducted to determine the seasonal variations in survival percentages. (See Section 13.5.1). In this study, survival rates of red mullet *(Mullus barbatus)*, annular seabream (*Diplodus annularis*), common two banded seabream (*Diplodus vulgaris*), brown comber (*Serranus hepatus*), red bandfish (*Cepola macrophthalma*) and black goby (*Gobius niger*) were obtained.

13.1.4.5 Passive gear selectivity (i.e. trammel nets, gillnets, traps, pots, longlines, etc.)

Several different research projects on passive gears have been carried out in different Mediterranean countries, with particular attention on selectivity either between species (interspecies selectivity) or between size and/or sex (intra-species selectivity). Most studies are looking at gillnets and trammels nets for various species (hake, red mullet, sea bream, cuttlefish) using indirect estimation methods of the size selectivity (e.g. parametric or recently non-parametric procedures) and relating to the catches of fish encountering the gear or simple morphometric information. Analysis of inter-selectivity has become more developed recently using multivariate analysis and diversity indices.

Some studies have been carried out measuring the selectivity of longlines, although the accuracy of such measurements is felt questionable because of the dependence on a combination of factors such as the type and size of the bait, the size of the hooks, the material used for branch lines. Some experiments, have demonstrated unquestionably, a relationship between fish size and hook size for swordfish longlines. Although there is no complete evidence for fish size-selectivity for the effect of hook size, these studies have shown smaller hooks do tend to give higher catch rates than larger hooks. Publications on the effect of bait, branch line size and number of hooks are not available for the Mediterranean and further research in this field could support further development of this fishing method, given its inherent environmentally friendly nature. A further problem with longlines is presented with the high number of incidental catches of marine turtles and sharks occurring in surface drifting longlines. Some experiments made during 2005 in the swordfish fishery, have showed that a change in the hook shape as well as in the fishing operations (depth at which hooks are soaked and hauling time) can partly mitigate this problem.

Pot selectivity is poorly reported in the literature and concerns only few species (deep pink shrimp, cuttlefish, and crawfish), while for other passive gears some works on size selectivity can be found for fykenets, providing a description of size composition. Lastly, a large number of documents exist comparing size and species composition between different gears used in the same area (trammel/trawl; gillnet/trawl; longline/trawl, etc.).

A review of static gear selectivity studies is presently in preparation by the TECHNOMED network.

13.1.4.6 Impact of fishing gear

Literature on fishing effects on the ecosystem has increased in the last ten years, but often the information presented on the fishing techniques concerned by this problem is only partially given. Often scientists forget to give a good description of the gear and the fishing practices and comparisons are often made between techniques of quite different characteristics making it impossible to correctly quantify the effects. Besides the studies on discards problems research has also been conducted on the physical impacts on the seabed and the incidental catches of endangered species (turtles, marine mammals, sharks, birds). On bottom impact, the main subject of concern is related to the fishing activities on ecological sensitive areas such as seagrass areas and coral reef areas of the continental slope. Regarding endangered species some research has been carried out to mitigate the catch of turtles by longline and cetaceans by static nets (deterrent acoustic devices). Lastly two studies in the Mediterranean have specifically looking at the effects of ghost fishing.

13.1.4.7 Technology creep

Few specific studies have been carried out in Mediterranean Sea on the effects of the regular improvement of fishing gear and vessels characteristics on fishing effort and fishing mortality. Recently within the 6th EU framework programme, the CAFÉ project has undertaken to examine the relationship between capacity and effort and hence fishing mortality for two Mediterranean fleets; the French demersal trawl fishery targeting hake; and Greek pelagic fisheries targeting small pelagic species. Collation of data on gear and vessels characteristics, measurements of various effort parameters and their evolution over the last 10 years; will be undertaken in these studies and are designed to contribute to the implementation of a fishing effort management system for Mediterranean fisheries in the future.

13.1.5 Regulation of Mediterranean fisheries

A preliminary investigation of technical measures relating to fishing gears was completed taking into account European regulations and national legislation from several countries in the Mediterranean Sea.

At this stage, the objective of this investigation was to draw a view of the current Mediterranean legislation, to find problems, gaps and contradictions on different fishing gear legislation. The preliminary data collected shows a highly complex situation both in technical measures applied in different countries and also in the terminology used. Moreover some important technical parameters (i.e. strengthening bags, etc.) are not included in several national legislations.

Therefore it is necessary to continue the investigation of technical measures as there are suspicions regarding some of the data collected. There is a need for more reliable information to be collected to update, improve and standardise the data already available. There is also a need to pay more attention to different gear legislation, in light of the new EU Regulation, which fixed for EU countries the management measures for a sustainable exploitation of fishery resources in the Mediterranean Sea (EC Reg. 1967/06).

The final aim of the current investigation should also support the harmonization of legislation both for the EU and non-EU countries and define a common point of view for a reasonable fisheries management policy in the Mediterranean Sea.

13.2 List of Participants

Antonello Sala	CNR-ISMAR	Italy
Jacques Sacchi	IFREMER	France
Enric Massutí	IEO	Spain
Abdellah Srour	GFCM	FAO
Alessandro Lucchetti	CNR-ISMAR	Italy
Yeliz Ozbilgin	Mersin University	Turkey
Huseyin Özbilgin	Ege University	Turkey
Altan Lök	Ege University	Turkey
Adnan Tokaç	Ege University	Turkey
Alen Soldo	University of Split	Croatia

13.3 Discussion and conclusions

The approach applied in the GFCM/ATSELMED-2 review of the codend selectivity, allows a critical analysis of some factors affecting the bottom trawl selectivity in Mediterranean. It is not only a mere review of the available papers, but it is also a first tentative in describing how some technical parameters (e.g. mesh size, mesh configuration, twine diameter, mounting ratio) affect codend selectivity. The first analysis revealed, for both the species analysed (hake and red mullet), a highly significant effect of mesh configuration on L50, with a higher effect for hake probably due to differences in fish morphology.

Therefore, the topic group believes that square-mesh codends will generally bring some advantages in terms of selectivity for these two commercial species, but other experiments need to be assessed on several fisheries and evaluated in terms of marketable fish losses.

A more detailed review of the work carried out is needed to further verify the data already collected. In particular the authors found many problems with the terminology used in the different papers.

The ToR's members agree to consider the knowledge of the national gear legislation to be very important in order to understand the present situation and to plan harmonization of the technical management measures in the Mediterranean Sea.

13.4 Recommendations

1) The WGFTFB will explore the possibilities to develop scientific collaboration with the General Fisheries Commission for the Mediterranean (GFCM) on fishing technology in the Mediterranean fisheries with focus on the following aspects:

- Network of Mediterranean technologists: GFCM established a network of technologists (GFCM-TECHNOMED) in 2004, which also includes the fishing industry sector. The network is aimed to discuss and share information and experiences on any subject related to fishing technology such as selectivity, development of new fishing gears, etc. The GFCM network started working by correspondence and it is being managed through the GFCM website (www.faogfcm.org). Scientists of WGFTFB are encouraged to join this network.
- Harmonisation of the legislation related to fishing gear in the Mediterranean: WGFTFB will request the coordination of GFCM for the achievement of the work started on this issue.
- Participation in the technical meeting of GFCM: Scientists of WGFTFB are encouraged to participate and to present the results of their research on fishing technology during the meeting of the relevant subsidiary body of SAC/GFCM.
- With the coordination of the GFCM, to draw up a selectivity database with complete list of all the bibliographical information on codend selectivity

studies, including all the technical data and parameters of selectivity available.

2) Survival studies need to be extended to cover other Mediterranean fisheries with the implementation of a standardised methodology. Studies should be done for other fishing gears and key-species (i.e. hake, red mullet, etc.).

3) To consider the specific characteristics of Mediterranean fishing gear in conjunction with the preparation of the FAO fishing gear classification (Section 14), as many Mediterranean fishing gear experts indicates that such classification needs to be updated considering all the fishing gear used in the Mediterranean area.

4) With reference to GFCM/ATSELMED-2 recommendations, the working group suggests to standardize fishing terminology used in scientific papers on fishing gear and techniques in order to allow easy comparison of obtained results from different Mediterranean areas.

5) Considering the GFCM resolution GFCM/31/2007/3 on 40 mm square-mesh codends in trawl fisheries exploiting demersal resources and taking into account the conclusions of the GFCM-ATSELMED-2 (Barcelona, 2–4 April 2007), the WGFTFB encouraged the promotion of research programmes on different fishing technology aspects including the impact of implementing 40 mm square-mesh in the Mediterranean trawl fisheries. The WGFTFB also encourages fishing gear technologists to present any related results and works for consideration by the technical Working groups of GFCM/Scientific Advisory Committee.

13.5 Individual presentations

13.5.1 Survival Rate of six fish species after escape from trawl codend in the Aegean Sea in winter

F. Duzbastilar, A. Lok*, C. Metin, H. Ozbilgin, G. Metin, A. Ulas, A. Ozgul, B. Gul, I.Aydin, A. Tokac

Abstract

Survival rates of red mullet (*Mullus barbatus*), annular seabream (*Diplodus annularis*), common two banded seabream (*Diplodus vulgaris*), brown comber (*Serranus hepatus*), red bandfish (*Cepola macrophthalma*) and black goby (*Gobius niger*) were investigated after escaping from a commercial bottom-trawl codend in the Bay of Izmir, east coast of the Aegean Sea. The experiments were conducted between 29 January and 5 February 2007. A traditional bottom trawl with a 40 mm codend was used. A cover was attached over the codend to catch the escaping fish. At the end of each tow, the cover was detached from the codend and deployed at the observation site (17–26 m) by divers. Two controls and three experimental hauls were carried out. First control tow was terminated in 5 min, the other control and three test tows were carried out for 15 min. The cod-line was left untied in the case of the controls. Divers observed the cages three times per day over a 7-day period to remove dead fish and feed the survivors.

Survival rates in the 5 min tow control cage were higher than the 15 min tow control cage for four species. There were not any *G. niger* and *D. vulgaris* in the 5 min tow control cage. Survival percentages in the 5 min tow control cage, 15 min tow control cage, and the average of three test cages were, respectively, 89.5, 44.6, and 49.2 for *M. barbatus*, 100, 96.6, and 98.9 for *D. annularis*, not applicable, 100, and 100 for *D. vulgaris*, 98.9, 98.3, and 98.5 for *S. hepatus*, 100, 90.4, and 97.4 for *C. macrophthalma* and finally, not applicable, 57.7, and 81.6 for *G. niger*.

For the same gear and fishing ground, available data for *M. barbatus* in September 2001 indicates a significant decrease in survival rates from summer to winter with approximately 10 ºC decrease in water temperature. The study will be continued to investigate the seasonal differences in survival rates.

Discussion

The author was asked the reason why there was a pronounced difference between the 5 and 15 minutes control for red mullet and black goby. Rather high density of the fish and longer time of swimming in the 15 min control cage were considered to be main reasons.

13.5.2 Efficiency of a change in the mesh codend geometry and he use of sorting grids to improve the size selectivity of bottom trawl in the western Mediterranean

E. Massutí, F. Ordines, B. Guijarro*

Abstract

The Mediterranean bottom trawl fishery is multispecies and exerts a high fishing pressure on younger and immature individuals. The General Fisheries Commission for the Mediterranean (GFCM) has recommended the improvement of selectivity in this fishery. We model the selectivity in the bottom trawl of the Balearic Islands (western Mediterranean), by using the 40 mm "traditional" diamond mesh (DM) codend and an "experimental" square mesh (SM) codend, and flexible sorting grids with a bar spacing of 15 and 20 mm (SG15 and SG20, respectively), under commercial conditions. The comparison of DM and SM codends was made using three conventional nets, traditionally used by the trawlers of the study area at different depths, employing the covered codend method. The comparison of SG15 and SG20 was made using a divided trawl, which allowed the simultaneous employment of both grids, installed in each extension piece of the net and angled around 40º. An inside 20 mm DM small codend was used to retain the escapees. The efficiency of these systems to improve trawl selectivity is assessed in terms of size selectivity parameters and escapement of small individuals. The divided bottom trawl used did not show problems for manoeuvring on board. The flexible grids did not show any limitation for routine commercial manoeuvres, with no difficulties for hauling these structures onto the net drum. For all species, the highest value of L_{50} was obtained with SM, except for the *Merluccius merluccius*, *Lepidorhombus boscii* and the decapod crustacean *Parapenaeus longirostris*, which showed higher values with SG20 than with SM. However, the selectivity with SG20 for *M. merluccius* cannot be considered as fully true, because a percentage of the specimens do not interact with the grid, due to the saturation effect detected with sorting grids on the deep shelf. No saturation effect was detected with sorting grids on the slope and with DM and SM codend along the whole bathymetric range surveyed. The selection range of sorting grids was substantially wider than those estimated for DM and SM codends. The selectivity performance of these selection devices is also compared with the results obtained by other authors in some areas of the western Mediterranean off Iberian Peninsula. We conclude that a change in the geometry of square mesh codends seems to be more appropriate than the introduction of sorting grids for the improvement of bottom trawl selectivity in the area.

Discussion

A concern was raised that the use of different material and rigging ratios could be used by fishermen to impede the selectivity of square mesh codends and therefore any new regulations needed restrictions on twine thickness, meshes round and the use of cover bags to avoid the efficacy of the regulations being lessen.

Information was provided on the present selection parameters for square mesh and grids, and this could be incorporated into models to allow estimation of the impacts of new technical measures.

13.5.3 Review of the fishing gear management measures in the Mediterranean Sea

A. Lucchetti, A. Sala*

Abstract

The present document concerns a comparative study of fisheries laws and regulations covering the entire Mediterranean basin and focuses on one main issue: the Mediterranean technical measures on fishing gears.

During the last number of years, the technical aspects of legislation on fishing gears have become an important issue, mainly in light of the new EC Reg. 1967/06, which replaced the EC Reg. 1626/94. The new Regulation has changed many rules on fishing gears compared to the previous one, so it is important to define a common point of view on the new situation.

The EC Reg. 1967/06 implements some technical parameters very important for improved selectivity including mesh configuration (square mesh codend) and the twine diameter of towed net and gillnet. Nevertheless a few concerns have been raised as underline in this report.

Furthermore it compares national legislation of EU and non-EU countries with the aim of finding possible alternative solutions; in fact comparing the National legislations could be useful to verify how the different countries have tackled similar problems.

The document intends to open a dialog between fishing gear technologists on the technical aspects of fishing gears considered important to manage the marine resources in different countries of the same basin. The goal of the document is to outline the technical issues we need to investigate in the future and the possible solutions we can suggest to fishery managers for standardization of technical and management measures in Mediterranean Sea.

13.5.4 A multidisciplinary approach for improvement of fishing gear selectivity in Mediterranean Sea

J. Sacchi

Abstract

Under the recommendation of General Fisheries Commission for Mediterranean Sea (GFCM) to reduce the capture of juveniles and discards in Mediterranean Sea, two workshops were organized with the participation of FAO projects, COPEMED and ADRIAMED. They focused on the improvement of Mediterranean bottom trawl selectivity. The main goal of the first Atselmed meeting (Sète, February 2005) was to discuss and define most reliable methodologies appropriated for Mediterranean fisheries that must gain the agreement of scientists and fishermen. During the first meeting, different selectivity studies dealing with various issues - diamond or square mesh codend, selectivity, sorting grids, survival after escapement, material effects, - and including Mediterranean multispecies inshore fisheries or deep shellfish fisheries were presented and discussed by the participants to review technical difficulties, particularly related to the large species diversity and the low level of catches. Discussions underlined the unquestionable benefits of application of square mesh to the different codend configurations used in Mediterranean Sea and recommendations were made to develop studies favouring the implementation of this type of selective device.

The second meeting (Barcelona, April 2007) had the main objective to define strategies allowing a gradual implementation of the 40 mm square mesh codend in order to take account of the multispecies nature of most Mediterranean bottom trawl fisheries and to ascertain the short and long-term socio-economic consequences of this measure particularly for the

multispecies coastal fisheries. In light of recent studies multidisciplinary approaches and models have been discussed and proposed for the analysis of its medium and long terms effects.

Recommendations were also made for the creation of a selectivity database including all the technical data and selectivity parameters of available and extended to static gears. Furthermore the GFCM within its thirtieth session in Istanbul, (24–27 January 2006) has endorsed the proposition of the last ATSELMED meeting in Sète (February 2005) to promote the establishment of a network of Mediterranean technologists for assisting its Scientific Advisory Committee in its recommendations on fishing management in Mediterranean Sea. This network is made up of Mediterranean scientists and experts from industry involved by their works in one of the different fields of the fisheries technology (fishing gear technology, selectivity, environmental impact of fishing gear, effects on fishing effort and capacity, fuel saving, vessel conception and deck management, etc.).

14 ToR d): Gear Classification

14.1 General Overview

The ToR cited below, was presented in plenary by John Willy Valdemarsen.

14.1.1 Terms of Reference

1) Present a draft FAO/ICES fishing gear classification based on the structure of gear definitions agreed during the 2006 WGFTFB meeting.

2) In consultation with management bodies and by reviewing current initiatives, identify which gear parameters that should be monitored to provide better estimates of commercial CPUE.

14.1.2 Abstract

A drafting group consisting of Wilfried Thiele, John W. Valdemarsen, Ulrik Jes Hansen, Francois Theret and Dick Ferro worked by correspondence to prepare text of definition and classification of fishing gear following the 2006 WGFTFB meeting in Izmir. In this intersessional drafting process, participants in the topic session in Izmir supported by expertise from other important FAO regions were consulted. A draft text proposal was ready for review during the topic group sessions in Dublin.

Because of time constrains it was decided to only consider the first part of the ToR during this meeting. It was informed that the second part would be considered for inclusion as part of a new recommendation for an FTC Study Group (Section 19.1.4).

Tasks for this meeting were defined as:

- Decide on final text for definitions of various gear categories'
- Agree a way forward to finalize the ToR.

12 participants listed below, representing 12 countries from various FAO regions took part in the work during two 4–5 hour sessions during the meeting. The format of classification of gear in a maximum three levels, as agreed in the 2006 Izmir meeting, was confirmed. Target groups for the reviewed classification were briefly discussed. In addition to the collection of fishing data by gear types, which is used for statistical purposes, it is recognized that the FAO definitions of fishing gear is benchmark knowledge for training and education within the fishing sectors. Such definitions are also often basic information in formulation of legal instruments dealing with fishing gear. It was therefore decided by the group that brief and concise definition of a fishing gear category could be followed by additional information that

describe the operation of the gears and the various contexts they might be applied in, when appropriate. Each gear category should be illustrated with graphics in a similar style.

The group revised the text of most gear categories, but because of time constrains the gears belonging to the categories hooks and lines and other gears were not reviewed during the session.

The revised text agreed as by the topic group except the last mentioned categories is presented for information in Annex 6 (It should be noted that this version is not a final output, and should therefore not yet be used for a replacement of the existing 1971 FAO Technical Paper 222).

A subgroup (Valdemarsen, Ferro, Moth Poulsen and Thiele) identified which gear should be graphically illustrated, as basis for a request to the FAO Secretariat to contract an appropriate consultant to complete this work. The topic group recommended that the illustrations should be in a similar format as in a FRS (Aberdeen) report[4] describing fishing gears.

John Willy Valdemarsen presented the outcome of the topic group during their meeting in Dublin in plenary. Some members, who did not participate in the topic group discussions, were concerned that special gears used in their region were not included in the global list of gear categories. The Chair responded that participants should analyse the draft list of fishing gear categories and their description to identify if a particular gear has been missed out, and then propose through the Chair how such gear should be included in the final global classification. The draft classification will be attached as an annex to this report, and the Chair should receive such comments before 1 December 2007.

One member intervened about inclusion in the gear descriptions of selective devices developed to reduce capture of non-targets in various trawl fisheries. As the variety of such devices is numerous, this was not found to be appropriate within the scope of this global gear classification and description work.

As the editing of the document was not completed during the topic group meetings, the FTFB was not in a position to approve a final new global gear classification. The Chair (John Willy Valdemarsen) was requested to coordinate in consultation with the FAO secretariat the completion of the work, including the development of appropriate gear illustration. Time frame for this work is to have a draft document ready for presentation to the FTFB members at their meeting in 2007.

14.1.3 List of Participants

John Willy Valdemarsen (Co-Chair)	IMR	Norway
Wilfried Thiele (Co- Chair)	FAO	Italy
Dick Ferro	FRS	UK-Scotland
Esteban Puente	AZTI	Spain
Bundit Chokesanguan	SEAFDEC	Thailand
Suzuette Soomai	MALMR	Trinidad
Thomas Moth Poulsen	FAO	Italy
Andrej Seefoo	Inst. Nacional de la pesca	Mexico
Francois Theret	EU	Belgium
Steve Eayrs	Gulf of Maine Res Inst.	US
Stephen Walsh	NWAFC	Canada

4 R.d Galbraith and A. Rice after E.S. Strange., 2004. An Introduction to Commercial Fishing Gear and Methods used in Scotland. Fisheries Research Services. Scottish Fisheries Information Pamphlet No. 25. 43pp.

Gerard Bavouzet IFREMER France

14.1.4 Recommendations

1) The topic group members, assisted by other identified experts from other FAO regions will complete the text editing by correspondence using the ICES SharePoint facilities. John Willy Valdemarsen will coordinate the editing. A draft document should be finalised within or prior to the FTFB meeting in 2008.

2) Other members of FTFB can provide comments to the annexed draft definitions if there are fishing gear used in different countries, which cannot be included in the listed categories and in their descriptions. Deadline for submission of such comments is December 1st 2007.

15 ToR e): Advice to Assessment Working Groups

15.1 General Overview

This ToR was introduced at plenary by Dave Reid (FRS, Scotland) and a background for the ToR was given. ICES is now asked to provide advice that is more holistic in nature, including information on the influence and effects of human activities on the marine ecosystem. From the fishing technology perspective this includes information on how fishermen are responding and adapting to changes in regulatory frameworks e.g. the introduction of effort control; technological creep; fleet adaptations to other issues e.g. fuel prices etc. In response to this WGFTFB initiated a ToR in 2005 to collect data and information that was appropriate for fisheries and ecosystem based advice. In 2006, the FAO-ICES WGFTFB was formally requested by the Advisory Committee on Fisheries Management (ACFM) to provide such information and to submit this to the appropriate Assessment Working Group. This type of information is becoming more and more important at both international and national levels. It demonstrates that the community of gear technologists have an important role to play in this and that our expertise is considered to be highly valued.

15.1.1 Terms of Reference

WGFTFB should explore the means by which it can best provide appropriate information for Assessment Working Groups and ACFM in fishery and ecosystem based advice. This will include the information required for fisheries based forecasts, technological creep and changes in fishing practices, implementation of regulations and other fleet adaptations, ecosystem effects of fishing and potential mitigation measures. All areas for which ICES provide stock advice are considered.

15.1.2 General Issues

The conveners issued a circular questionnaire to the appropriate WGFTFB members in EU countries as well as Norway, Iceland and the Faroe Islands during February 2007 (see Annex 7). It contained a series of questions relating to recent changes within the fleets observed and also highlighting gear/fleet/fishery related issues that are important but are not currently recognised by Assessment WG's. Where possible, contributors were requested to quantify the information provided or state how the information has been derived e.g. common knowledge, personal observations, discussions with industry etc.

Specifically FTFB members were asked to comment under the following headings:

- Fleet Dynamics
- Technology Creep
- Technical Conservation Measures
- Ecosystem Effects
- Development of New Fisheries

Responses to the questionnaire were received from:

IMR, Norway	IMARES, Netherlands
IMR, Sweden	FRS, UK-Scotland
CEFAS, UK-England	IFREMER, France
BIM, Ireland	IMR, Iceland
AZTI, Spain	FFL, Faroe Islands
ILVO, Belgium	

The conveners met in Dublin 24–26 April during the WGFTFB meeting to collate the information provided. The full information for individual ICES Expert Groups is given in Annex 8 but some of the general issues raised are summarized as follows:

Fleet Dynamics

The overall picture from the questionnaires in 2007 is that the strong signals on fuel cost and reduced days from last year are not as apparent as fleets seemed to have adapted to these. The trend now is one of many small-scale changes and initiatives, with a lot of evidence of fishermen trying out new fisheries. Specific examples of such changes in fleet dynamics include the following:

- Switch by Scottish vessels to *Nephrops* (mixed) from whitefish (mixed) trawl fisheries. This includes a small number of large vessels 1000hp+. The main reason appears to be lack of quota and restrictive days at sea in certain areas.
- Scottish seine net vessels (~75%) working more inshore waters in IVa to target small haddock and whiting. This allows more landings for days at sea.
- A gradual shift in the Dutch fleet from beam trawling for flatfish to twin-trawling and Danish seining for mixed species e.g. *Nephrops,* red mullet, gurnards.
- Shift of effort by 20% of the Northern Irish *Nephrops* fleet from VIIa to IVa (Farne Deeps) due to restrictive quotas in Area VIIa.
- Two of the largest Irish whitefish vessels have shifted effort from deepwater species in VIa and VIIb-k to the mixed demersal fisheries at Rockall (VIb). In addition 4–5 other Irish vessels have also increased effort in the Rockall fishery, moving from the mixed demersal fisheries in Areas VIIb-k.
- French vessels have switched from anchovy and tuna pelagic trawling to monkfish bottom trawling in recent years.
- Only Ireland seems to have a targeted decommissioning scheme currently in operation and in some countries, notably Sweden, numbers of vessels have actually increased.

Technology Creep

The effects of technological creep are still evident in many fisheries; with vessels becoming more efficient and targeted in their approach e.g. the use of new instrumentation on nets and in navigation have been introduced, notably for door attitude and for control of purse seines. These are believed to have given a small (10%) increase in efficiency. There is increased use of trawls with increased groundgear coverage in Scotland in *Nephrops* and whitefish fisheries using double bag trawls that give approximately 33% increases in catch efficiency. Similar trawls have been introduced into the Faeroese monkfish fishery with trawls with 50% more ground coverage. The concept of "negative" technological creep reported last year is still evident. There has been definite shift from beam trawling by Dutch and Belgium vessels to more fuel-efficient methods or alternative beam trawl riggings and particularly the use of "outrigger" trawls. An increase in the Swedish *Nephrops* creel fishery in the Eastern Skagerrak since trawling was banned in the area is also reported.

Technical Conservation Measures

In a number of fisheries there is some evidence of limited voluntary uptake of TCMs. Motives for uptake are mixed, including days at sea, national regulations, improved quality and local pressure but the overall impacts are probably still small. Specific examples include:

- In Sweden there is a steady increase of *Nephrops* grid uptake since the introduction in legislation in 2004. Approximately 75% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2006 (40% of *Nephrops* trawl landings). Approximately 50% of the *Nephrops* trawl effort (without grid) has opted to use 120mm SMP in their 90mm trawls as a consequence of extra days at sea.
- Approximately 4 UK vessels are using species selective trawls voluntarily in the Farne deeps *Nephrops* fishery; the gears used reduce discarding of haddock and whiting in excess of 50%. Improved catch quality and value.
- The UK beam trawl fleet in the southwest is now using benthic release panels. Research shows that these release about 75% of benthic invertebrates from the catches and there are indications that they also release small monkfish.
- A large number of French vessels are reported to be using square mesh panel (100mm inner opening) on the top of the rear-tapered section of the trawl, to decrease catches of juvenile hakes in *Nephrops* fishery in the Bay of Biscay. The incentive is access to fish *Nephrops* in the hake box. The use of the Square mesh panel is now mandatory to obtain a *Nephrops* license in the Bay of Biscay.
- To reduce bycatch of saithe, cod and haddock during pelagic trawling for herring, Norwegian vessels are using grids. The use of grids is now mandatory (from 2007) in some areas for small/medium sized vessels. They are being used voluntarily in other areas where bycatch of especially saithe occur.
- In the Faeroese sector it is now mandatory for pelagic trawlers targeting blue whiting to use sorting grids to reduce bycatches of cod and saithe.

Ecosystem Effects

Ghost fishing in a number of areas including the deepwater fisheries in Areas VIb and VII b,c and the Baltic remains a problem. There are also recent reports from Norway of a growing ghost net problem in the Tampen Bank Area of Area IVa. Retrieval surveys are now being carried out in these areas but the scale of the problem still remains unknown. There are also repeated claims by Irish fishermen of the widespread use of 100mm mesh gillnets for hake, which are illegal in Area VII but legal in Area VIII. Irish vessels have recovered many such nets and several vessels have been arrested.

A number of measures have been taken by Belgium and UK beam trawl fleets to reduce ecosystem impacts, through a combination of reduction in discards through the use of T90 codends; benthos bycatch from benthic release panels and reduced bottom impact from experimental roller gear, usage of outrigger trawls instead of beam trawls with chain mats. Research into low impacts gears is also reported in Norway, the Netherlands and the Faroe Islands and the motivation in many cases is due to increasing consumer and NGO demands specifically targeting trawling and beam trawling, and the development of low impact gears is likely to increase further.

There is some evidence of a reduction in cetacean bycatch in pelagic trawl fisheries through the adoption of alternative fishing tactics e.g. sinking the headline of trawls in the Albacore tuna fishery. Under the EU funded NECESSITY project, initial reports from trials carried out by IFREMER from France and St Andrews University (USTAN) in the UK with specifically designed acoustic deterrent devices fitted to pelagic trawls in the bass fishery during 2006 and Q1 of 2007 have shown some reduction in bycatch but more observations are required. There seems to be only limited compliance, however, with EU regulations regarding the use of acoustic deterrent devices in gillnet fisheries. There has been significant take up of pingers in

Sweden where the Council Regulation came into force at the beginning of the year. Manufacturers also report they have received inquiries and orders from other Baltic states – notably Estonia. However, apart from some small orders from some Spanish fishermen at the point when some vessels were being forced to return to port a year or so ago, and one or two small UK and Irish orders, there has been no significant interest from any of the other regions affected by the Council regulation.

Development of New Fisheries

As with last years report there are very few examples of new fisheries being developed given that most species are exploited to some degree, but there are several specific examples reported as follows:

- A new fishery has developed in Ireland for boarfish (*Capros aper*) during March/April 2007. This is driven by the very short fishing time now on all of the quota pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Landings may exceed 5,000 tonnes in 2007. Pipefish and lantern fish are also being considered as possible fisheries.
- Beam trawlers from the UK are targeting cuttlefish (*Sepia spp.*) in mainly the Eastern English Channel. There has been an effort shift (<5%) of the fleet (rough estimates: 10 vessels). Landings in 2004: 974 tonnes; 2005: 694 tonnes; 2006: unknown but probably more than 2005. Best catches are expected in period November – February.
- One 24m Irish whitefish vessel targeted John Dory in ICES Area VIIg during July – August 2006 using standard rockhopper trawls. The vessel was catching up to 300–400kg of Dory per tow and landing up to 3–4 tonnes for 5–7 day trips with a mixture of lemon sole, mixed flatfish, hake.
- Development of electrical fishing in SW Scotland for Razor clams (*Enis spp).*

15.1.3 Information for Individual Assessment Working Groups

Specific information relating to different areas and fisheries by Assessment Working Groups and other Expert Groups are detailed in Annex 8. Information is provided for the following WG's:

AMAWGC	WGMHSA
WGNSSK	HAWG
WGNSDS	WGNPBW
WGSSDS/WGHMM	WGECO
WGDEEP	WGMME
WGBFAS	

15.1.4 Recommendations

1) The topic group will continue to collate this information on an annual basis, based on the issues related above and subject to further revision of the questionnaire and better quantification of the information where possible.

2) WGFTFB should continue to receive feedback from the different Expert Group's and AWAWGC, to assess the usefulness of the information supplied and also target specific areas that are identified of particular importance to individual assessment WG's.

16 Ad hoc topic group on calls for a ban on trawling

16.1 General Overview

During the 2006 WGFTFB meeting, the WG recognized that collectively it is not directly addressing some of the recent scientific and public perceptions expressing concerns about bottom trawling impact on the seabed and on biodiversity. In the worst-case scenario this has led to a ban on bottom trawling in certain areas. In order to address this issue successfully, in the first instance the WG needs to define the problem areas and review the current state of knowledge and actions being taken, as well as examining the scientific basis behind the documentation in the public domain and formulating a response, where appropriate. The WG recommends that an *ad hoc* discussion group meet at the 2007 meeting to discuss "the rising frequency in the calls for global bans on bottom trawling". The goal is to identify the challenges and obstacles to quantify and then minimize negative effects of bottom trawling on the seabed and on biodiversity while permitting access to the resource. The WG recognizes that it needs input from WGECO, FAO and fishery managers, as well as NGO's and that senior level managers/Chairs from these groups should be invited to contribute to discussions. In preparing for the 2007 WGFTFB meeting, a small group of members should be selected to consider this initiative, and work by correspondence throughout the year, canvassing opinion from a variety of sources.

An introduction to the purpose and findings of the Ad hoc group and also discussions held with WGECO, earlier in April were presented at plenary by the Chair. A further meeting of this group was then held during the WGFTFB 2007 meeting and a summary of the group findings were presented back to plenary.

16.2 Individual Presentations

Philip MacMullen, SFIA, UK

Philip MacMullen gave an introductory presentation. His thesis was that WGFTFB should strongly support the creation of the Topic Group. He explained that, whilst there was a demonstrable need to protect certain habitats and species from fishing impacts, the issues were being cynically manipulated and obscured. The motives of many of the environmental NGOs were to bring about a complete ban on towed gears and to undermine the market for seafood.

In these circumstances WGFTFB had a role to play in challenging mis-information, providing balancing arguments and working with others (like WGECO) to develop clear, protocols for managing and reducing fishing impacts.

16.3 List of Participants

Dominic Rihan	BIM	Ireland
Steve Walsh	DFO	Canada
Jochen Depestele	ILVO	Belgium
Steve Eayrs	Gulf of Maine Research Inst.	US
Alain Frechet	MLI	Canada
Chris Glass	Univ. of New Hampshire	US
Svein Lokkeborg	IMR	Norway
Philip MacMullen	SFIA	UK
Barry O'Neill	FRS	UK – Scotland
Paul Winger	MI	Newfoundland
Thomas Moth-Poulson	FAO	Italy

16.4 Outcome and Recommendations

Following discussions held the following text was agreed by WGFTFB:

The conservation and sustainable use of marine ecosystems is increasingly attracting international attention as scientific information reveals the richness and vulnerability of such biodiversity. Both fisheries management and science are undoubtedly changing in the face of increasing knowledge of the marine environment and pressure from outside interests. Management measures commonly used to protect vulnerable areas and species include spatial and temporal closures, effort reduction and gear restrictions. The requirement for fishing practices to incorporate species selective devices for reduction in unwanted catches, modifications to the gear to minimize the extent of the footprint on the seabed and the elimination of destructive fishing practices is now a prerequisite. It should be remembered though; fishing consists of different gears, deployed in diverse ways for different fisheries (fishing grounds and target species) and with different fishing practices so the need for a balanced approach to assessing impacts that does not differentiate between "normal" effects of fishing practices should not be confused with "destruction." Furthermore, threats to vulnerable marine ecosystems are not specifically limited to fishing practices.

The purpose of this submission is to outline to ICES on efforts and actions taken or planned by ICES/FAO WGFTFB in dealing with the impacts of fishing gears on marine ecosystems. The ad hoc group formed at the WGFTFB meeting in 2006 by correspondence, reviewed the current situation on calls for bottom trawl bans and formulated a discussion document (see Annex 9). The group met in 2007 and concluded that there is a broader issue at stake and that WGFTFB must develop a plan to be proactive in its role in the Ecosystem Approach to Fisheries that should concentrate on environmentally responsible fishing of all gears. The group will work by correspondence to produce this submission and present it to FTC for formal adoption at the ICES Annual Science Conference, Helsinki, 2007.

This document will serve as a guiding policy for WGFTFB and will consider the following for inclusion subject to review:

- Collaboration with WGECO and other benthic and fish groups to develop a systematic approach for the identification of mitigation methods for the protection of vulnerable marine areas and species.
- Collaboration with environmental NGO's, economists, industry to inform the debate.
- Through the collaborations detailed above, the development of an integrated framework for assessing impacts, taking account of all factors including the advice of gear technologists.
- The further development of alternative gears with reduced habitat impact including an assessment of the ecosystem impacts of such gears, given that they may also have impacts not previously documented.
- Systematic advice to industry to minimize impacts through the development of protocols and codes of conducts, as well as facilitating change in the industry to adopt more benign gears where appropriate.

To move this debate forward WGFTFB and WGECO will seek to hold a joint workshop in 2008 to discuss the efficacy of Technical Measures on a wider ecological scale. (See Section 19.1.3).

17 Summary of posters and other presentations

A short open session was held on Tuesday 24 April at which the following presentations were given to plenary. A number of posters were also displayed.

17.1 Perfecting the methodology of sturgeon survey in the Northern Caspian Sea

O. Lapshin*, B. Kotenev, D.Vasilyev, G. Sudakov Abstract

Abstract

Results of the previous more than 30-year survey confirmed the weaknesses of the 9-meter otter trawl used for obtaining data for stock assessment as a standard gear. We propose to change from the 9-meter otter trawl in shallow areas of the Caspian Sea and introduce surrounding and tri-wall set gillnets. Surrounding gillnets should be use as control fishing gear on sites specified on the basis of biotope structure analysis and sturgeons' distribution. Catches of the surrounding gillnets with known catchability coefficient are a basis of catchability coefficient estimations for standard fishing gear used for stock assessment – tri-wall set gillnets.

In Russian waters of the Caspian Sea the abundance of four species of sturgeons was estimated: Great sturgeon, Russian and Persian sturgeons, and Stellate sturgeon. Because of very high level of unreported catches of sturgeons in the Caspian Sea their abundance is estimated from 1998 up until now mostly by direct methods. Starting from 2004 sturgeons' surveys are undertaken in the framework of a joint program, approved by all Caspian states for 2004–2006 and due to continue until 2009.

The data on sturgeon distributions in the Northern Caspian Sea during summer trawl surveys of 2001–2005 showed that total abundance of sturgeons in shallow zone of the Northern Caspian Sea is continuing to decline. Stocks of Great sturgeon and Stellate sturgeon are declining most rapidly. The decline of their abundance in feeding areas is due to increasing illegal catches and decreasing artificial reproduction. Rise of water temperature in the Northern Caspian Sea due to global warming in the region, observed from 1998, is also important. As a result, feeding areas have shifted to slope regions of the Caspian Sea and to the region of Ural furrow.

Analysis of the results of trawl surveys of recent years show that in conditions of rarefied concentrations of sturgeons the present grid of stations make trawls an inefficient fishing gears, especially for Stellate sturgeon and Great sturgeon. For better estimation of sturgeons' abundance it is necessary to use new survey gears and to change the methodology of the surveys. In accordance, in the Northern Caspian Sea experimental combined surveys were conducted in 2004–2006 using 9–meters otter trawl, tri-wall set gillnets, and hydro-acoustic equipment.

Results of the experiments show that sturgeon catches in traditional survey gears (otter-trawl, traditional single-wall set gillnets) were substantially lower, compared to catches of experimental survey gears (tri-wall set gillnets), not only by value but also by diversity of species. Gillnets were also found to be more effective with respect to older age groups. The results of the experimental surveys were used in frameworks of model analysis of sturgeons and showed much better consistency with other sources of information used in the stock analysis.

Discussion

The author enquired as to whether it would be possible to receive ICES endorsement for use of new methodologies for sturgeon surveys in the Northern Caspian Sea as presented and to

formulate this into an ICES Cooperative Research Report. It was felt that this should be referred back directly to the Russian national delegate to make a formal request to ICES for assistance.

17.2 Physical impact of trawl gears on benthos and habitats

B. Vincent

Abstract

The assessment of the physical impact of towed fishing gear, particularly trawls, has been carried out with an innovative method. As the usual method consists in studying the global impact of the whole fishing gear, we chose to study separately each major part of the trawl gear having an immediate potential destructive effect on the benthos: doors, sweeps, tickler chains, footrope, ground gear

We present the methods and sampling devices used at sea to study the impact of considered trawl components and the main results concerning the damages caused to the benthos species, for the considered trial areas. Then we present some technical alternative for these components, which achieve a reduction of the impact and maintain reasonable fishing efficiency.

17.3 An offshore method for estimating survival of mackerel that has been crowded in a purse seine

I. Huse

Abstract

Survival estimation of mackerel is vulnerable to the species extreme sensitivity of handling and stress. A protocol for a technique to find the mortality in offshore commercial situations where purse seines are dried up and the mackerel released after a period of severe crowding causing stress is critical for the understanding of mackerel survival. Compared to coastal catches and survival experiments, differences in sea temperature and sea state, size and condition of fish, together with gear and catch effects may give different results in the commercial offshore fishery. The method developed is based on the competence of fishermen using pen-storing of wild caught mackerel, and the experiences from earlier offshore experiments in mackerel survival. The method ensures minimal handling and confinement stress after the experimental testing; it samples all part of the catch that has been dried up, both surface and netting exposed fish, and it provides good controls for each parallel.

17.4 Technological input for catching living fish – Hake catching case for tagging

*G. Bavouzet *, H. Pontual, JP. Vacherot, M. Bertignac*

Abstract

In all European hake-tagging experiments of which we are aware (Belloc, 1935; Lucio *et al.*, 2000), the number of tagged fish and recorded recaptures have been very small, and in fact insufficient to plan a large-scale experiment with confidence. In this paper, we present the hake-tagging needs to attempt to reduce uncertainty on biological parameters (growth) and on population structure.

Catching living fish with many techniques, excepting trawling, are unsatisfactory (fish injured, scales pull out), with survival rate compromised and low number caught. As an alternative, in line with what was used by Belloc (1935), Maucorps and Lefranc (1973), and Robles *et al.* (1975), we developed a new codend for trawl gear designed to reduce stress and physical

damage during capture, according with mechanical and hydrodynamic constraints, new concept and materials used by net maker and sail maker.

Specifications target the different steps to build a new performing codend to catch living fish: the conception and the design, ½ scale model tested in Lorient flume tank and a prototype full scale at sea with a towed video system (EROC), providing real-time observations of trawl behaviour and a video system mounted on the trawl (VECOC), used to record images inside the new codend.

These experiments demonstrate the efficiency of the new concept. Four sea campaigns from 2002 to 2006 on RV Gwen-Drez facilitated the capture of 18 327 hakes, tagged and released. Systematic age overvalue is demonstrated by "sea experiments truth" shown up by tetracycline mark. These applications raise new issues regarding hake ageing and a better understanding on environmental parameters that influence otolith development.

17.5 Monitoring the use in commercial fisheries of selective codends manufactured with T90 meshes

W. Moderhak

Abstract

From the 1.01.2006 the T90 codend construction can be use legally for cod fishing in the Baltic Sea. Beginning March last year three T90 codends were distributed among fishermen from different parts of the Polish coast. The results of retention of undersized cod in T90 and Bacoma codends obtained during the fishing season will be presented. This project is financed by the EU.

17.6 Selective trawl with belly manufactured of netting with T90 meshes

W. Moderhak

Abstract

The investigation of a trawl with a belly section made of T90 netting was conducted last year on the Polish research vessel BALTICA. The initial results were presented during FTFB meeting in Izmir last year. After this, based on the initial findings a modification of the T90 gear rigging was made, adjusted accordingly to decrease drag. A reduction of 30% the resistance of the new gear allowed a corresponding decrease in the size of otter boards and ground gear weight. The study shows changes in construction of the gear when using T90 netting trawl in the belly sheet. Beside resistance (energy consumption), a selectivity investigation of two trawl gears (T90 and standard-diamond) was made during the last two cruises. The project is financed by the EU.

Discussion

The question was raised whether any experiments had been carried out with a standard diamond mesh codend with a reduced number of meshes in the codend circumference as this would have a bearing on selectivity and would be useful as a comparison. It was recommended this analysis should be carried out. The example was given of a recent Danish modelling experiment, which showed that for a diamond-mesh codend the 50% retention length (L50) is increased through a combination of turning the mesh orientation and reducing the number of meshes in the circumference. This model showed turning the mesh and reducing the meshes in the circumference of the codend had separate effects.

17.7 Localized Depletion Experiment for Bering Sea Pacific Cod

*M. E. Conners, P. Munro**

Abstract

We conducted a field experiment to determine if an intensive trawl fishery in the Bering Sea creates a localized depletion in the abundance of Pacific cod (*Gadus macrocephalus*). Localized depletion has been suggested as a mechanism by which commercial harvest could affect foraging success of endangered Steller sea lions (*Eumetopias jubatus*) in Alaska. The results of the experiment strongly indicated no difference between stations within a regulatory no-trawl zone and in an immediately adjacent trawled area. These results imply an absence of localized depletion effects at the scale of the experiment, although fishing effects may still occur at different spatial and temporal scales. Corollary studies suggest that cod in the study area were highly mobile over short time scales, violating any assumption of a closed population in the exploited area. Localized depletion is strongly dependent on assumed spatial and temporal scales. Movement of the target organism is critical in determining regional effects of fishery removals.

17.8 Selectivity of commercial and square mesh codends in the deep water trawl fishery in the Aegean Sea

A. Tokac, H.Ozbilgin, M.H. Kaykac

Abstract

A switch from diamond to square mesh codends is considered as a potential measure to reduce the capture of immature fish in the Mediterranean demersal trawl fisheries. However, data on the comparison of the selectivity of diamond and square mesh codends is rather limited when the variety of the grounds and multispecies nature of the fisheries are concerned. This study presents the results of a selectivity study where commercially used diamond and square mesh codends tested for seven marketable species in the deep waters of the Aegean Sea under an EU funded project (NECESSITY). Both the codends were made of 40 mm nominal mesh size PE material. Experiments were conducted aboard commercial trawler Niyazi Reis (26.2 m LOA, 294KW) between 1st and 15th August 2005 by using covered codend method. Selection parameters were obtained by fitting logistic equation using maximum likelihood method after stacking the data for each codend.

Fifty percent retention lengths of diamond and square mesh codends, respectively, were found as 16.03 (se. 0.41) and 19.38 (se. 0.51) mm for Norway lobster (*Nephrops norvegicus*), 14.46 (se. 0.14) and 16.24 (se. 0.14) mm for rose shrimp (*Parapenaeus longirostris*), 11.14 (se. 0.13) and 13.78 (se. 0.40) cm for hake (*Merluccius merluccius*), 13.13 (se. 0.12) and 15.12 (se. 0.33) cm for greater forkbeard (*Phycis blennoides*), 8.45 (se. 0.18) and 9.66 (se. 0.35) cm for blackbelly rosefish (*Helicolenus dactylopterus dactylopterus*) and, 10.23 (se. 0.08) and 8.89 (se. 0.09) cm for four spotted megrim (*Lepidorhombus boscii*).

Results can be summarised, as the presently used commercial codend is rather unselective. Square mesh codend improve the selectivity for two crustacean and four fusiform fish species, however, the L_{50} is significantly reduced for four-spotted megrim, the only flatfish species. Therefore, before square mesh codends applied as legislation, special attention needs to be paid on the species composition of the fishing ground.

17.9 Trawl codend mesh selectivity of 50 mm braided PE material for commercially important species in the Aegean Sea

Z. Tosunoglu, C. Aydin

Abstract

The aim of this study is to estimate the selectivity of 50 mm diamond mesh (braided PE) codend for commercially important species, deep-water rose shrimp (*Parapenaeus longirostris*), hake (*Merluccius merluccius*), horse mackerel (*Trachurus trachurus*), anglerfish (*Lophius piscatorius*) and John Dory (*Zeus faber*) in the Aegean Sea. Fishing trials were carried out on commercial trawler 'Hapuloğlu' between 9 and 12 December 2006. Data were collected by a knotless PE (*Raschel*) codend of the 1200 mesh trawl net that is used commercially by the fishermen. The mean mesh size of the codend meshes (nominal 46 mm) was measured near to 50 mm by a digital calliper. Selectivity data were collected by the covered codend method and analysed by means of a logistic equation with the Maximum Likelihood Method. The mean selectivity curves were estimated from the individual hauls was fitted taking into account the between haul variation. A total of ten successful hauls were performed. The 50% retention length and selection range of rose shrimp were estimated as 19.6 and 6.2 mm carapace length, respectively. These values were also estimated 11.4 cm and 4.1 cm for hake and 15.6 and 5.5 cm for horse mackerel. The alternative (of European Community) 50 mm diamond mesh size of braided PE for Mediterranean showed relatively better selectivity considered to the MLS of the horse mackerel and the %50 sexual maturity size of the rose shrimp, whereas it shows substantially low selectivity for hake regarding MLS and no selectivity for anglerfish and John Dory. These results showed that dimension of the body shape and behaviour of the fish species play an important role in size selectivity and it is difficult to manage multispecies fisheries based simply on mesh size regulation. For this reason, codend designs (made of this material) such as narrow codend and square mesh ensure better mesh opening in relation to fish body shape during trawling must be investigated immediately.

17.10 Characteristics of three various types longlines for swordfish (*Xiphias gladius* L.) in Datça-Bozburun Peninsula, southern Aegean Sea

O. Akyol, T. Ceyhan

Abstract

This study reports the technical characteristics of longlines for swordfish and fishing methods in three main fishing ports, where Datça, Palamutbükü and Selimiye in Datça-Bozburun Peninsula (Aegean Sea). A total of 1910 hooks and 36 km lengthways of three types of longlines from 18 longliners in the region were defined.

17.11 Size selectivity of diamond and square mesh codends for four commercial fish species in the eastern Aegean Sea

A. Lok, C. Metin, A. Tokac, H. Ozbilgin, H. Kaykac, A. Ulas, G. Metin, I. Aydin, C. Aydin, B. Gul

Abstract

Data on the comparison of the selectivity of diamond and square mesh codends is not sufficient when the geographical area and species varieties are concerned in the Mediterranean. Here we present the selectivity of diamond (DM) and square mesh codends (SM) for four marketable fish species in Izmir Bay, Eastern Aegean Sea. Trials were carried out aboard RV "Egesüf" (27 m LOA, 463HP) between 18 and 29 July 2005 by using covered codend method. Both the codends were made of 44 mm nominal mesh size PE material.

Selection parameters were obtained by fitting logistic equation using maximum likelihood method after stacking the data for each codend.

Fifty percent retention lengths (L_{50}) of diamond and square mesh codends, were found as 12.37 (se. 0.21) and 14.19 (se. 0.09) cm for red mullet (*Mullus barbatus*), 9.29 (se. 0.07) and 8.71 (se. 0.14) cm for annular sea bream (*Diplodus annularis*), 14.71 (se. 0.16) and 15.36 (se. 0.18) cm for picarel (*Spicare smaris*) and, 12.39 (se. 0.23) and 12.53 (se. 0.10) cm for common pandora (*Pagellus erythrinus*), respectively.

It can be concluded that effect of using square mesh codends instead of diamond mesh may have positive, insignificant or negative influences on selection depending on the physical and behavioural characteristics of species. Therefore, before square mesh codends can be applied as a legislation, which may be the case in Turkish waters in the very near future, special attention needs to be paid on the species composition of the fishing ground, and escape behaviour of common species in catch composition needs to be better understood.

17.12 FISHSELECT – Study of cod (*Gadus Morhua*)

L. A. Krag, B.Herrmann, R.P. Frandsen, K-J Stæhr, N. Madsen, B. Lundgren

Abstract

The cod stocks in Kattegat/Skagerrak are at a critical level. Cod is caught in most fisheries both as a target species and as unwanted bycatch. For a sustainable exploitation of a marine resource like the cod stock, a meaningful relationship between the mesh size regulation and the minimum landing size (MLS) is necessary. We use the FISHSELECT methodology to provide the cross-section data that will affect cod's ability to penetrate different mesh sizes and types. Penetration experiments are also performed testing 75 cod in 118 meshes of different size and type. Assuming that the cross-section size is compressed by 10% and can be described as an ellipse, the simulated results are in close agreement with the laboratory experiments. Finally, the cross-section data and the selected escapement model are applied to simulate the selection of cod in the mesh sizes and types used today for commercial codends in Kattegat/Skagerrak. The highest L50 obtained for cod, with the most optimal mesh opening in a 90 mm diamond mesh codend is 34.8 cm and 30.2 cm in the 70 mm square mesh codend. As the MLS for cod in Skagerrak and Kattegat is 40 cm, these preliminary results show a mis-match between regulations on mesh sizes and MLS, which potentially can lead to high discarding in the fisheries concerned.

17.13 FISHSELECT-Development of methodology

B. Herrmann, B. Lundgren, L.A. Krag, R.P. Frandsen, N. Madsen, K-J Stæhr

Abstract

A new methodology, FISHSELECT, developed to make a first prediction of the basic selective properties of different netting designs is presented. The methodology identifies species-specific morphological features that are important for mesh penetration and data on these features are processed in an integrated software tool. The methodology consists of the following steps (1–5):

1) Laboratory experiments

For selected species, morphological characteristics important for mesh penetration are identified and cross-sections at corresponding positions are assessed using a specially designed contour tool and image analysis functionality in the software tool. Different types of parametric shapes can be fitted to describe the cross sections in the form of a few parameters. Cardboard templates with pre-cut holes of a large range of different sizes and shapes are used

to imitate different mesh designs. We record if the individual fish, with optimal orientation can or cannot pass through the mesh templates.

2) Simulating experiments

A flexible simulation model that employs information on fish cross-sections and data on mesh geometry is used to simulate the penetration chances of individual fish. A scenario identical to the setup in the lab is simulated using the same fish and the same selection of mesh shapes and sizes. Repetitive simulations using different escapement models with options for degree of compression and for geometrical description of the fish cross-sections are run.

3) Comparison

The penetration results from the laboratory experiments are compared with the results from the simulated experiments. If the degree of agreement for a given set of the options described in 2) is high for the large majority of meshes and fish, the setup is accepted. This means that measured morphological features and the measuring method used are suitable for the purpose.

4) Establishment of morphological relationships

If 3) is successful, the features found to be important for mesh penetration is measured on a larger sample of fish covering a relevant length span. Hereby, a more reliable relationship between these measures and the length of fish is established and in addition, the statistical variation is quantified. The established relationships can then be applied to estimate the morphological data for a fish population of any size structure.

5) Predictions

A new series of simulations incorporate the model established in 3) and the morphological relationships established in 4) to predict basic selective properties for different netting designs. Together with information on distribution of fishing effort in a specific fishery and on length distribution in the covered areas, the predictions may indicate the consequences on discard rates and catch efficiencies of applying different netting designs in towed fishing gears. Also the effect of altering the minimum landing size can be investigated.

17.14 FISHSELECT – Study of plaice (*Pleuronectes platessa*)

Frandsen, R.P., Herrmann, B., Krag, L.A., Stæhr, K-J. Lundgren, B. and Madsen, N.

Abstract

The plaice stocks in Kattegat/Skagerrak have decreased in recent years. Plaice is caught in demersal fisheries both as target species and as bycatch and minimum landing size (MLS) in these waters is 27 cm. For a sustainable exploitation of a resource like plaice, the interactions between regulations on mesh size and MLS need to be documented and taken into account.

We use the FISHSELECT methodology to identify the morphological characteristics and corresponding cross-sections that are expected to affect the selective properties in different mesh sizes and types. Following this, laboratory experiments were conducted to test whether a given fish was able to pass through a series of meshes. Results from these experiments were used as initial input in a model that simulates the selective properties of any given mesh design.

In Kattegat/Skagerrak, mesh size regulation is 90 mm for diamond mesh codends. Until recently, a 70 mm full square mesh codend was legal as well. In this study, we investigated if there is a reasonable match between these netting designs and the MLS by estimating 50% retention length (L50) for all relevant mesh openings in a 90 mm diamond mesh and a 70mm square mesh codend. If L50 for all configurations is much smaller than MLS, the risk of

discarding is expected to be high. Conversely, if it is much larger than MLS, there is a risk of losing marketable fish. Whether these risks actually result in a high discard rate or a loss of marketable fish, depend on the size structure of the population.

Highest L50 for the 90 mm diamond mesh codend was found to be 20.5 cm, which is well below the MLS of 27 cm. Also for the 70 mm square mesh codend the highest L50 found (17.2) was well below the MLS. This indicates a mis-match between mesh size regulation and MLS that will increase the risk of a high discarding.

18 National reports

The contents of the individual National reports are NOT discussed fully by the group, and as such they **do not necessarily reflect the views of the WGFTFB**.

18.1 Belgium

Institute for Agricultural and Fisheries Research – Unit Animal, Fishery (former Agricultural Research Centre Ghent – Sea Fisheries Department)

Conatct: J. Depestele, E. Vanderperren, H. Stouten, F. Delanghe, J. Vanhee, K. Vancraeynest, B. Verschueren and H. Polet

Alternative fishing methods

A new research programme aimed at the introduction of more environmental friendly fishing methods was started in the autumn of 2004. The programme involves making an inventory of fishing methods worldwide including evaluation of their environmental impact and the introduction of impact mitigating technical modifications in existing gears. Proposals will be made to investigate complete new fishing methods in follow-up projects.

Following gears have been tested:

- **Outrigger otter trawl** for beam trawlers – used by several vessels.
- **Alternative beam trawl** (combination of roller gear, large meshes in top panel, benthos release panel and T90 codend) – used by one vessel.
- **Twin beam trawl**
- **Angling** for sea bass – used by one vessel.
- **Longlining** – used by one vessel on an experimental basis.
- **Pots** for shrimps – used by one vessel on an experimental small-scale basis.

Experiments with following gears are in preparation:

- Selective **electro-trawl** for brown shrimp with reduced bottom contact.
- **Trammel nets** as an alternative for beam trawls.
- **Pots** for whelks.
- **Pots** for lobster.

Reduction of discards and environmental stress

The following initiatives were taken to find ways to reduce the discards and environmental impact of beam trawls:

- Study of the selectivity of the T90 codend on RV as well as large-scale tests on commercial vessels.
- Study of the benthos release panel.
- Study of a square mesh tunnel in front of the codend.

Reduction of fuel consumption

Following initiatives were taken to find ways to reduce the fuel consumption of beam trawlers:

- Introduce alternative gears (outrigger).
- Roller gear for beam trawls.
- Large meshes in the top panel.

Supporting projects

In the gear section of ILVO-Fishery, a long-term strategy is being developed for the Belgian fishing fleet, which is to specialise in terms of gears and target species. To support this study and to support the gear work, the project IDEV is running with following tasks:

- Inventory of fishing gears used worldwide with a technical description and identification of environmental impact. Where possible, this will be completed with economic information.
- Development of a methodology to objectively compare the environmental impact of different fishing gears.
- Yearly interviews in the fishery sector to screen the sentiment in terms of investments, attitude towards environmental impact, attitude towards alternative fishing gears etc.
- Study of fleet dynamics.
- Study of micro worlds as a means to influence the opinions of managers and the industry.

Climate change

At the start of 2007, a project was started to investigate the consequences of climate change for the sea fisheries and to suggest ways to respond under different scenarios.

Reduction of cod bycatches in *Nephrops* beam trawls

The EU-project "*Nephrops* and CEtacean Species Selection Information and TechnologY" (NECESSITY) (Contract SSP8-CT-2003-501605) to reduce cod-bycatches in *Nephrops* beam trawls has been completed and aimed at a reduction of cod bycatches. A series of trials have been carried out on RV BELGICA and on a commercial vessel with a lowered headline, a square mesh panel in the codend, an inclined separator panel and a horizontal separator panel. The reduction of cod bycatch achieved is low.

The DEGREE project

The task of ILVO-Fishery in the EU-project DEGREE (SSP8-CT-2004-022576) is to 1) compare the cost structure of the trammel net fishery and the beam trawl fishery, both targeting the same species and 2) develop environment friendly gear alterations for the beam trawl. Both tasks are proceeding well and results are promising.

18.2 Canada

CSAR – Centre for Sustainable Aquatic Resources, Fisheries and Marine Institute of Memorial University of Newfoundland

Contact: Paul Winger

Low Profile Trawl for Northern Shrimp:

Earlier results using a multi-level trawl revealed strong variation in the vertical density distribution of shrimp in the mouth of conventional trawls used in Newfoundland and

Labrador waters. The results lead to the design and flume tank testing of a new low profile wide opening trawl design. The full-scale prototype has been constructed and will be tested this summer. Contact: Harold DeLouche (Harold.DeLouche@mi.mun.ca).

Longlining through the Ice:

Winter longlining for Greenland halibut (turbot) has been continued in the Baffin Island Region of the Canadian Artic. Gear developments and operational techniques are being refined and taught to the Inuit. Catch rates are commercially viable but developments in handling, processing, and export are still ongoing. Contact: Philip Walsh (Philip.Walsh@mi.mun.ca).

Snow Crab Pot Selectivity:

Based on the results of earlier experiments, escape mechanisms were introduced into the commercial snow crab fishery on an experimental basis in 2005, 2006, and 2007. Catch data continues to show that installing mechanisms around the bottom of the trap results in reduced numbers of under-sized crab being caught and discarded. Contact: Paul Winger (Paul.Winger@mi.mun.ca).

Seabed Friendly Shrimp Trawls:

Design and testing is currently underway on several modifications for offshore shrimp trawls to reduce their downward footprint on the seabed. Several models are being tested in the flume tank and sea trials are expected later this year. Contact: Harold DeLouche (Harold.DeLouche@mi.mun.ca).

Codpotting:

Thirty codpots of the collapsible circle 6 design have been built and prepared for distribution to harvesters later this year. The pots will be concurrently tested in three bays during the fall cod fishery and compared with traditional harvesting methods. Contact: Philip Walsh (Philip.Walsh@mi.mun.ca).

Northwest Atlantic Fisheries Centre

Contact: Stephen J. Walsh and Alain Frechet

Vessel and Gear Conversions:

Vessel and gear conversion on bottom trawl surveys aimed at groundfish and shrimp in the Northern Gulf of St. Lawrence were finalised. At sea trials were conducted in 2004 and 2005; these included parallel tows with both research vessels and gears. The intercalibration started with a comparison of tow-by-tow results, followed by a length based analysis – if warranted. The old time series was thus converted to the new trawl and vessel equivalents.

The next step was to evaluate the impact of such a change into the assessment of Northern Gulf of St. Lawrence cod. The 2006 formulation and indices used in estimating stock size were used to evaluate any impact on the perception of stock size. There were few minor changes with the use of this new index of abundance, which is used along with three others indices of abundance (sentinel mobile survey, sentinel longline catch rates and sentinel gillnet catch rates) as a basis of the calibration of the VPA. Although the new index showed more fish being caught at age, the annual trend did not change significantly. Thus the impact from the VPA was minor in terms of the estimates of population size and fishing mortality but the effect was rather found in the estimates of catchability estimates at age for the DFO survey (*i.e.* $N_{i,t} = q_i \cdot I_{i,t}$ where N = population estimate ate age $_i$ in year $_t$, q_i = catchability at age $_i$ and $I_{i,t}$ = index of abundance for age $_i$ in year $_t$). Contact: Alain Fréchet, Maurice Lamontagne Institute, Québec (frecheta@dfo-mpo.gc.ca).

Establishment of a Pre-Survey Trawl Performance Validation Test Site:

A test site was selected in Conception Bay in September 2006 where depths are typically of the average depths in the Grand Bank survey and is close to port. The test site was extensively surveyed for bottom sediment type, and depth. Bottom currents were not measured but were assumed to remain fairly stable. The survey trawl, Campelen 1800 shrimp trawl, was rigged with hydro-acoustic trawl instrumentation to measure the following parameters: door, wing, opening, and depth. Bottom contact sensors will be added in 2007. The codend was left untied. After surveying several locations and depths a test site corridor was chosen. Since that time, the site has been visited by both offshore research vessels that have fished reciprocal tows to gather further information on the variability in trawl performance as well as building a trawl performance prediction model. Once a baseline has been established from the model then the pre-survey trawl performance validation and shake down trials will be routinely carried out at the test. Contact: Stephen J. Walsh, Northwest Atlantic Fisheries Science Centre, Newfoundland (walshs@dfo-mpo.gc.ca).

Abrasive-Resistant Rope for Lobster Pot Fishery:

Highly abrasive-resistant rope is being manufactured for use in the lobster pot fishery. To date, floating polypropylene rope is commonly used between lobster pots. However, this floating rope poses a threat to whale entanglement. Previous use of sinking rope has been unsuccessful particularly in the Bay of Fundy where high tides and rocky bottom result in high abrasion of rope and loss of fishing gear in short as a few months of use. The newly designed abrasive-resistant rope sinks so as to avoid whale entanglements though it is not clear how long the rope can withstand the rocky environment. Field tests with lobster fishermen will be undertaken to evaluate its performance over the spring and fall seasons. Contact: Edward Trippel, St. Andrews Biological Station, New Brunswick (trippele@mar.dfo-mpo.gc.ca).

18.3 Denmark

DIFRES, North Sea Centre, Hirtshals, Denmark

Activities in 2006 have mainly been embedded in nationally coordinated projects, with particular focus on selectivity in commercial trawls.

A national project; SELTRA was funded by DFFE in collaboration with the Danish Fishermen's Association to further improve selectivity of bottom trawl fisheries. The project runs in 2006–2007 and gears from *Nephrops* and whitefish fisheries were investigated.

In 2006 focus was on:

1) Size selectivity of *Nephrops*. Selective properties of a 90 mm diamond mesh codend and a 70 mm square mesh codend were assessed and compared.
2) Species separation of Haddock and Cod in a raised footrope trawl. To estimate the proportion of the catch that passes under the footrope, collecting bags were mounted underneath the trawl.
3) Simulation of selectivity in the T90 codend, which is now in the legislation as an alternative to the BACOMA codend. (Herrmann, B., Priour, D., Krag, L. A., 2007: Simulation-based study of the combined effect on codend size selection of turning meshes by 90° and reducing the number of meshes in the circumference for round fish. (Fisheries Research 84: 222–232).

In 2007 several designs of species selective *Nephrops* trawls and codends will be tested in the flume tank and during sea trials. Furthermore, the properties of a T90 codend will be tested.

DIFRES participates in the EU project, DEGREE that aims at reducing the environmental impact of benthic fisheries. In 2006, pilot studies of a modified oyster dredge were carried out in collaboration with the fishing industry. Further studies on the selectivity of the dredge and

its impact on the benthos will be investigated in 2007. A qualitative investigation of the ground gear used in the Danish fisheries was also carried out.

In order to achieve a better understanding of the selectivity process determined by the relationship between fish morphology and mesh configuration, a multidisciplinary project (FISHSELECT) was initiated in 2006. It involves investigation of fish morphology, testing of different mesh shapes and sizes in relation to different fish species, and simulation of gear selectivity. Posters of the work will be available at http://www.difres.dk./

The large-scale EU project (NECESSITY starting in 2004) aimed at reducing bycatches in European *Nephrops* fisheries. As part of this project, DIFRES conducted experiments in Kattegat and Skagerrak in 2005 and data analysis was conducted in 2006. The project is reported to the commission in 2007.

For further information on our research activities please visit our home page which is located at http://www.difres.dk/dfu/dfuvis.asp?id=654

18.4 France

IFREMER

TEDs (Turtle Excluder Devices) — CHAMAD – Madagascar / Gabon

At the request of the Malagasy shrimp fish farmers and fishermen (GAPCM) the contract was prolonged now that the use of BRD is compulsory aboard their trawlers one of our technologists was sent over to Madagascar, to train the local fishermen in the installation and utilisation of these devices. Our cooperation was also requested by American scientists from NOAA to heighten the Gabonese fishermen's awareness to the use of TEDs. The cooperation should result in testing selective devices at sea, onboard boats fishing shrimps and fish. Later in the year, the technologist was involved in the workshop organized by the FAO, North Sea Centre in Hirtshals, on "Turtle Excluder Device optimal rigging and development". A model of TED was defined for the future Malagasy regulations.

Improving shrimp trawls in order to reduce fuel consumption — CHAMAD – Madagascar

Relevant studies were completed as part of the contract signed with the GAPCM. In a first step work on the optimisation of twin trawls (four trawls by boat) and single trawls (two trawls by boat) geometry by numerical modelling (DynamiT software) was completed. In spring 2006, the option chosen by the GAPCM underwent flume tank tests, then tests at sea in Madagascar. The design and the size of the doors used required further flume tank tests. Then the GAPCM suggested that twine diameter be reduced, large size windows be added in the body of the trawl and polyfoil doors be used. After numerical modelling, the new concept was tested at sea in October 2006. The tests confirmed a 20% fuel consumption reduction as per the predictions of numerical modelling with DynamiT.

Fisheries and Energy Workshop organised in Paris

The cost of energy is a major concern for the fishing industry. Ifremer, in close cooperation with the CNPMEM (French national Committee for sea fisheries and sea farming) and the DPMA (Sea Fisheries and Aquaculture Directorate), organised, a workshop dedicated to the "technical approaches in view of saving energy onboard fishing vessels" on 12 December 2006. Many technical solutions were tackled: fishing strategies, behaviour of the skippers, alternative energy, development of the fleets and fishing gears. The basis of a short-term operational programme was defined.

EU Necessity / trip Nececet pro2

Several devices for cetacean escapement along with a new generation of acoustic deterrents were tested at sea. One of the acoustic deterrents was developed in cooperation between Ifremer institute and IxTrawl Company.

While the tests on the cetacean escapement devices gave disappointing results, those conducted on the acoustic deterrents seem promising. The tests achieved under commercial fishing conditions in the course of Nececet pro2 trip and during winter 2006 and spring 2007 should confirm the good results obtained in August 2005 and September 2006 on groups of common dolphins in the Glenan Archipelago (South Brittany).

Development of a database and a web interface that gives the possibility to consult and update the trawl drafts catalogue

The tool enables to find all the drafts from the selection criteria of a given type of trawl (pelagic trawl or bottom trawl).

Single beam sounders on EROC (engin remorqué d'observation des chaluts / towed device for trawl observation)

During a trip supported by the RV "Thalassa", from 24 February to 9 March 2006, for the first time tests were achieved on the integration of an acoustic echo sounder on an EROC platform and its use onboard the vessel. The first results are most encouraging which provide much higher a resolution than the ship-borne echo sounders.

EU Premecs II

The final report submitted to the European Commission's for approval in February 2006 was accepted in May 2006.

DynamiT Modelling Software

The developments mainly concerned the integration of selective devices (as part of project Necessity), with an effort to improve the ergonomics of the software.

Selectivity studies in shrimp fisheries in French Guyana (Duhal)

Two Ifremer technologists took part in a trip onboard a commercial trawler. The object of the trip was the development of a selective device (BRD) meant to reduce bycatch in shrimp Guyanese fisheries. Several square mesh window configurations were tested. According to the results, it is possible to reduce significantly bycatch without affecting shrimp catches. A gear combining both BRD and TED will be tested in spring 2007. Such a selective fishing gear should meet the fishermen' approval. A new device comprising a concentrating window placed ahead of the TED and a new positioning of the square meshes will be tested with the fishermen. The aim is to reduce losses of shrimps and increase the escapement of fish bycatch.

EU Degree

Ifremer is involved in the development of new bottom trawls components generating no or hardly any impact on the benthic habitats (doors, footropes). These developments are based on flume tank tests, numerical modelling and tests at sea.

A list of the doors manufactured by Morgère and implemented in France was drawn up. The list provides the main characteristics of the doors, of the boats on which they were implemented, along with the size and power of these boats.

A series of tests were completed in Boulogne flume tank on door models, which enabled to measure the force exerted by the doors on the seabed in various configurations. These tests will enable to validate the numerical models that have already been developed.

Two force sensor manufacturers (FGP and SixAxes) and an acoustic sensors manufacturer specialised in fisheries technology (IxTrawl) have investigated the way to measure the force exerted in real-time by the door on the sea bed in fishing conditions. The first prototype of door impact surveillance will be tested in July 2007 onboard the R.V Gwen-Drez.

Coupled model of netting hydrodynamics and netting mechanics

The numerical model developed is based on Navier-Stockes/Brinkman equations. Several flume tank tests were conducted on a codend in our flume tank in Boulogne sur Mer. The results provided by the numerical model are satisfactory. The model reproduces especially the speed variations occurring both inside and outside of the codend model.

Technology creeping effects for Mediterranean bottom trawl fishery

Within the CAFÉ project (6th EU framework program) this study aims to examine the relationship between capacity and effort and hence fishing mortality for Mediterranean demersal trawling fishery targeting hake as case study. The difficulties are the measurements of the various technical characteristics and their evolution of the trawling on these relations. Initial works have been undertaken on the collation of data on gear and vessels characteristics, deck and propulsion equipment and tactics recorded over the last 10 years; these data will be matched with the cpue to determinate at least their relative effect on fishing efficiency.

Experimentation on Fish pot in Mediterranean Sea

With the aim to find low impact gears, the implementation of pot fishing for the French Mediterranean small-scale fleet commenced in 2005 by Ifremer. Norwegian collapsible pots have been experimented targeting fish living on the continental slope between 100 and 600 m. Several technical modifications have been tested to adapt them to the fleet characteristics (vessels less of 15 m LOA,) and fishing conditions (depth, hard bottom, current). Problems with target fish behaviour, stability of pot, choice of material type and netting colour, scavengers, competition has been encountered and must be specifically tackled in the next experiments.

18.5 Iceland

Marine Research Institute, Isafjordur, Iceland

Contact: Einar Hreinsson eihreins@hafro.is***, Haraldur Arnar Einarsson*** haraldur@hafro.is***, Ólafur Arnar Ingólfsson*** olafur@hafro.is***.***

Pelagic trawling

This is the third year with ongoing research on large pelagic trawls with the main focus on capelin and blue whiting. Escapement of capelin through various mesh sizes was the main issue in the January 2007 survey. A new trawl design was filmed and tested, and was found to solve the meshing problem. Various methods were applied, mainly filming with ROTV and using high frequency sonar. Processing of results and preparation of report is underway. Another survey will be conducted in May 2007 where the research objective is species selectivity in the blue whiting fishery, which is conducted with large pelagic trawls. Sorting grids will be filmed with ROTV and measurements of additional parameters will be made.

Size selectivity in ground fishery

Some surveys have been carried out on size selectivity of demersal trawls where various grids, BACOMA panels and codends with different mesh sizes or types have been tested. Most of

the data were collected with the twin trawl method. The focus was on cod and haddock, with all bycatch measured or counted. Most of the data has been analysed and a national report and a reviewed paper are being prepared.

Artificial bait in long-line fishery

Development of artificial bait (minced bait in paper bags) for longline fisheries for haddock and cod has been in progress for the past three years in collaborative research. The experiments have shown the artificial bait to give equal or higher catches compared to traditional bait from the same raw material. Trials will be conducted and a report written this year.

Species selective *Nephrops* trawling

Today, large amounts of juvenile fish are discarded in the Icelandic trawl fishery for *Nephrops*. A considerable proportion of landed catch in this fishery consists of demersal fish species. In 2007 we plan to conduct experiments to separate fish from *Nephrops* to retain both in separate codends. A rigid grid, similar to the Nordmøre grid used in shrimp fisheries, will be tested. If successful, improved quality of *Nephrops* and fish is expected, in addition to reduced discard of fish.

Species selective demersal trawling

Various authors have shown that by using a horizontal separator panel, separation of species like haddock, cod and flatfish has been achieved. A project on species separation in demersal trawling will be ongoing in 2007 onboard an Icelandic trawler. The horizontal panel allows for either reducing catch of some species, or using different codend mesh sizes for different species.

Effect of hook size and bait size on size selectivity in the Icelandic longline fishery

Published results from the effects of hook- and bait sizes on size selectivity of gadoid fish have been non-conclusive, probably partly due to confounding effects. To date, results from Icelandic waters are non-existing. A designed experiment to describe relative selectivity of cod and haddock for different hook- and bait sizes will be conducted in 2007. Several trips will be conducted throughout the year.

18.6 Ireland

Irish Sea Fisheries Board, (BIM)

Contact: Dominic Rihan : rihan@bim.ie

EU NECESSITY Project

The Marine Technical Section continued its work on improving the selectivity of *Nephrops* trawls as part of the EU funded NECESSITY project. During 2006 two further trials were completed following on from the work carried out in 2004 and 2005. The first trial on the Rossaveal based vessel *Roisin Bairbaire* tested an experimental trawl design with a reduced top section on the Aran prawn grounds. This experimental trawl was of the same design as tested on the Clogherhead vessel *Margaret Mary* in 2005. These trials did not prove as successful as the previous work on the *Margaret Mary*, as no significant reduction was seen in the catches of juvenile whitefish species and it is not clear whether this was due to differences in depth, areas or problems with the nets used in the trials. A further analysis of the results is being carried out. The second trials assessed the implications of increasing codend mesh size in *Nephrops* fisheries. A set of experiments was completed over a 15-day period in November on board the Rossaveal based vessel *Ceathrar Aluinn*. These trials were carried out on the

Aran grounds and selectivity data from codends of 80mm (taken as a standard codend), 90mm and 100mm, all constructed in 6mm single twine was successfully collected. From the initial analysis of the results carried out it was apparent that the 80mm codend commonly used in the fishery is unselective for fish and *Nephrops*. The results for the 90mm and 100mm codends showed slight improvements in selectivity but with a corresponding small loss in marketable *Nephrops*. Given the importance of *Nephrops* to the Irish demersal fleet further investigation of codend selectivity in other fisheries are planned in 2007 to provide more extensive data to back up the argument for a general increase in codend mesh size for *Nephrops.*

On the cetacean side of the NECESSITY project, BIM continued to work with Aquatec Subsea Ltd in the UK in developing an interactive acoustic deterrent device to reduce cetacean bycatch in pelagic trawl fisheries. A joint study by Galway and Mayo Institute of Technology (GMIT) and the Irish Whale and Dolphin Group (IWDG) tested the prototype unit constructed in 2005 in the Shannon Estuary in Ireland with wild bottlenose dolphins. Further trials were carried out off the South coast in early 2006, again with the assistance of GMIT and IWDG. These experiments aimed to test the deterrent device on common dolphins. The results indicated that the device worked in that it interacted as designed but the deterrent signal produced did not seem to scare the common dolphins to the same degree as the bottlenose dolphins encountered during the Shannon Estuary trials. Later in the year the device was further tested as part of experiments being carried out by the Danish institute DIFRES in the Mediterranean with common dolphins. The device again did not seem to deter the animals encountered to any large extent, indicating a difference in reactions to deterrent signals between different species of cetaceans. Further trials in cooperation with DIFRES are planned for early 2007 to try to overcome this problem.

EU DEGREE Project

A new EU funded research project to develop new gears/fishing techniques that have a lower impact on the seabed commenced in 2006. The project named DEGREE, involves eleven institutes from EU and Norway and will run for 3 years. BIM's main involvement will be looking at trawl doors in conjunction with SFIA in the UK and French and Italian partners. Extensive flume tank testing was carried out in conjunction with SFIA during 2006, which focused on existing trawl door designs and assessing how they can be manipulated to reduce bottom impact and drag through simple door rigging. Hew and innovative trawl door designs and footropes will be tested in 2007, with the ultimate objective to integrate all the gear modifications into one complete "green" trawling system to be tested during the final phase of the project.

Environmentally Friendly Fishing Methods

Continuing its promotion of environmentally friendly fishing methods, BIM conducted a number of gear trials in 2006.

As a follow up to the DEEPNET project that highlighted sustainability issues regarding deepwater gillnet fisheries in the NE Atlantic, technical staff from BIM with assistance from Norwegian experts completed a second extensive gill net retrieval survey on board the Killybegs vessel "*India Rose*" during August-September. The first leg, which covered Rockall, recovered some 240 nets with a total length of 12km, along with a number of deepwater crab pots and various other lengths of wire and rope. Based on this short survey it is reasonable to conclude that, even with the EU ban on gillnetting in depths over 200m, introduced in 2006, there is still a significant amount of lost nets on the Rockall slope. The second parts of the survey covered areas to the north, west and south of the Porcupine and in total 79 hauls were completed in depths of 200–1425 m, covering approximately 300 nautical miles. Only a small quantity of lost monkfish nets was recovered but in the south Porcupine Area two tied-up bales of discarded netting were retrieved. Both of these bales were identified

from their construction as illegal 100mm hake nets. The retrieval of these net bales raised two immediate issues. Firstly, it substantiates the findings of the DEEPNET report, that vessels dump nets at sea and secondly provides further evidence indicating that illegal small mesh hake nets are being used in the fishery.

Trials begun in 2005 were continued during 2006 to assess the resilience of the current commercially available acoustic deterrent devices or "pingers" and also the practicalities of using these devices in a commercial environment. Under EU Regulations, the use of acoustic cetacean deterrents or "pingers" became mandatory on bottom gillnet fisheries in certain EU waters including areas off the south and south-west coasts of Ireland from January 1 2006. The trials completed highlighted a number of serious issues and difficulties relating mainly to the reliability of the current devices. Problems with deployment were also found, although some of these problems were resolved by changes to rigging or operating practice. All of these issues were discussed with the EU at a meeting held in April. Further trials during July-September 2006 attempted to establish the effective range of "pingers". Sea trips were carried out by BIM in the commercial gillnet fishery for hake off the south and south-west. The vessels, mfv *Holly-B* and *Girl Geraldine* carried three trains of nets on board with pingers spaced at 200m, 600m and a control set of nets with no deterrent devices. Observers accompanied vessels to sea and recorded data on cetacean bycatch and pinger functionality. No harbour porpoise were caught in nets that had functioning pingers attached from 125 hauls observed, strongly indicating a larger spacing between pingers does not reduce their operational effectiveness. Similar trials carried out in the Danish North Sea hake fishery where the harbour porpoise bycatch is quite high supported these findings.

An environmental management system (EMS) puts in place a continual process of planning, implementing, reviewing and improving the actions that an organisation undertakes to manage risks and opportunities relating to the environment; food safety and quality; profitability and Public Relations. Working with Seafood Services Australia BIM begun the implementation of such a Seafood Environmental Management System (EMS) in three pilot fisheries i.e. Irish Sea *Nephrops,* South coast whitefish and North-west crab during 2006. The pilot projects began in October with the first visit by EMS facilitators from Seafood Services Australia during which initial meetings were held with the relevant co-op mangers and fishermen to introduce the concept and identify the issues within each of the fisheries that could be incorporated into the EMS. This approach seemed to be well received by the Irish industry and the pilot projects are due to continue in 2007.

The second phase in a tagging programme, which aims to collect key information on the horizontal and vertical movements of albacore tuna and contribute to the management of this potentially valuable fishery, was completed in 2006. The work was carried out as part of collaboration between BIM, the Commercial Fisheries Research Group in GMIT and Basque Institute, AZTI. A total of 153 albacore tuna were successfully tagged and released at the end of July from the Fenit vessel *Ocean Dawn* chartered specifically for the tagging experiments. As this is the first study of its kind for Atlantic albacore tuna, these initial experiments concentrated on assessing the feasibility of using electronic archival tags with albacore tuna and based on the results, a much larger study is planned.

Fuel-Efficiency

With the dramatic rise in the cost of fuel during 2006, BIM looked at a number of practical solutions to reducing fuel consumption for all types of fishing vessels. A small committee was established at the end of 2005 with representatives from the different Divisions within BIM, along with outside assistance from Engineer and Marine Surveyor Noel O'Regan of Promara Ltd. This Committee met regularly in 2006 and has looked at all aspects of the fuel debate. A Fuel Seminar was hosted at Fish Ireland, 2006 in Killybegs to examine all ways of increasing fuel efficiency including vessel design, gear modifications, operational changes or the use of

alternative gears. A number of separate initiatives commenced in 2006 including the following projects:

In April 2006 a series of fuel efficiency trials were carried out on two sister ships *Boy Jason* and *Cisemair* based in Castletownbere. Prior to testing the owners of the two vessels were also supplied with simple daily and trip logs to record fuel consumption under normal operating conditions in the periods before and after trials. Both bollard pull tests and steaming trials were carried out on both vessels, which showed by controlling pitch and rpm, fuel consumption could be reduced to generate the same steaming speed. These trials clearly demonstrated that operating at the optimum speed for the vessel's length would reduce the fuel consumption. Measurements were also taken on the *Boy Jason* before and after annual hull cleaning and a dramatic improvement in fuel consumption in the region of a 15% reduction was observed. Again this illustrates, that a simple factor such as excessive growth on the hull can significantly influence fuel consumption.

During 2006 Promara and BIM also worked on the design of a concept "Green Trawler". The "Green Trawler" potentially provides a showcase on how the industry might move forward in the face of increasing fuel costs and reducing fish quota. The vessel will be designed for swift transit to port with reduced operating costs. This concept vessel does not follow the design restrictions imposed by current rules and regulations that have developed in the EU fleet but aims to incorporate the highest levels of efficiency in terms of hull design, propulsion system and fish and gear handling. An initial desks study was completed in 2006. Following on from the design phase, which has been completed in 2006 it is then planned to construct models of the intended hull design for tank testing and the final phase of the study will be consult with a shipyard to cost the concept vessel.

A joint study involving BIM and SFIA investigating the differences between single and twin-rig trawling in terms of balancing swept area to fuel efficiency commenced with initial flume tank testing in the SFIA facility in Hull. Full scale engineering and catch comparison trials due to be carried out on the Courtmacsherry based vessel "Aaron-H" were, however, postponed due to bad weather at the end of 2006. These trials will not be carried out in early 2007.

Waste Management

Presently in Ireland there is no recovery route for the disposal of waste fishing gear, particularly monofilament gillnets, and it is well recognised that landfill sites are now over used. Recognising this, BIM along with the DCMNR and the PETLON UK recycling group initiated a project during 2006 whereby monofilament nets were collected, baled and eventually recycled into various products.

The pilot project included a technical and economic assessment to calculate all of the parameters involved; method and cost of baling, method and cost of both the tying and storage of the bales, methods of sourcing the material and information for the fishers regarding preparation requirements. A total of 70 bales were produced from the waste nets collected and this first shipment of bales was delivered to PETLON and recycled into re-usable plastic products. The successful outcome of this initiative will provide an incentive to explore other avenues of recycling for other materials that are presently disposed of by other less environmentally sustainable means; steel wire, polypropylene and polyethylene and this will be looked at in 2007, in cooperation with PETLON UK.

Onboard Processing and Packing

On foot of growing industry interest to maximise the value of landings, support was provided in 2006 for an onboard processing and packing initiative, using monkfish as a candidate species. A Spanish expert provided onboard training in Greencastle for 20 crewmembers, from eight different vessels, on processing and packaging techniques to satisfy the demands of the

Spanish market and a processing manual and training DVD was produced to assist fishermen preparing the species at sea. Following an official audit of the layout and Food Safety Management System aboard the MFV *Marliona*, the DCMNR granted the first approval number to an Irish whitefish vessel to process fish at sea. During two trips at sea, BIM provided onboard training on the processing of monkfish and the documentation procedures required for the Food Safety Management System. During these trips, a total of 700kg of processed monkfish products were packed and frozen onboard for Irish, Spanish, Scottish and Japanese markets. The response from industry to this initiative has been very positive and has confirmed that onboard processing can reduce transport costs and allow the controlled release of product when market conditions are most favourable.

Nephrops tailing machine

BIM in consultation, with COWI engineers, have completed detailed workshop trials of a prototype machine for the automatic tailing of *Nephrops*. Sea trials are planned for March 2007.

18.7 Norway

Norwegian College of Fishery Science, Tromsø.

Eduardo Grimaldo

Evaluation of the escape of fish at towing depth, during haul back and at surface

Percentages of escaping cod and haddock from three different selections systems (a conventional diamond-mesh codend, a codend fitted with exit windows and a codend fitted with a sorting grid) were investigated by using the covered codend technique. A MultiSampler was attached to the cover in order to collect escaping fish at three phases of the towing process (at depth, during the haul back and at surface). *Contact person: Eduardo Grimaldo (*mailto:eduardo.grimaldo@nfh.uit.no*)*

Testing of a two-body trawl design modified for sampling

A new version of the trawl has been tested successfully using finer twines and 80 mm mesh size, but with the same solidity as the conventional 170 mm/155 mm design. *Contact person: Roger B. Larsen (*mailto:rogerl@nfh.uit.no*)*

Small-scale longline

Further studies with the automatic longline hauler device were made on Greenland halibut and cod. The focus was documentation of improved quality and outcome on landed fish. The results are published (in Norwegian). *Contact person: Roger B. Larsen (*mailto:rogerl@nfh.uit.no*)*

Mechanized long-line

Based on the design from coastal fisheries a version of the system was tested on an auto-line vessel. Focus in the experiments were unaccounted mortality, and the new system reduced the loss of fish to minimum levels of 1% for cod, <2% for haddock and <1% for Greenland halibut. The results are published (in Norwegian). *Contact person: Roger B. Larsen (*mailto:rogerl@nfh.uit.no*)*

Zooplankton trawls

The college participated in further testing on modified designs of full-scale trawls. The fishery for *Calanus finmarchicus* is performed as a commercial operation. *Contact person: Roger B. Larsen (*mailto:rogerl@nfh.uit.no*)*

Institute of Marine Research, Bergen

Contact: Arill Engås

Fish trawl development

IMR, Bergen and SINTEF Fisheries and Aquaculture, Hirtshals have continued their work to develop a new fish trawl concept in cooperation with Norwegian trawl gear manufacturers. Catch comparisons between a standard Alfredo 5 trawl equipped with 21 "rockhopper discs as ground gear with a similar trawl equipped with 50 x 50 cm plates as ground gear documented catch increase with the novel gear of more than 25%. These experiments were conducted off Northern Norway in April 2006 onboard a commercial trawler rigged for twin trawling. In the same experiment lifting plates attached between the floatline and an extra line were successfully tested. With towing speeds exceeding 3 kn the drag of the trawl equipped with lifting plates is less than for a trawl equipped with floats with similar lifting power.

The self-spreading ground gear is the basic concept in development of a less bottom impact ground gear under development in the EU-funded DEGREE project. Recent development of this concept has included the use of roller bobbins along the plated gear, which lift the plates 5–10 cm above the bottom. The performance of this gear modified ground gear was documented with acoustic instruments and cameras in towed vehicle and attached to the trawl onboard the research vessel "G.O. Sars" in March 2007. Next step in the evaluation of this bottom "friendly" gear is comparisons of its catchability with a standard rockhopper ground gear onboard a twin trawler in October 2007. *Contact: John Willy Valdemarsen;* mailto:john.valdemarsen@imr.no

A new environmentally friendly shrimp trawl concept

IMR, Bergen in cooperation with SINTEF Fisheries and Aquaculture, Hirtshals is working on a new shrimp trawl concept aiming to reduce the drag by 25% without reduction in efficiency. Reduced bottom impact and better selective performance than existing shrimp trawls are also major objective of this trawl development project. Self spreading groundgear, large upper panel meshes and modification of the upper panel design is a key element in the new trawl concept. Mathematical simulation and model testing of new concepts are conducted. 1:2 scale model of the trawl was tested onboard a 50' trawler in September 2006. A full-scale trawl is designed and is currently under production to be tested onboard a commercial triple rig trawler in May 2007. *Contact: John Willy Valdemarsen; john.valdemarsen@imr.no*

A new demersal survey trawl

IMR is presently working on a project with the objective to develop a generic trawl design that has the potential for taking quantitative catches of fish in a survey stratum. Contact: John Willy Valdemarsen, john.willy.valdemarsen@imr.no

Development of a responsible fishery with midwater trawls for gadoids in the Barents Sea

Midwater trawling targeting gadoid fish (cod, haddock and saithe) was banned in the Barents Sea in 1979 due to high catch rates of juveniles and poor quality of fish while high catch rates. As bottom impact while bottom trawling becomes an issue of increasing concern, the research community in Norway in cooperation with the fishing industry has started a project to evaluate if modern midwater trawl techniques again can become an economical viable and sustainable trawl technique for catching codfish in the Barents Sea.

The project includes activities to study fish behaviour in the capture process combined with studies of the technical performance of pelagic trawls. In an experiment in March 2007 collecting bags attached outside the belly in various positions in front of the codend were successfully tested. In the same experiments water flow through the aft belly of the trawl was

measured and compared with the speed of the trawl through the water using two ADCP sensors. Preliminary analysis of these data indicates that the flow into the entrance of the codend (135 and 20mm) was identical to the trawl speed, which ranged from 3 to 4 knots. *Contact: Terje Jørgensen, terje.joergensen@imr.no*

Sorting grid in pelagic trawl for herring

Trawling for herring close to the coastline in fjords of Northern Norway is often associated with bycatch of cod and especially large saithe. Trials with a steel grid system in the extension piece have given good results, sorting saithe and cod. Fishing on dense shoals of herring (500 tonnes/hr) has given rise to occasionally losses of herring. The grid is mandatory for small/medium sized vessels in some areas and used voluntarily in other areas where large bycatches of saithe occurs. *Contact: Bjørnar Isaksen, bjoernar.isaksen@imr.no*

Live fish technology

Due to better landing prices, several Danish seiners have converted to earlier invented technology for fishing, transporting and delivering live cod. The cod are either stored for a short period in pens before selling to the market, or ongrowned for a couple of months. In 2006 and 2007 work has been concentrated on developing pens with flat and stretched bottom panels that can be handled on small coastal vessels. In addition, the effect on busted swim bladders in relation to fish welfare has been studied. *Contact: Bjørnar Isaksen;* mailto:bjoernar.isaksen@imr.no

Observation and gear development in seine net

New acoustic symmetry sensor has been tested and by adjusting the ropes based on information from the sensor, a more steady catch performance of the gear is obtained. *Contact: Bjørnar Isaksen;* mailto:bjoernar.isaksen@imr.no

Bycatch of King Crab in passive fishing gear

During the gillnet fishery for lumpsucker, high number of king crab are caught, creating large problems for the fishermen. In order to solve this problem, small traps were tested as an alternative gear. Traps gave low catches of king crab, but also very low catches of lumpsucker compared to gillnets. Preliminary trials were also carried out to test gillnets mounted on the top of a stiff small-meshed net. The height of the small-meshed net was 70 cm. Similar catch rates for lumpsucker between standard gillnet and the modified gillnet were obtained, while bycatches of king crab were virtually eliminated using the modified gillnet. Further large-scale experiments are planned in 2007. Contact; Dag Furevik, *furevik@imr.no*

Mortality of fish crowded and slipped in purse seine fisheries

A new offshore method to find the survival of crowded and slipped pelagic fish in purse seine fisheries was developed and tested. Fish that was captured in the purse seine were carefully transferred to large pens. The pens were 44 m in circumference with 8 m deep walls and 12 m depth at the deepest of the coned bottom. After the transfer, one pen in each pair was dried up until the fish had no regular schooling behaviour, but were going into a frenzy. After 15 minutes the pen was released and the fish was free to swim in the whole pen. In the pilot experiment, 2 parallels were tried, and in the second trial the control group had a mortality of 0.2%, what indicates that the method is applicable as presented. In September 2007, an experiment with 4 pens and 6 parallels are planned. *Contact: Irene Huse, irene.huse@imr.no*

Survival of fish escaping from trawl codends

The EU-founded project “Survival” has been completed, a collaboration between the Institute of Marine Research, Fisheries Research Services (UK), Danish Institute for Fisheries

Research and the North Sea Museum (Denmark). The project has developed sampling techniques that overcome biases in escape mortality estimation, and has shown that a large portion of the selection of fish will happen at the surface when handling a side trawl, and it is shown that the survival is lower of fish escaping at the surface than for fish escaping at the fishing depth. Repeated encounters of fish in intensively fished grounds was estimated by a new antenna for PIT-tag in the marine environment, showing that 8–9% of the fish was captured more than once in such a fishery. *Contact: Irene Huse, irene.huse@imr.no*

Behaviour of red king crab towards a commercial trawl

Bycatch of red king crab during bottom trawling in the Barents Sea is an increasing problem. Based on the pilot experiment with filming the behaviour of crab entering the trawl in 2005, an experiment with slacked ground gear was conducted in 2006. It showed that large cod escaped under the crab-rigging with slacked out ground gear. The number of crab in the catches was reduced from a mean of 15 to 10 by the crab rigging, but the variance in the data was high, and several hauls with no crabs reduced the power in the statistical testing, and the differences was not significant. Contact*: Irene Huse, irene.huse@imr.no*

SINTEF

Optimisation of bottom trawl gear with respect to energy consumption

The main objectives are to develop better methods and models for predicting the behaviour of trawl nets and associated components, making it possible to develop and use trawl equipment in a more energy efficient and environmentally sound way. One of the final results will be a computer tool for daily use during bottom trawling. In 2006 the main results were development of a new computation module for this software. In addition, experiments were performed to investigate the hydrodynamic properties of the rockhopper ground gear. *Contact: Vegar Johansen* vegar.johansen@sintef.no

Hook inspection:

Longliners may operate as much as 40,000–50,000 hooks per day. After hauling the hooks are repaired and transported to a storage room. Before repairing damaged hooks, visual inspection takes place. SINTEF has developed a prototype for automatic hook inspection based on computer vision. This system is able to determine very small deformations in the hooks. Deformed hooks will reduce the fishing efficiency. The computer vision system will give a signal to the operator if a damaged hook passes by. This will increase the fishing efficiency and reduce the workload for the crew by eliminating the need for manual inspection. *Contact: Vegar Johansen* vegar.johansen@sintef.no

18.8 Portugal

INIAP/IPIMAR

Contact: Paulo Fonseca

Development of Bycatch Reduction Devices (BRD's) for the bottom trawl crustacean fishery

Within the scope of the projects: "***Nephrops*** and **C**rustac**E**an **S**pecies **S**election **I**nformation and **T**echnolog**Y**" (**NECESSITY**) (QCAIII/6th Framework) (2004–2007); and project "*Tecnologias da pesca – Fishing Technologies". Program MARE, FEDER, QCA-III, 22-05-01-FDR-00014* (2000–2007), IPIMAR has been involved in the development of gear alterations in order to improve fisheries management in trawl fisheries. Grids sorting systems, as well as square mesh codends have been tested, on board the RV "Noruega from IPIMAR and the crustacean trawlers "Costasul", "Gemini" and "Saturno". A number of prototypes were designed for this purpose. Two of them correspond to modified versions of the

Nordmore grid: GCRUST1, designed to separate crustaceans from fish bycatch, excluding this last fraction; and GCRUST2, separating between crustaceans and bycatch into two different codends. The third one, GCRUST3, aiming at the exclusion of immature *Nephrops*, was developed at the Fish Technology Department of IPIMAR. A metal frame with a selective zone made with a square mesh netting panel was tested in three versions differing in the mesh size (55 *versus* 60mm, full mesh) or the material (one grid was made entirely in polyurethane). A 60mm mesh size square mesh codend was also tested.

GCRUST1 proved to be effective in excluding fish bycatch, particularly small pelagic species, while retaining most of the target species, *Nephrops* and rose shrimp, while the use of square mesh codends proved to be the best option to sort out immature *Nephrops*.

Between species differences in behaviour towards the sorting grids were recorded, with evidence of active escape behaviour by small pelagics. Size-dependence was also found for a number of species.

Selectivity parameters were estimated for *Nephrops* in the grids and square mesh codends tested, and selectivity models proposed using the non-linear mixed-effects approach of Millar *et al.* (2004), which allows for the inclusion of the effects of explanatory variables such as total catch weight, species catch weight and depth. Contacts: Paulo Fonseca (pfonseca@ipimar.pt) ; Aida Campos (acampos@ipimar.pt)

Estimation of the impact, in landings and in the spawning biomass, of changes in trawl gear selective characteristics

The benefits to be gained by introducing gear modifications such as the use of square mesh codends or grids with the aim to exclude immature *Nephrops* were addressed within the scope of the project **EFIMAS** – "**E**valuation Tools for **FI**sheries **MA**nagement Option**S**" Case Study 4 – *Nephrops*. Specific Targeted Research Project SSP8-CT 2003-502516. 2006–2007.

The short, medium and long-term effects, in *Nephrops* landings and in the spawning biomass, were assessed. It was demonstrated that some of these alterations, particularly the introduction of square mesh codends, could give a positive contribution for this species. Contacts: Fátima Cardador (cardador@ipimar.pt); Paulo Fonseca (pfonseca@ipimar.pt); Cristina Silva (csilva@ipimar.pt); Aida Campos (acampos@ipimar.pt)

Automating Counting of *Nephrops* using underwater video analysis

Underwater videos illustrating the behaviour of *Nephrops* and fish bycatch approaching the grid area were obtained for **GCRUST3**, by using an underwater video camera mounted on the trawl upper belly. Live footages of the fishing grounds were also obtained with the UWVC attached to the trawl headline, allowing for the observation of *Nephrops* habitats at 550 meters.

IST/IT – Technical University of Lisbon and IPIMAR have started the development of a tool for automatic detection and counting of *Nephrops*. The detection procedure follows a human visual attention model, by considering three different features: intensity map (IM), edge map (EM), and motion map (MM). Preliminary results show that the proposed methodology is able to reliably detect candidate regions after combining the partial results from each map. Contacts: Paulo Lobato Correia (plc@lx.it.pt); Lau Phooi Yee (plc@lx.it.pt); Paulo Fonseca (pfonseca@ipimar.pt); Aida Campos (acampos@ipimar.pt)

Definition of fishing trip types in the bottom trawl fisheries off the Portuguese coast

The bottom trawl fishery in Portuguese continental waters is a multispecies fishery, composed of more than 100 trawlers where a high number of commercial species (fish, crustacean and

cephalopods) are landed. The importance of the fishery as a whole process should be considered in any fisheries management scheme. However, attention has been mainly focused on biological issues when looking for regulation measures, with few attempts to study fleet dynamics and market behaviour, which can ultimately dictate the fishing activity. A line of activity has been started within the project "*Tecnologias da pesca – Fishing Technologies". Program MARE, FEDER, QCA-III, 22-05-01-FDR-00014* (2000–2008), with the characterisation of the bottom trawl fleet with the purpose of defining landing profiles (LPs), based on landings for these vessels. A number of different LPs emerged from the analysis, each defined by the relative importance of their target and bycatch species. Correspondence between some of these LPs and vessels technical characteristics allowed for the establishment of 3 main fleet components, indicating the existence of different groups of trawlers developing the same fishing pattern over time. An in-depth spatial analysis is being carried out for some of these groups, by relating data from the Portuguese Vessel Monitoring System (MONICAP) with landings within the framework of a GIS tool developed by the University of the Algarve/FCMA (Afonso-Dias *et al.*, 2004). A better understanding of the fleet dynamics is expected to results from this analysis. Contacts: Aida Campos (acampos@ipimar.pt); Paulo Fonseca (pfonseca@ipimar.pt)

Topography and experimental fishing at the Portuguese slope

Topography and experimental fishing surveys were carried out in different zones of the continental Portuguese slope, mainly between 600 and 1500 m depths, to characterise existing fishing grounds of the continental EEZ and identify potential new areas.

Systematic echo sounding was carried out for seabed morphology mapping and delimitation of new grounds suitable for deep-water fishing. Spatial interpolation methods suited to sparse and irregular data points were tested in order to obtain the most accurate seabed DTM (Digital Terrain) models and the geographic distribution of bottom features relevant to fishing. Fishing maps of the surveyed areas have been produced and a database is being implemented to properly manage all the collected data.

Fishing trials with trawls, longlines and traps prototypes were carried out at the South and Southwest slopes. Black scabbard fish (*Aphanopus carbo*) and deep-water prawns blue and red shrimp (*Aristeus antennatus*) and scarlet shrimp (*Aristaeomorpha foliacea* and *Aristaeopsis edwardsiana*) stand out as the most captured species in trawls, whereas sharks were by far the most important species in bottom longlining. Experiments using traps targeting deep-water prawns were inconclusive mainly due to the reduced number of trials carried out. Contact person: Victor Henriques (victorh@ipimar.pt)

18.9 Scotland

Fisheries Research Services, Aberdeen

Contact: Barry O'Neill, Dick Ferro, Emma Jones, Mike Breen and Dave Reid

Assessing the benthic impact of towed gears.

A Scottish Executive funded project to assess the physical, ecological and environmental impact of towed gears has begun. It is also linked to the EU funded project DEGREE that aims to develop gears of reduced impact.

Trials to develop methodologies to profile the physical impact, take core samples inside and outside of the tow path and samples of the sediment plume behind towed components were developed.

A sledge was also developed to sample the plume and analyse the particle size of sediments resuspended by towed components. Contact: Barry O'Neill (oneillb@marlab.ac.uk)

Unaccounted fishing mortality.

The EU funded project SURVIVAL was completed. A study was made of the impact that unaccounted escape mortality may have on stock assessment predictions. Contact: Mike Breen (breenm@marlab.ac.uk)

Survey gear performance.

Trials were carried out using bags on the escape of monkfish at the ground gear of the FRS monkfish survey trawl. An individual based model of monkfish herding was developed and parameterised using video observations collected previously. Calibration and assessment were carried out on two different GOV groundgears on the Rockall Bank. Contact: Dave Reid (*reidd@marlab.ac.uk*) Rob Kynoch (kynochr@marlab.ac.uk)

Serpent project.

A baited camera system is being developed as an alternative non-destructive method to survey groundfish and will be compared with trawl gears and traps. This technique will be used to assess localised changes in fish assemblages following construction of a new oil platform in the North Sea. Contact: Emma Jones (jonese@marlab.ac.uk)

Relating effort, capacity and fishing mortality

In the EU funded project CAFÉ to define capacity and effort metrics data collation and exploration has been on going. Contact: Dave Reid (reidd@marlab.ac.uk)

Vessel tracking

As part of the EU funded CEDER project a GPS based tracking system has been installed on a sample of the pelagic fleet and the data is being compared with VMS data to identify the coarsest resolution required to discriminate activity (fishing, steaming, scouting). Contact: Dave Reid (reidd@marlab.ac.uk)

Fishing gear selectivity.

Trials to estimate the whitefish and *Nephrops* selectivity of *Nephrops* trawls with square mesh panels placed in either the codend or extension were carried out on a commercial fishing vessel. The final report of the EU funded project NECESSITY is being written. Contact: Dick Ferro (ferro@marlab.ac.uk) Rob Kynoch (kynochr@marlab.ac.uk)

18.10 Spain

Azti, Sukarrieta, Spain

Contact: Esteban Puente (epuente@suk.azti.es)

Fish Aggregating Devices as Instrumented Observatories of Pelagic Ecosystems (FADIO)

EC contract QLRI-CT-2002-02773**:** The general objective of the project is to develop prototypes of new autonomous instruments (instrumented buoys and electronic tags) to create observatories of pelagic life. The project attempts to establish the first steps towards the development of new methods for providing meaningful indices of local abundance in tropical tuna stocks based on data collected by pelagic observatories deployed either singly or in networks. Nine European partners are involved in the project. AZTI has studied the fishing fleet activity in relation with fish aggregating devices (FADs), the characterisation of the fishermen experience in relation with FAD colonisation and tuna behaviour, as well as the collective pelagic fish behaviour using the technological developments of the project.

The main products of the projects were the development of a prototype of an autonomous instrumented buoy to monitor the pelagic environment, new electronic tags to monitor the trophic condition of the fish, as Ph tags, and new autonomous listening stations of acoustic tags with satellite linked communications. These new tools will allow studying fish aggregations in the pelagic environment, which have been scarcely studied due to the difficulty to access and observe them. Another important output of the project was the use of fisher's knowledge to understand fish behaviour around drifting FADs and compares it with scientific observations. This new source of knowledge on fish behaviour was identified as a powerful tool to study fish behaviour on future studies. This project was completed in 2006

Nephrops and Cetacean Species Selection Information and Technology (NECESSITY)

EC contract 501605: The overall aim of the project is to develop alternative gear modifications and fishing tactics in collaboration with the fishing industry to reduce bycatches in the relevant European *Nephrops* and pelagic fisheries without reducing significantly the catch of target species. AZTI is involved in the part of the project aiming at the minimisation of the cetacean bycatch, focusing in the VHO trawl fishery. After characterisation of the incidental bycatch of cetaceans (levels of the bycatch, operational factors associated with the bycatch, seasonality and geographical occurrence), the study has focused in 2005 on the design and testing of model dolphin escape devices in the flume tank. Taking into account previous studies of dolphin behaviour inside a trawl net, the escapement device has been designed with big diamond shaped openings in the upper part of the extension of the trawl net with overlapped small meshed netting covers, altogether with a rope barrier located at the same level of the net. In 2006, different configurations of the escapement devices have been fitted to a commercial trawl and tested in several fishing trials in the commercial fishery. Underwater cameras were used to assess the hydrodynamic performance of the net, the eventual dolphin escapement, as well as fish behaviour (target and non target species). The results of the trials showed that the escapement device designed do not affect the behaviour of target species (hake) inside the trawl net and hence do not affect the catch rate of the trawl for this species. The video footages also show that the escapement device provides an escapement opening for dolphins in the upper part of the net. Unfortunately, given the low frequency of the dolphin bycatch occurrence, no encounter of dolphins inside the net was recorded during the trials so the efficiency for dolphin escapement still needs to be proven. The project is continuing.

Design and trial of a new trawl net to reduce fuel vessel consumption in the bottom trawl fishery targeting multispecies in ICES VIIIa,b,d

Thinner and robust netting materials are available in the market for the construction of fishing net that can reduce the drag of the trawl and hence improve the energy consumption of fishing vessels. A modified design of a commercial bottom trawl net has been designed and built with the half upper part of the trawl replaced by high tenacity polyethylene netting excepted for the codend. Preliminary trials at sea have been carried out in 2006 to establish the working method for the assessment of the hydrodynamic performance of the trawl system, its catching efficiency and the level of fuel consumption of the towing vessel during fishing. The preliminary trials point out that there is room for fuel consumption optimisation in further stages of the study while keeping similar catch rates for the target species. The project is continuing.

Development of an electronic logbook for the artisanal tuna fishing fleet

In the last years, AZTI has developed and provided to the Basque tuna fishing fleet an electronic catch reporting software for on board utilisation. The aim of the project is to help fishermen to better manage the information regarding fishing activities using information from

the individual fishing operation, as well as to get detailed information on the activities of the fleet to improve the fisheries catch data base used by AZTI in fisheries monitoring and fish stock assessment. Training on the use of the software and trials of the equipment were performed in the summer tuna fishing season. As a result, several improvements on the software and the data collection were made. New trials are planned for the next summer fishing season. The long-term aim of the project is on one hand that the electronic logbook becomes a routinely used tool for fishermen, on the other hand to guarantee the collection of complementary information for fisheries monitoring on a routine basis. The project is continuing.

AZTI Remote Sensing Service

The application of satellite remote sensing in relation with temperate tuna fisheries has been studied by AZTI since the late 90's. AZTI HRPT Ground Station receives and processes data from NOAA, SEASTAR and FENGYUN satellites to obtain SST images to produce isotherms, chlorophyll 'a' concentrations and altimetric maps. By means of HF transmission and internet facilities, AZTI is providing these oceanographic event maps to the tuna fishermen during the tuna fishing season in order to minimize the time expend to locate the fishing areas where fish aggregates and hence reducing fuel consumption. This project is carried out annually.

Application of an Unmanned Aerial Vehicle (UAVs) to fisheries inspection

Fisheries inspection is a time and resources consuming activity. The use of an UAV as a complementary tool could reduce substantially the resources and improve the level of control coverage by fisheries inspectorate services in the coastal area. The main aims of the project are to adapt an UAV model equipped with digital video recording and still photograph equipment for the purpose of inspection, as well as to develop and adapt the inspection protocols considering the use of such a tool. The Fisheries Inspectorate Service is involved in the project to assess the suitability of the UAV and to contribute to the definition of new inspection protocols. A prototype of UAV was built and preliminary tested in 2006 by means of simulated inspection routine programs. As a result of the trials different technical improvements in the UAV prototype have been identified. The UAV could replace some of the fisheries inspection tasks done usually by means of fisheries patrol vessels in the coastal area (up to 50 km from the coast). It also could reduce time, fuel and human resources for fisheries inspection. The project is continuing.

Development and testing of a semi- automated rod for the tuna fishery with pole and line

The pole and line artisanal tuna fishery with live bait requires a large crew to operate manually the pole to catch tuna fish (white and red tuna). The aim of the project is to develop an automated rod prototype that can reduce substantially the manpower needed for the fishing operation. A first prototype has been designed, built and tested in the commercial fishery during the summer tuna fishing in 2005. As a result of the fishing trials with the prototype, several technical improvements have been identified and defined in terms of technical specifications. Two more improved prototypes were built in 2006. They will be tested in the commercial tuna fishery in 2007. The project is continuing.

Analysis of the acoustic spectrograms of tuna fishing vessels

Vessel noise is an important factor to be taken into account in the fishing performance of artisanal tuna fishing vessels using trolling as well as pole and line with live bait. It is necessary to minimise fish avoidance to the vessel during fishing. The study aims are: to establish a standard procedure for the measurement of noise radiated by commercial vessels using hydro-acoustic equipments; to define the noise pattern of different categories of vessels;

to define the noise characteristics that have an influence on fishing performance according to sound and vibration sensitivity of tuna fish. Different noise recording operations of commercial fishing vessels were carried out in 2006. The analysis of the sonograms recorded is in process. It is carried out in consultation with the technical workshops that usually prepare acoustically the fishing boats by studying the air radiated noise of the vessels. The aim of the study is to establish the underwater noise pattern of those mechanical deficiencies in the vessels detected by aerial noise recording. The project is continuing.

18.11 Sweden

Institute of Marine Research, Lysekil, Sweden

Contact: Daniel Valentinsson

Species selectivity in *Nephrops* trawls

The Institute of Marine Research of Swedish Board of Fisheries finished its practical work on selective gear in the *Nephrops* fisheries within the EU funded NECESSITY project and during 2006 trials were completed following on from the work carried out in 2005 on species selective Nordmore grids. The 2006 trials on the Kattegat vessel "Camo" tested a *Nephrops* grid modified by mounting horizontal bars in the lower half and normal vertical bars in the upper of the grid. Grid bar distance was 35mm. The aim of this modification was to allow catch of both *Nephrops* and sole while deflecting cod out of the trawl. The results were, however, disappointing with large losses of both *Nephrops* (25% of marketable catch) and flatfish, and this modification was not considered a viable option for the fishery in the Kattegat.

Retrieval of ghost nets

Ghost net retrieval exercises were carried out in 2006 by two groups of gillnet fishers and divers in the Baltic Sea in cooperation with the Institute of Marine Research. The work was done during the summer closure of the cod fishery and was focused on wrecks and traditional gill net grounds and resulted in some cases in large amounts of retrieved gillnets, especially from wrecks. Such retrieval exercises are to be carried out routinely in the coming years.

Species Selectivity

For 2007/2008 we aim to evaluate the feasibility to avoid cod catches with the Faroese "flexi grid" in small to medium sized pelagic herring trawls in the Kattegat. Furthermore the long-term selective properties in T90-codends will be evaluated in Baltic cod trawls.

Mitigation of seal damages and use of fishpots

The development of a successful seal-protected salmon and whitefish trap was reported to FTFB in 2006. The fish chamber has a rigid frame and double netting which separates the fish and the seal. To empty the rigid gear construction the fish camber is lifted completely out of the water using inflatable pontoons. The trap is called the "pushup" trap and is now in widespread use in both Finland and Sweden.

To avoid bycatch of undersized whitefish a selection window has been developed for the pushup trap. Efficient selection can be achieved with rigid frames mounted in each side of the fish chamber. The spacing of vertical bars in the frame determines the selection size.

Work is also ongoing to evaluate the use of pots as seal-safe alternatives to the cod gillnet fishery. Tests with floating pots of the Norwegian design are ongoing in the Baltic. The catch rate of one pot equals approximately that of a 50 meter gillnet in the same area. A comparison between squid and herring as bait showed that squid is completely inefficient in the Baltic.

18.12 The Netherlands

IMARES, Ijmuiden, Netherlands

Contact: B. van Marlen (bob.vanmarlen@wur.nl).

Release of cod from demersal trawls (EU-project RECOVERY)

This project was finished and a poster presentation made at the ICES symposium in Boston, 2006. The selection data collected allowed only in some cases analysis of selection parameters. New values were derived for the major target species for a number of gear configurations, including the standard 12m beam trawl (contact: bob.vanmarlen@wur.nl).

Reduction of cetacean bycatch in pelagic and fish bycatch in *Nephrops* fisheries EU-project NECESSITY (*Nephrops* and CEtacean Species Selection Information and TechnologY)

Nephrops

The final project meeting was held in Iraklion, Crete in March 2007. All participants are now working on the final reports, and the project will probably be finished in time and within budget. Various solutions were found to improve the size and species selection in *Nephrops* trawls. The economic implications of using these new nets and effects on various stocks and the ecosystem were analysed. This will be reported and various publications can be expected.

Cetaceans

A second trip was carried out on FRV "Walther Herwig III" in cooperation with BFAFi Hamburg, Germany in September 2006 using a tunnel barrier inside a pelagic trawl. Although dolphins were in the vicinity of the trawl, and the video recording equipment worked well technically, no footage was made of dolphin escapes, and the barrier did not avoid all bycatch of dolphins. Further observation work was done at the dolphinarium of Bruges in Belgium to find out what signals can disturb echolocation by dolphins (contact: dick.dehaan@wur.nl). Additional stomach analyses were done on bycatch dolphins and a paper presented at the ICES symposium in Boston, 2006 (contact: bram.couperus@wur.nl). The final project meeting was held in Sukarietta, Spain, in March 2007. All participants are working on finishing the final reports. The results were hopeful for acoustic deterrents and variable for excluder devices in trawls. This will be reported and various publications can be expected.

Development of fishing gears with reduced effect on the environment (EU-Project DEGREE)

The first meeting was held at IMR Bergen Norway in February 2006. Biological and physical modellers met at FRS Marine Lab Aberdeen in September 2006. The movement of simple structures on sediments can now be analysed and visualised. Possible links with the MAFCONS-model were discussed (contact: gerjan.piet@wur.nl). A start was made with tank experiments to solve additional questions raised by ICES concerning the use of electric pulses. A selection of sharks was collected during a survey and stored in a tank at IMARES. Negotiations were started with the pulse trawl producing company Verburg-Holland Ltd. to enable detailed specs of the stimulus to be received, enabling full representation of the *in situ* trawling situation during the experiments. (Contact: bob.vanmarlen@wur.nl).

National projects

Mesh size study (70, 80, 90 mm) with the beam trawling industry to investigate the potential to reduce discards (contact: floor.quirijns@wur.nl).

A number of beam trawlers are investigating towing two sets of smaller trawls from each beam in order to reduce fuel consumption, referred to as 'outrigging', similar to the work in Belgium (contact: tammo.bult@wur.nl).

A group of skippers experimented with alternative beam shapes e.g. 'fly-beam', and wheels replacing beam trawl shoes to reduce the drag of trawls in order to save fuel. Fuel savings reported are in order of magnitude of 10–15% (contact: tammo.bult@wur.nl

18.13 USA

NORTHEAST

Massachusetts Division of Marine Fisheries – Conservation Engineering Program

Contact Michael Pol (mike.pol@state.ma.us), David Chosid and Mark Szymanski

Development of a Species-selective Haddock Trawl without a Horizontal Separator Panel

A semi-pelagic sweepless raised footrope ("five-point") trawl targeting haddock *Melanogrammus aeglefinus* was initially field tested in June and July 2006; further tests took place in February and March 2007 and are ongoing. Initial results using alternate and twin trawling showed a significant 98% reduction in bycatch of Atlantic cod *Gadus morhua* without significant loss of haddock compared to a standard haddock trawl net. Subsequent testing, in collaboration with David Martins and Steve Cadrin of SMAST, compared the five-point trawl to a trawl with a separator panel over a broader geographic and temporal scale using three commercial vessels. The results from the second phase of 63 alternate tows indicate that the net geometry and stability of this net are highly variable, and testing was hampered by the lack of fish. Further work on understanding the dynamics of the net design is necessary.

Further Testing of Cod-Avoiding Trawl Net Designs

Field work was completed testing two experimental nets designed to catch flatfish while releasing Atlantic cod *Gadus morhua* through the top of the net, either with large square mesh, or by removing much of the top half of the net in December 2006. Final data analysis is underway.

The Design and Preliminary Testing of an Innovative Scallop Dredge

Limited field-testing and underwater video imaging of a hydrodynamic wheeled sea scallop *Placopecten magellanicus* dredge was conducted. Collaboration with Cliff Goudey of MIT Sea Grant CFER (more below).

International Technical Workshop on Gadoid Capture in Pots (GACAPOT)

The workshop was held on 4 November 2006 in Gloucester, Massachusetts. Fifty people attended the meeting from sixteen different countries to hear nine presentations. A workshop report will be produced in the coming months.

Experimental Haddock Demersal Longline Fishery in Coastal Massachusetts

This project, currently underway, aims to determine if haddock *Melanogrammus aeglefinus* can be selectively targeted with low bycatch of Atlantic cod *Gadus morhua* in a nearshore region off Massachusetts using demersal longline gear. Three bait types are being compared for their selectivity of haddock vs. Atlantic cod: food-grade herring, clams, Norbait®. Eight soaks of three strings with two sections of each bait type are planned.

Determining the best mesh size for gillnetting monkfish *Lophius americanus*

This project is designed to fish three different gillnet mesh sizes for monkfish (10-, 12-, 14-inch) in US Northwest Atlantic continental shelf waters to determine selectivity curves, and to measure differences in monkfish length and/or weight. Determining selectivity curves is essential for proper management of the fishery; also the use of 12-inch and larger mesh sizes may result in greater profits than 10-inch mesh, assisting conservation of monkfish and benefiting fishermen at the same time. These particular sizes of mesh were chosen because 10-inch is the current minimum, 12 inch is the most widely used size currently fished and 14-inch the next logical size increment to test.

University of New Hampshire

Contact: Pingguo He (pingguo.he@unh.edu)

Two projects to separate haddock from other groundfish species were funded. The rope separator haddock trawl has been completed with promising results for reducing cod catch and maintaining haddock catch. For a period of alternating tows when commercial catch rates were obtained, cod reduction was about 61% while haddock reduction was 16%. Catch of flounders, skates, dogfish and other demersal species were almost completely eliminated. The raised footrope haddock trawl project is still under way, but showed promising results with a few tows completed. An international haddock symposium with collaborative partners is being planned for 25–26 October 2007 in Portsmouth, New Hampshire, USA. For more information please visit the symposium website: http://www.seagrant.unh.edu/haddock.html.

A topless shrimp trawl to reduce pelagic species bycatch has initiated with sea trials continuing. The results indicted that around 90% reductions in Atlantic herring bycatch without loss of shrimp catch during a period when there were abundant herring mixed with shrimps. Another shrimp trawl project to modify the Nordmøre grid was also nearing completion. Three designs of modified grid systems were tested. A size-sorting grid installed in front of the main Nordmøre grid was able to reduce small shrimps by 30 to 40 count/kg when the shrimps caught by a net with a regular grid were about 130 to 160 count/kg. A combined rope grid and size-sorting grid was able to reduce both small shrimps and finfish bycatches. Fishermen have started using some of the grid designs on commercial basis and have provided very positive feedback.

A project to reduce small monkfish in a monkfish trawl is being planned. Sea trials will be conducted this summer. The design incorporates various grid designs to separate the fish by sizes. A project to design and test a wheeled groundgear to reduce seabed impact in the whiting fishery is being planned with initial test on a beach and further tested in the sea.

University of Rhode Island – Rhode Island Sea Grant

Contact: Kathleen Castro, David Beutel, Laura Skrobe (lskrobe@uri.edu), and Barbara Somers

OUTREACH: Sand County Dedicated Access Pilot Program

This project is a regional program working with the New England Fishery Management Council (NEFMC) to hold workshops with presentations on the legal issues of dedicated access. The proceedings of the workshops would then form the basis for a workbook on how to proceed, which would be applicable throughout the Northeast. Over time this program has changed from one with a local focus to a regional effort.

Regional Bycatch Assessment Team

The National Marine Fisheries Service established Regional and National Bycatch Assessment Teams (NBAT and RBATS) to develop bycatch reduction implementation plans and URI-RISG is a member of the Northeast (NE) Regional Bycatch Team. In 2006, a Northeast Region Workshop was held on creating a guide to Developing a Cooperative Research Project

and Proposal. RISG contributed to that guide by writing chapters and editing, and provided photos that were used throughout the guide. The guide is available on line at: http://www.nero.noaa.gov/StateFedOff/coopresearch/guidelines/

Northeast Regional Gear Conservation Engineering Working Group

Since 2004, URI-RISG has been the organizing unit for developing a Gear Conservation Engineering Group. The group was established through funding from the NMFS Saltonstall-Kennedy program and has continued with support from the Northeast Consortium. Past educational workshops were on gear selectivity and catch comparison, and most recently in the summer of 2006 a discard mortality workshop was conducted. A website was developed: http://seagrant.gso.uri.edu/reg_fish/gear/index.html that explains bycatch, issues surrounding different gear types, solutions, experts, references, links to other groups, and events, and the newest inclusion is a searchable Research Projects Database consisting of the projects in the northeast.

Capturing the Data

URI-RISG has been working on a 5-year project to capture fishermen's observation through a variety of avenues. Most recently, a RISG Request for Proposals (RFP) was released with a special section for funding fisheries collaborative mini-grants. To get things started, a meet and greet workshop was held with a goal of opening up discussions and getting collaborative research ideas flowing that investigate the changes that have occurred in the fisheries, the fishing communities or the habitat and/or fish themselves. This forum allowed for introductions that resulted in collaboration between fishermen, commercial and recreational, and faculty and staff from various universities. A total of 45 people attended and approximately half were academics/researchers and the other half was fishermen/other. A total of 12 pre-proposals were submitted to the RFP and ideas for future projects and collaborations have been discussed.

RESEARCH: Bycatch Reduction in the Directed Haddock Bottom Trawl Fishery

The effects of employing a large mesh faced (top, bottom, and side wings) bottom trawl designed to capture haddock while reducing the bycatch of cod as well as other species was investigated. This experimental net, named the "Eliminator Trawl," exploits the differences in fish behaviour. Two vessels, F/V Iron Horse and F/V Sea Breeze, conducted side-by-side comparison hauls with one vessel towing the control net (currently regulated specifications) and the other towing the experimental net. A total of 100 successful tows were completed. All species captured were weighed for total weight. Haddock, cod, and the majority of the flounders caught were measured. The "Eliminator Trawl" significantly reduced the catch of stocks of concern including Georges Bank (GB) cod, GB yellowtail flounder, GB winter flounder, witch flounder, and American plaice. Other species such as monkfish and skate also showed significant decrease in catch in the experimental net. In addition, the catch of GB haddock, the target species, did not differ significantly between nets. The results of this study indicate that the "Eliminator Trawl" would be an efficient tool in the B Days-at-Sea Program as well as a Special Access Program as it appears to meet the minimum bycatch requirements to be considered for both these programs.

Fishery Independent Scup Survey of Eight Selected Hard Bottom Areas in Southern New England Waters

Funding was obtained through the Mid-Atlantic Research Set-Aside in 2004, 2005, 2006, and 2007. The project is designed to collect scup from ten separate hard bottom sites in Southern New England, which are un-sampled by current state and federal finfish trawl surveys. Two commercial vessels are conducting the fieldwork and the University of Rhode Island – Rhode Island Sea Grant is leading the data analysis and report preparation. Staff from the RI

Department of Environmental Management – Division of Fish and Wildlife (RIDEM – DFW) and the Massachusetts Division of Marine Fisheries are collaborating on the project. The National Marine Fisheries Service (NMFS) and the RIDEM – DFW, will statistically compare the age distributions of the catch to each of the other collection sites, to finfish trawl data collected.

MIT Sea Grant College Program Center for Fisheries Engineering Research (CFER)

Contact: Cliff Goudey (cgoudey@mit.edu)

Reduced Impact Scallop Dredge

A new scallop dredge design has been developed and tested that eliminates the normal cutting bar, using hydrodynamics to encourage the lifting and capture of scallops. The design was developed after tow tank testing the effectiveness of various hydrodynamic devices at raising scallops off the bottom. A prototype 7-foot dredge was constructed and observed *in-situ* and evaluated in fishing trials. Preliminary results of the research were reported at ICES 2006 in Boston. Follow-on research is planned in collaboration with the Dept. of Agriculture Fisheries and Forestry in the U.K. The CFER prototype dredge has been shipped to Dr. Sam Shephard of the School of Ocean Sciences University of Wales – Bangor for testing in a scallop fishery based out of Douglas on the Isle of Man. Tests are scheduled for the week of April 23. The habitat-friendly approach will also be evaluated in The Netherlands in collaboration with Machinefabriek TCD/Visserijcoöperatie Urk and IMARES. A four-meter Holland beam trawl is being fitted with wheels and the hydrodynamic devices to evaluate their effectiveness on flatfish.

Acoustic control of trawl door altitude

Trawl doors are known to be the greatest single source of benthic disturbance of the trawl system, yet in many fisheries their contact with the seabed in not crucial to catch efficiency. A method is under development that will control the height of the trawl door based on height measurement of a door-mounted sonar. Based on a setting established before the tow, the doors will descend to a specified height and then "terrain follow." The technology will allow the exploitation of certain demersal species such as haddock by vessels without the complexity of acoustic-link sensors and an auto-trawl system. Tank tests of half-scale models are scheduled in late April at the St. John's flume tank. Sea trials on a commercial vessel will occur later in the year.

Whale-safe fishing gear

CFER continues its efforts to introduce the Whale-Safe Buoy into fixed gear fisheries to reduce the entanglements of marine mammals and endangered species and the loss of gear from buoy-line weak links. By including a stem beneath the buoy with gradual taper and stiffness, the gear is readily shed at low tension in the line, discouraging an encounter from progressing into an entanglement.

NOAA Fisheries Northeast Fisheries Science Center – Protected Species Branch

Contact: Henry Milliken (henry.milliken@noaa.gov) and Heather Haas

Cetacean Bycatch reduction

A Workshop was held in December 2005 in Atlantic City, New Jersey to obtain industry input on reducing cetacean bycatch in trawl fisheries. Over fifteen Industry participants attended the workshop. Four video systems were purchased and tested and successfully used aboard commercial mackerel and herring vessels to assess the effectiveness of openings in the mesh at retaining the targeted species. Efforts are underway to coordinate experiments with

commercial fishermen for the winter, spring and summer of 2007 for the trawl fisheries to evaluate alternative methods to reduce cetacean bycatch in trawl fisheries.

Turtle Bycatch in Trawls

A workshop on sea turtle trawl bycatch in trawl fisheries was held in January 2007 in Ocean City, Maryland and feedback was received concerning possible bycatch reduction technologies that could be tested in this fishery. A study of the mid-Atlantic scallop trawl fishery during the summer of 2006 was conducted on mitigating sea turtle bycatch with turtle-excluder devices (TEDs). Twenty-eight days of paired comparisons on one vessel between a TED equipped trawl and a standard trawl were conducted and we collected clear underwater video data of scallops entering the trawl and passing through the TED at depth to 35 fathoms. Efforts are underway to coordinate experiments with commercial trawl fishermen for the winter, spring and summer of 2007. The goals of these experiments are to evaluate alternative methods to reduce sea turtle bycatch in trawl fisheries. These efforts are based on input received from the workshop held in Ocean City.

Turtle Bycatch in Crab and Whelk Pot

A total of 1,659 whelk and crab pots were scanned using 900 MHz side scan sonar in the lower Chesapeake Bay, Virginia. During the study, several sonar targets were investigated, but no sea turtles (and no marine mammals) were found entangled in any of the pot gear. Side scan sonar equipment in combination with qualified technicians and vessel captains can reliably monitor pot fisheries (within specific environmental conditions). Although the technology appears adequate for sub-surface monitoring, the interaction rate between turtles and pot gear is likely too low to justify additional work in the same conditions. A final report of this work was generated.

Scallop (*Placopecten magellanicus*) dredge fishery

In collaboration with the sea scallop industry, Virginia Institute of Marine Science and the NMFS Southeast Fisheries Science Center, we conducted five days of testing of a modified dredge designed to force turtles over the top of the dredge as compared to under the dredge. This work was completed in Panama City, Florida and all trials were videotaped. A final report for this work is being compiled and should be available before April 2007. Three experimental dredges are being used by the Industry to assess the effects of the new dredge design on the catch of scallops and finfish bycatch. Preliminary data suggest modest scallop loss while there have been substantial reductions in the catch of several finfish species. A contract is in place to collect 155 days of comparative catch data on commercial scallop vessels using the modified and standard dredge. At this time, because the fishing effort was not located in areas of historical sea turtle bycatch, we have extended the contract through 2007. In 2007 the Elephant Trunk closed areas will be opened, which may be an area with scallop resource and sea turtles resident while fishing effort is occurring. This co-occurrence may help us assess the effectiveness of our modified dredge design.

We completed two video cruises to attain behavioural information of sea turtles and their interactions with scallop dredges. We have attained over 80 hours of footage but have not been able to video a sea turtle interaction.

Survival of Sub-legal Atlantic Cod in the Northwest Atlantic Longline Fishery

This study was a cooperative effort between fishermen and scientists using standard commercial fishing practices. 3,764 sub-legal cod were assessed for survival at three different depth ranges and four sea surface temperature ranges. Survival, assessed after holding the fish in cages for a minimum of 72 hours, ranged from 30.8% to 100%. Binomial logistical regression analysis indicated that depth, sea surface temperature, and de-hooking technique all

affected survival. Depth and temperature affected survival more than the de-hooking technique. Survival improved as depth and sea surface temperatures decreased. Unsnubbed fish had less mortality compared to snubbed fish. A Final Report for this work is on-line at http://www.northeastconsortium.org/projects.shtml.

NOAA/UMASS Cooperative Marine Education and Research Program, School for Marine Science and Technology

The Performance of a Haddock-Separator Trawl on Georges Bank

A field experiment was designed to examine the feasibility of using a net panel or "haddock separator" placed inside a trawl to reduce the bycatch of cod in the Georges Bank haddock fishery. The expected behavioural pattern of the two species, in which haddock rise when encountering the separator panel and cod swim down, was examined using video technology. The field results showed a significantly reduced cod-to-haddock ratio (11%) in the experimental trawl compared to the control net (43%). However, there was also a concurrent 42% reduction in the catch of haddock in the separator trawl, which represents an important economic loss, and is an industry concern.

In situ video observations of fish behaviour were used to evaluate behavioural response of fish to trawls with separator panels. The reaction of each fish was observed and recorded based upon: swimming speed, swimming direction, general behaviour and spatial reference. Haddock and cod exhibited different swimming direction, with haddock actively swimming upward and cod moving downward, suggesting that the panel effectively separates cod and haddock. A better understanding of these behaviours could improve current selective fishing gear and further reduce the amount of bycatch in today's fisheries. Contact: David Martins (dmartins@umassd.edu), Adam Barkley, Sally Roman and Steve Cadrin.

Improved bycatch information from an electronic study fleet

More accurate and precise estimates of fishery discards, fishing effort and catch rates are essential for managing sustainable fisheries and monitoring rebuilding programs. The SMAST study-fleet project was established in 2000 as a partnership between commercial trawl fishermen in New Bedford, the University of Massachusetts and NOAA for the collection of catch and fishing effort information and environmental data. The program is transitioning to an electronic data collection system in which vessels are being equipped with electronic scales, net mensuration technology, temperature sensors and computers that integrate each vessel's positioning system with an electronic logbook. Improvements in monitoring are illustrated by the use of bottom temperature to identify bycatch hot spots, and by tow-by-tow information on trawl behaviour and fishing effort. Applying advanced technology improves the efficiency of catch monitoring and facilitates rapid transfer of data to fishery scientists and managers. Contact: David Martins (dmartins@umassd.edu), Sally Roman, Crista Bank, Steve Searcy and Steve Cadrin.

Gulf of Maine Research Institute

Testing Raised-Webbing Gillnets to Reduce Bycatch of Cod While Targeting Pollock

"Norsel" mounted gillnets were constructed with webbing that begins at 48 inches off the seafloor in an attempt to increase the ratio of pollock (*Pollachius virens*) to Atlantic cod *(Gadus morhua)*. During six days of sea trials conducted in January and February 2007, catch was dominated by spiny dogfish (*Squalus acanthias*) with disappointingly low catches of pollock. Comparisons between the norsel mounted nets and control nets of identical mesh size; length; and height indicate the norsel mounted nets have lower catch rates for all species. Notably cod catches are decreased by 54% and pollock catches are decreased by 78%. Extremely low sample sizes limit the utility of the data collected so far. More trials are

planned for June 2007 when pollock are likely to be more numerous. A collaboration with Massachusetts Division of Marine Fisheries. Contact: Shale Rosen (srosen@gmri.org), Catherine Salerno (csalerno@gmri.org), Steve Eayrs (seayrs@gmri.org)

ADM Associates, Magnolia, Massachusetts

Evaluation of Hook Size and Shape in the Catch of Sub-legal Cod and Haddock in the Recreational Fishery

A 54 ft commercial charter vessel operating out of Gloucester, Massachusetts was hired for 30 one-day trips and recreational fishermen were invited to participate free of charge providing they agreed to use one of four specified hooks. These included #6 and #8 "J" hooks and #10 and #12 circle hooks. A biologist was aboard to record the catch of legal and sub-legal cod and haddock (and other species). All fish were measured and the numbers of gut-hooked and lip-hooked individuals were recorded. Sub-legal fish were returned overboard with notes made regarding any possible damage.

Objectives were to: provide information (to management) about the catch of sub-legal cod and haddock with the gear typically used in the recreational (charter boat) fishery in the northeast region; determine the relative catch of sub-legal cod and haddock with normal and oversize hooks; determine the relative catch of sub-legal cod and haddock with "J" hooks versus circle hooks; estimate the relative damage (possible mortality) to sub-legal cod and haddock with normal versus oversize "J" hooks and circle hooks; provide 600 educational contact days to recreational fishermen; determine whether use of charter fishing vessels is an appropriate way to conduct cooperative research. Contact: Allan D Michael (amichael41@comcast.net) and Sharon Fleming

NORTHWEST

NOAA Fisheries Alaska Fisheries Science Center & Fisheries Behavioural Ecology Program, Newport, Oregon, USA

Bycatch-Related Gear Research

Behavioural impairment and mortality in fish escapees and discards from fishing operations may be predicted directly from measurements of reflex actions (Davis and Ottmar, 2006; Davis, in press). A major advantage of this technique is that routine long-term holding of fish in cages or tagging and recapture are not needed for determination of mortality. Reflex impairment in walleye pollock, sablefish, coho salmon, northern rock sole, and Pacific halibut was significantly related to delayed and total mortality in biphasic relationships described by sigmoid curves. These relationships are termed RAMP (reflex action mortality predictors). RAMP initially increased without concomitant mortality, and then continued to increase as mortality appeared and increased. The essence of the approach is to find ways to stimulate reflex actions consistently in control fish and then measure reflex impairment in stressed fish. Reflex impairment can be observed after capture or escape in either free swimming fish or restrained fish. For free swimming fish, impairment of orientation, position, and startle responses to visual and sound stimuli can be observed and recorded in sea cages or tanks on board ships. For restrained fish, impairment of body flex, operculum closure, mouth closure, gag response, and vestibular-ocular response can be observed. Other reflex responses may also be present in species of interest. Measurement of reflex impairment may be a powerful tool for expanding the scope and replication of fishing experiments in the field and for comparing bycatch mortality among various fishing practices and fisheries. RAMP may also be used in any context in which rapid assessment of fish welfare is needed, e.g. aquaculture, fish transport, and stock enhancement, holding for experimentation. The RAMP method is being expanded to crab and other invertebrate bycatch species in future research. Contact: Michael W. Davis (michael.w.davis@noaa.gov)

Herding behaviour of flatfish: comparison of 'on-bottom' vs 'off-bottom' sweeps

Trawls are inherently behavioural devices, harnessing fish avoidance behaviour to facilitate capture. A case in point is the flatfish trawl, which utilizes extremely long bridles between the trawl doors and the wings of the net. Commonly referred to as sweeps, this gear herds fish into the path of the net. With growing concern over seafloor habitat destruction, the AFSC RACE program has begun investigating the use of sweeps which ride several inches above the sediment surface, minimizing the disturbance of benthic macro invertebrates and other emergent structures which constitute fish habitat, while also minimizing loss of catch (contact: craig.rose@noaa.gov). In support of this effort, laboratory experiments are being conducted to examine the initial phases of flatfish herding and how this is influenced by sweep height off the bottom. Importantly, prior research has demonstrated that ambient illumination influences whether or not flatfish initiate herding in response to disturbance by trawl ground-gear. Thus, experiments are being conducted under both well-illuminated conditions, where visual processes control behaviour relative to trawl gear, as well as in the dark, where non-visual processes will be dominant. The results of this work will assist in evaluating the merits of such experimental gear**.** Contact: Clifford Ryer (cliff.ryer@noaa.gov), Paul Iseri (paul.iseri@noaa.gov), Craig Rose (craig.rose@noaa.gov**).**

Evaluating the role of fish behaviour in surveys conducted with underwater vehicles

Use of underwater vehicles including submersibles, ROVs and towed camera systems to assess the abundance and distribution of fishes has increased rapidly over the last several decades, particularly in deep water and in structurally complex seafloor habitats where surveys with traditional sampling gear are unsatisfactory. It is often assumed that visual survey data provide more accurate information on density and distribution than sampling with conventional extractive gear. However, a review of observations reported for 46 demersal marine fish taxa showed that almost all of the fishes respond in some way to the vehicles under certain circumstances. The responses are context specific, depending upon operational variables including vehicle type, speed, light and sound levels. Some fishes are affected indirectly, by attraction to sediment disturbance and prey species gathered in artificial lights. Whether or not movements or changes in behaviour affect survey bias is more difficult to assess. A simple conceptual model is presented to evaluate relationships between stimulus intensity, distances from the vehicle where reactions occur, and survey bias. Largest bias is caused by attraction or avoidance that occurs outside the field of view provided by cameras or observers. While light level and vehicle speed have been explored experimentally in a few cases, much remains to be learned about how reactions and biases vary among species and age classes, among different vehicles, and under different operating conditions. Given the poor understanding of survey bias, we recommend that surveys be conducted using methods that minimize variation in vehicle operation and that vehicle time is devoted specifically to manipulations of operating conditions to evaluate bias quantitatively. There is no good substitute for direct observations on fish behaviour, distribution and abundance; and survey design and accuracy can be improved through experimentation. Contact: Allan Stoner (al.stoner@noaa.gov), Clifford H. Ryer (cliff.ryer@noaa.gov), Steve Parker (steve.parker@oregonstate.edu), Peter Auster (peter.auster@uconn.edu), Waldo Wakefield (waldo.wakefield@noaa.gov).

Observations on Hooking Behaviour in Pacific Halibut and Pacific Cod

Recent laboratory experiments on feeding behaviour in Pacific halibut and sablefish indicate that catchability on longlines is likely to vary with temperature, light level, fish density, and other environmental variables. Field observations are now being made with an in situ camera system in Kodiak to determine the effects of current velocity and direction, light level, and

social context on bait attacks and hooking in Pacific halibut and Pacific cod. Contact: Allan Stoner (al.stoner@noaa.gov).

NOAA Fisheries Alaska Fisheries Science Center Conservation Engineering Project, Seattle, WA

The Conservation Engineering project of the Alaska Fisheries Science Center, NMFS has pursued three principal development studies in the last year. These included:

- Continued improvement and testing of salmon excluders for the pollock fishery,
- Modifications of halibut excluders for Gulf of Alaska cod trawlers, and
- Reducing effects of trawl sweeps and bridles on soft-bottom habitats.

The salmon excluder effort continues from earlier efforts that achieved moderate exclusion rates for chinook salmon (30–45%) with minimal <2% pollock escape, but have had problems with clogging at high catch rates of pollock or jellyfish. To reduce those problems, excluders that allow escape only during haul back (or periodic slow towing) were tested in March.

The principal obstacle for the Gulf of Alaska halibut excluders has been the necessity of hauling them onto net reels, precluding rigid structures. The excluders are based on providing a long (10 m) section just ahead of the codend with side panels composed of rectangular slots that allow all but the largest halibut through, but are too narrow for most cod. Using relatively stiff, plastic–coated cables has greatly improved durability and catch comparisons in April 2007 are testing whether they achieve the desired selectivity.

Sweep modifications to reduce seafloor effects have been based on installing small (20 cm) bobbins at wide (10 m) intervals to create space between the sweeps and bridles and the seafloor. Pilot tests in 2006 and full scale testing 2006 indicated that flatfish catch rates were not significantly affected and that damage to sessile invertebrates was reduced. This work is limited to soft (sand/mud mixtures) habitats, with no fixed substrates that would allow higher profile, rigid living structures.

Each of these projects will be continued in 2007. We also will initiate a project estimating damage and mortality to crabs that encounter trawls, but are not retained in the net. Contact: Craig Rose (*:craig.rose@noaa.gov*)

Oregon Department of Fish and Wildlife Marine Resources Program

Behaviour of nine species of Pacific rockfish after hook and line capture, recompression and release

We evaluated the effect of barotrauma on the behaviour of 9 species of Pacific rockfish after hook and line capture and release, using a video-equipped underwater release cage. Behavioural impairment from barotrauma was depth-related, but highly species-specific. Increased depth of capture was associated with lower behavioural scores for black rockfish (*Sebastes melanops*), blue rockfish (*S. mystinus*) and yelloweye rockfish (*S. ruberrimus*) but not for canary rockfish (*S. pinniger*). Behaviourally impaired fish showed a decreased ability to maintain vertical orientation and were slower in exiting the release cage. Species differed in the degree of behavioural impairment from barotrauma and in how rapidly behavioural impairment increased with depth of capture. When captured at depths between 40 and 99 m, blue rockfish showed the most serious behavioural impairment, with eight of eighteen (44%) failing to swim away at release and simply drifting off in a sideways or upside-down posture. In the same depth range, all of the other species sampled showed only moderate behavioural impairment, indicative of some potential for survival after fishery discard. Surface observations of the external signs of barotrauma were variable between species and were poor indicators of which species would show behavioural impairment upon release at depth. Within individual species however, the external signs of barotrauma were associated with an

increased probability of behavioural impairment at release. Contact: Bob Hannah (Bob.w.hannah@state.or.us), Keith Matteson.

The effect of depth of capture on submergence success of surface-released Pacific rockfish

We evaluated the effect of depth of capture and size on the ability of Pacific rockfish to return to depth following hook and line capture and surface-release. Submergence success was above 80% for all rockfish captured in depths less than 30 m. Yellowtail rockfish (N=51, *Sebastes flavidus*) were 100% successful at submerging in less than 49 s at all depths sampled (10–51 m). At capture depths of 40–51 m, submergence success was 89% for quillback rockfish (N= 9, *S. maliger*), 65% for black rockfish (N=46, *S. melanops*), and 30% for canary rockfish (N=40, *S. pinniger*). At depths of 30–51 m, submergence success was 32% for blue rockfish (N=31, *S. mystinus*). The external signs of barotrauma (e.g. exopthalmia, eversion of the esophagus) increased with depth of capture, and were least prevalent in yellowtail rockfish and quillback rockfish. The presence of severe esophageal eversion (beyond the buccal cavity) was strongly negatively associated with submergence success for several species ($P<0.01$). Logistic regression showed a negative relationship between depth of capture and submergence success for black rockfish ($P<0.001$), blue rockfish ($P<0.001$) and canary rockfish ($P<0.05$). Increased body length negatively influenced submergence success only in blue rockfish ($P<0.05$). A synthesis of data on submergence success with studies of behavioural impairment of rockfish released at depth suggests that the ability to submerge may be a particularly poor proxy for short-term discard survival in blue rockfish. Contact: Bob Hannah (Bob.w.hannah@state.or.us), Steve Parker (Steve.parker@Oregonstate.edu), Keith Matteson.

Reducing bycatch in hook-and-line groundfish fisheries: evaluation of the effect of increased bait height above bottom on the catch of demersal rockfishes (*Sebastes*)

We studied how increasing the height of angled baits above the bottom using long leaders (3.0 and 4.6 m) inserted between the lowermost bait and the terminal weight (long leader gear) altered the species and size composition of the catch off the Oregon coast. Specifically, we examined if long leader gear would reduce the bycatch of demersal rockfishes, particularly yelloweye rockfish (*Sebastes ruberrimus*). Long leader gear was easily handled by fishers and reduced catch rates of large (>29 cm) yelloweye rockfish by 100% ($P < 0.10$) in nearshore (shoreward of the 73 m isobath) fishing and 79% ($P < 0.05$) in offshore fishing in comparison to the control gear. Long leader gear reduced catch rates of large canary rockfish (*Sebastes pinniger*) by 86% ($P < 0.01$) in nearshore and 31% ($P < 0.10$) in offshore areas. The catch of quillback rockfish (*S. maliger*, -100%, $P< 0.05$) was eliminated with long leader gear. Long leader gear reduced or eliminated the bycatch of many small rockfish, including rosethorn rockfish (*S. helvomaculatus*) and greenstriped rockfish (*S. elongatus*). With the exception of lingcod (*Ophiodon elongatus*, -70% in offshore fishing, $P < 0.01$), target species catch rates were not significantly reduced (Pacific halibut, *Hippoglossus stenolepis*, +15%; black rockfish, *Sebastes melanops*, -19%, $P > 0.10$; yellowtail rockfish, *S. flavidus*, +7%). Replicate drifts over the same habitat, with and without the control gear, showed that gear interactions were not the cause of reductions in yelloweye rockfish bycatch. A comparison of catch rates and bycatch reduction in different tests showed that bycatch reduction for canary rockfish with long leader gear may be density-dependent, with the greatest reductions in areas of low abundance. Contact: Bob Hannah (Bob.w.hannah@state.or.us), Troy Buell.

Effectiveness of bycatch reduction devices (BRDs) in the ocean shrimp (*Pandalus jordani*) trawl fishery

We analysed observer data and historical bycatch data to evaluate the level of fish bycatch reduction achieved in the ocean shrimp (*Pandalus jordani*) fishery via the adoption of mandatory bycatch reduction devices (BRDs). The use of BRDs reduced fish bycatch by

between 66% and 88% from historical (pre-BRD) levels. Prior to BRD requirements, bycatch was composed by weight mostly of adult and juvenile Pacific hake (*Merluccius productus*), various smelts (Osmeridae), yellowtail rockfish (*Sebastes flavidus*), sablefish (*Anoplopoma fimbria*) and lingcod (*Ophiodon elongatus*) and ranged from 32% to 61% of the total catch by weight. By 2005, BRD use had reduced fish bycatch to approximately 7.5% of total catch, composed mostly of juvenile Pacific hake, slender sole (*Eopsetta exilis*), smelts, rex sole (*Errex zachirus*) and juvenile rockfish (*Sebastes*). BRD requirements have eliminated marketable-sized fish from the catch, changing the economic incentives in the fishery to favour the use of more efficient BRDs. Based on Oregon data, from 2002 to 2005 the use of soft-panel BRDs declined and the use of more efficient rigid-grate BRDs increased to 97% of all trips. Over this same period, mean bar spacing in rigid-grate BRDs declined from 43 mm to 32 mm, also contributing to BRD efficiency. Data collected from a trawl experiment testing a rigid-grate BRD with 19-mm bar spacing suggest that bycatch in the ocean shrimp fishery can be reduced further, perhaps below 5% of total catch. Contact: Bob Hannah (Bob.w.hannah@state.or.us), Steve Jones.

Discard mortality of recompressed rockfishes using acoustic telemetry

Determining the long-term survival of discarded fish is problematic, especially when a major factor in their physiological status is due to barotrauma. We used acoustic telemetry to monitor the vertical and horizontal movement patterns of rockfishes captured by hook and line and released using recompression techniques. We tagged 12 yelloweye rockfish *Sebastes ruberrimus*, 5 canary rockfish *S. pinniger*, 6 black rockfish *S. melanops*, 2 copper rockfish *S. caurinus*, 2 quillback rockfish *S. maliger*, 1 China rockfish *S. nebulosus*, and 1 vermillion rockfish *S. miniatus.* Depths ranged from 40–65 m. Inadequate data were recovered for the China and quillback rockfish. Using vertical movements as indicators of viability with time, we concluded that more than 50% of the tagged individuals for each species survived longer than 21 days, and many showed evidence of survival after several months. These results are encouraging in that mortality rates have been assumed to be near 100% and fishers have been releasing prohibited species by venting or recompressing fish with various methods. This study also indicates that recovery may be possible and studying movement patterns of tagged individuals may be possible. Contact: Steve Parker (*Steve.parker@Oregonstate.edu*), Polly Rankin.

Describing the behaviour of fishes during the capture process with trawl gear in darkness using an ultrasonic video imaging system.

Underwater observations of fish behaviour, especially in the vicinity of fishing gear, submersibles, ROVs, and other research tools, may be confounded by the presence of artificial visible lights. The Dual-frequency IDentification SONar, or DIDSON, ultrasonic imaging system provides an image of both fish and surrounding structure in real-time or recorded. We tested a DIDSON sonar in a selective flatfish bottom trawl to learn whether it could provide a clear view of fish behaviour and trawl net structure. A novel mounting frame design provided a stable platform for sonically imaging all areas in front of and in the mouth of the trawl (e.g. footrope, headrope, wings, mud cloud). We obtained images of large portions of the trawl, and of fish movements in relation to the gear, up to 17 meters from the sonar. Video cameras were used simultaneously, and the resulting paired images were used to confirm which species were observed on the sonar. The strengths of the new sonar are increased viewing range and the ability to see beyond moderate turbidity and obstacles. Weaknesses are insufficient resolution to reliably identify species, and the limited ability to distinguish fish in close proximity to the bottom when both are in relative motion. Contact: Waldo Wakefield (NOAA NWFSC), Steve Parker (Steve.parker@Oregonstate.edu), Bob Hannah, Keith Matteson.

Effects of catastrophic decompression on rockfish physiology and survival in the laboratory

Overfished species of rockfish (*Sebastes* spp.) from the Northeast Pacific experience high bycatch mortality due to barotrauma, which is induced from the rapid change in pressure during capture. As a result of barotrauma, "catch and release" techniques are often not effective for overfished species. Field experiments by the Oregon Department of Fish and Wildlife show that it may be possible for rockfish to recover from barotrauma if quickly recompressed prior to release. However, no work has followed the physiological recovery of rockfish after recompression or determined if it is possible for rockfish to survive such a severe physiological stress. We induced barotrauma in adult black rockfish from a simulated depth of 35 m with subsequent recompression. Following recompression, rockfish were slowly acclimated to surface pressure and transported to 2.4 m diameter tanks for recovery. Two control and two treatment fish were sampled for blood and tissue (eye, gill, heart ventricle, head kidney, liver, rete mirable, and gonad) at days 3, 15, and 31 post-recompression to evaluate the cellular-level response during recovery. This experiment was replicated 4 times, for a total of eight treatments and eight control fish sampled at each time point. No mortality from barotrauma occurred during the duration of the experiments. Results showed that damage due to barotrauma at the macroscopic level consisted only of swimbladder damage, at the histological level only rete mirabile damage was present, and at the enzymatic level, no differences between treatment and control fish could be detected due to extremely high variability. During the 1-month recovery period, swimbladder damage appeared to decrease while rete mirabile damage appeared to increase. These results indicate that although survival is attainable, long-term damage to the ability to regulate buoyancy may occur. Contact: Alena Pribyl (OSU), Steve Parker (Steve.parker@Oregonstate.edu).

Feasibility of using a fish pot to harvest Petrale sole

Flatfish stocks off the west coast are highly productive yet potential bycatch of co-occurring protected rockfishes limits the fishing areas to those outside of depth zones inhabited by rockfish species such as canary rockfish *Sebastes pinniger* or yelloweye rockfish *S. ruberrimus*. In addition, the major fishing gear used to harvest flatfish is bottom trawl gear, which has been under increased scrutiny due to potential habitat impacts and broad species selectivity. We conducted feasibility tests to target a high-value flatfish, Petrale sole *Eopsetta jordani*, using specifically designed pots that had the potential to reduce bycatch and reduce habitat impact associated with mobile gears. We tested the willingness of Petrale sole to come to bait in laboratory studies. We then tested several pot and tunnel designs during two cruises with mixed results. We showed that Petrale sole will come to bait and that they could be captured in pot gear. However, catch rates with our tunnel designs were low and we experienced bycatch problems of lingcod *Ophiodon elongatus*, halibut *Hippoglossus stenolepis*, and Dungeness crab *Cancer magister*. Although these bycatch problems may be surmountable, further research will await new tunnel designs and mechanisms to target Petrale sole locations. Contact: Steve Berkeley, Steve Parker *(Steve.parker@Oregonstate.edu)*

Planned/Ongoing Projects

Effects of bait size and hook size in groundfish hook-and-line fisheries

This small project will evaluate how changing the size of angled baits and the size of hooks used influence the species and size composition of the catch in nearshore hook-and-line fisheries targeting Pacific rockfish (*Sebastes*) and lingcod (*Ophiodon elongatus*). Contact: Bob Hannah, Troy Buell.

Evaluation of selective flatfish trawls as used in the nearshore groundfish fishery

We are using observer program data to evaluate the effectiveness of selective flatfish trawls (required nearshore since 2005) at reducing canary rockfish bycatch in the nearshore groundfish trawl fishery off Oregon and Washington. Contact: Bob Hannah, Steve Parker, Nancy Gove (NOAA NWFSC).

Test of a combination BRD/sorting grate in the ocean shrimp (*Pandalus jordani*) trawl fishery

We plan to test a single grate in the Oregon shrimp trawl fishery that incorporates a lower section designed to allow the escapement of undersize shrimp with an upper section that allows shrimp to pass into the codend but excludes all large and medium-sized fish. Contact: Bob Hannah, Steve Jones.

ROV survey of soft-bottom habitats near Nehalem Bank

This is a survey of the commonly trawled soft-bottom habitat in the vicinity of Nehalem Bank that was closed to all trawling as of summer 2006. The objective is to conduct a baseline survey that can be used for comparison with the same area after it has gone untrawled for 5 or 10 years to see if changes indicative of recovery from trawl impacts can be seen. Contact: Bob Hannah, Steve Jones, Bill Miller.

18.14 Faroe Islands

Faeroese Fisheries Laboratory P. O. Box 3051, FO-110 Tórshavn, Faroe Island

Contact: Kristian Zachariassen (krizac@frs.fo) ***and Bjarti Thomsen (bjartit@frs.fo)***

Impact of scallop dredging

Investigation of the impact of scallop dredging on benthic communities started in 2005. The investigation is carried out on a scallop area that has been closed for scallop dredging except for the years 1990–1991. The size of the area is ca.100 km^2 and is situated north of the Islands. Samples by grab, triangular dredge and commercial dredge as well as video have been taken all around the area. After sampling the area was open for commercial scallop dredging for about three years. After this period the area will be investigated again and samples before and after dredging will be compared. There has also been some experimental dredging carried out to see the direct effect of dredging. The first result will be accessible to the media 2008.

Ground-gear development

Experiments to reduce the impact on the bottom from trawl groundgear have been carried out in recent years mainly using underwater video observations. This work is now integrated in the EU project 'DEGREE'.

Myctophids

Myctophids have been observed, as bycatch is the blue whiting fishery around the Faroes, especially in 2002, when up to 7% of the Russian blue whiting catches were reported to be lantern fish. However, in recent years very little or no bycatch has been reported to the Faroese authorities. Work is being done to improve fishing methods and trawl to catch this fish in a joint Nordic project (Norway, Faroes and Iceland) in cooperation with Russian scientists. The horizontal and vertical distribution of myctophids has also been studied.

Mesopelagic fish are thought to be herded to some extent by the large meshes in the front part of the trawl, and therefore the catching area is larger than the entrance area of the codend but smaller than the entrance area of a large mesh trawl. For the purpose of density estimation of

mesopelagic fish the trawl was considered 100% effective in front of 40mm belly section and backwards. Based on these assumptions the conclusions was that the experimental fishing identified densities of mesopelagic fish and krill less than 1 g/m3 during the trial period, which is in agreement with knowledge in the existing literature on the subject. Such densities are considered too low for commercial fishing of these resources at current technological level.

Pelagic trawl research

A three year project has been initiated to study fish behaviour in pelagic trawls in relation to water flow and geometry. This project will be undertaken in close cooperation with Icelandic and Norwegian colleagues.

Size sorting grid for shrimps.

In a project together with the trawl factory Vonin Ltd, Canadian scientists and trawler owners in Canada and Greenland experiments with size sorting grids were carried out in Canadian and Greenland waters.

A full scale version of the grid system was first tested in the flume tank in St. John´s in April. The first experiments with the size sorting grids were carried out in Canadian waters in June. These tests showed big problems with clogging of shrimps in the grid.

A new version of the grid system was tested in Greenland waters in December. These experiments showed a big reduction of small shrimps in the catch, from 160 shrimps pr kilo to 130 pr kilo. The grid tested had a bar distance of 10 mm which was too much. To many medium size shrimps vent out together with the small shrimps. This same system with a bar distance of 7 mm will be tried in Greenland waters in the end of April 2007.

Effect of colour of gillnet for monkfish

In 2005 and 2006 experiments were made to see how the colour of gillnets affected the fishing efficiency for monkfish. A fleet of 200 gillnets with 5 different colours was tested. The fleet was tested 21 and 31times in 2005 and 2006 respectively. The fishing time was approximately 3 days each test at depths around 200m. The colour of nets seems to have no effect on the fishing efficiency.

Cod and Greenland halibut tagging

Since 1997, more than 25,500 cod have been tagged on various locations on the Faroe Plateau. More than 7,500 cod have been recaptured, and stomach content has been available for more than 1,500 of these fish. Analysis of this material provides a valuable understanding of the migration patterns and feeding behaviour of cod on the Faroe plateau. Some of these results were reported to the ICES 2003 Symposium in Bergen. A smaller scale tagging experiment on Greenland halibut and halibut was initiated in 2002. In total 399 Greenland halibut and 95 Halibut have been tagged and of these 24 and 13 respectively have been recaptured.

Tagging of monkfish around the Faroe Islands

Tagging of fish will give more information on migration. In the period 2004–2005 640 monkfish were tagged from a trawler and in 2005–2006, 370 fish were tagged from a gillnetter, with Floy tags. Four of the trawl tagged fish and 31 of the gillnet tagged fish have been recaptured. Most of them are recaptured in the same area as they were tagged, limited to a straight distance within a 100 km radius. One was recaptured south of Iceland.

Effect of fishery on coral areas

Coral reefs in the Faroese area have been mapped using information from interviews with fishermen and by underwater video observations. Underwater video recordings will continue in 2007 and more detailed mapping will be undertaken. This information will be used in the discussion with stakeholders on preserving coral reefs. Three different coral areas are now closed for trawl fishery to prevent damage on the corals by trawls.

Development of static gear

Development of fish pots was initiated in 2005 with the aim to increase the efficiency and to make them a real alternative fishing gear for traditional species (cod, haddock and saithe). Fish behaviour in relation to different design of pots has been studied using underwater video observation. Long lasting bait utilising thawing frozen bait soup has been developed. Experiments to increase pot efficiency using alternative stimulation have been carried out. This work will continue in coming years.

18.15 Germany

Institute for Fishing Technology and Fishery Economics, Federal Research Centre for Fisheries, Hamburg

Contact: H. Wienbeck:

Technical- biological investigations:

Reduction of cetacean bycatch in large midwater trawls and fish bycatch in *Nephrops* fisheries EU-project NECESSITY (*Nephrops* and CEtacean Species Selection Information and TechnologY): A second trip was carried out in September 2006 on FRV "Walther Herwig III" in cooperation with IMARES IJmuiden, Netherlands, using a tunnel barrier inside a pelagic trawl. Although dolphins were in the vicinity of the trawl, and the video recording equipment worked well technically, no footage was made of dolphin escapes, and the barrier did not avoid all bycatch of dolphins.

Selectivity of flatfish trawls in the North Sea

The aim of recent relevant activities at sea was a test of the selective efficiency of diamond mesh codends with 80 and 100 mm mesh opening both in beam trawls and bottom trawls. Presently prescribed mesh sizes for these gears are based on selectivity investigations from the early nineties when a compacted netting material was hardly used in the fishery. Due to the stiffness of the netting increased discard rates were expected. The experiments demonstrated unexpected high rates (90%) of undersized fish for both beam trawls and bottom trawls and for 80 mm and 100 mm mesh sizes. Virtually no selective effect could be observed with the 80 mm beam trawl codend compared to a 50 mm control codend. Solving the discard problem in the catch of flatfish seems unlikely simply by an appropriate mesh size increase. The regulation should include a detailed netting material description.

Catch efficiency of in experimental trawls in the Baltic

Comparing experiments with a trawl modified with a reduced "roof" (upper layer) succeeded in a remarkable reduction of the cod bycatch. However, this was also accompanied with a loss of some target species (flounder, dab, and turbot). Altering this net to improve its performance is currently under consideration.

A theoretical model for the optimum exploitation of fish stocks

This model investigates the effects of a large increase of mesh size compared to other technical means e.g. temporary or local closures or minimum landing size. In many cases it comes to the interesting conclusion that exploiting the stock at a higher age with no effort

reduction has much higher benefits both for the fish stock and the fishery as the artificial reduction of the fishing effort by hardly controllable means. Benefits for the discard issue would also be obvious. Recently, the model has been expanded to seven target species. In a mixed fishery on both cod and whiting a compromise on the optimum mesh size for both species was calculated.

Catch efficiency of set net and cod pots for Baltic Cod

First comparative experiments with set nets and codpots (3 Types) failed due to a lack of catch in set nets and pots in February. A second experiment was carried out in September with higher catches (5 kg/set net/day) in the set nets but again no catch in the pots. Only locally available herring had been used as bait for the pots and it would seem that this bait did not attract the cod. It appears reasonable to change the bait in further experiment or to use artificial bait specially proven to attract cod. However, even with attractive bait it seems presently doubtful that the commercial used Norwegian pots may provide an alternative to the set net fishery for cod in the Baltic

Technical investigations:

Underwater observation systems

Both versions of the surface towed intelligent powered vehicle (STIPS) with wireless transmission of video and control signals were used successful in 3 cruises on the FRV "Clupea". A new autonomous digital video recording system allowing real time UW-observations on FRV and bigger commercial vessels when using pelagic trawls was also tested successfully.

New Scanmar Equipment for research ships and its integration in the ship's network

After the completed installation of a cableless "Scanmar"- netsonde system on the fishery research vessel "Walther Herwig III" a similar system was introduced on the fishery research vessel "Solea". Both ships are now in the position to exchange their sensors. The data gathered with the system are fed into the ship's data logging system "Datadis" and are now available both with the navigational and meteorological data collected synchronously. The integration of further operational data of the ship is envisaged.

19 New Business

19.1 Recommendations

19.1.1 Date and venue for 2008 WGFTFB Meeting

WGFTFB proposes to hold a 5-day meeting in 2008 in Torshavn, Faroe Islands. A 5-day meeting was deemed necessary due to the high workload expected. The suggested dates are 7–12 April 2008.

19.1.2 Proposed Terms of Reference for the 2008 WGFTFB Meeting

The **ICES/FAO Working Group on Fishing Technology and Fish Behaviour** [WGFTFB] (Chair: Dominic Rihan*, Ireland) will meet from 7–12 April 2008 in Torshavn, Faroe Islands.

Topics

a) The Topic Group on "Application of fish behaviour for species separation in demersal fish trawls" will continue to work by correspondence following an agreed Action Plan timetable and report to the WGFTFB in 2008 to:

- Identify recent behavioural and gear research into the separation of groundfish species in demersal trawl gears;
- Identify basic principles, strategies and effectiveness of groundfish species separation techniques such as separator panels, grids and footrope modifications.

Conveners: Pingguo He, (USA) and Mike Pol (USA)

b) Term of Reference on "Incorporation of Fishing Technology Issues/Expertise into Management Advice."

Based on the questionnaire exercise carried out in 2005/06 and 2006/07 into developments in fleet dynamics etc, WGFTFB recommends that the topic group continue to carry out this survey on an annual basis.

Conveners: Dave Reid, FRS, Scotland, Norman Graham, MI, Ireland, Dominic Rihan, BIM, Ireland

c) A WGFTFB topic group of experts will be formed to consider the draft ICES Static Gear Manual.

The group will have the following ToRs:

- Review the current draft of the Static Gear Manual;
- Review available literature on the measurement of selectivity of all Static Gears and identify gaps in the knowledge; and
- Agree a structure for the completion of the manual and identify a drafting committee to complete this task.

Conveners: Andy Revill, CEFAS, UK and Rene Holst, DIFRES, Denmark

d) A WGFTFB topic group of experts will be formed with the following ToRs:

- Identify fisheries where technical mitigation measures have been introduced to reduce the bycatch of protected species; and
- Review the efficacy of these technical mitigation measures introduced to reduce the bycatch of protected species such as small cetaceans or turtles.

Conveners: Alessandro Lucchetti, ISMAR-CNR, Italy, Antonello Sala, ISMAR-CNR, Italy and Dominic Rihan, BIM, Ireland.

WGFTFB will report by XX May 2008 for the attention of the Fisheries Technology Committee.

Supporting Information

PRIORITY:	The current activities of this Group will lead ICES into issues related to the effectiveness of technical measures to change size selectivity and fishing mortality rates. Consequently these activities are considered to have a very high priority
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Item 3.16, 3.17, 3.18, 5.8, 5.11, 5.16, 6.3 (a) Action Item 3.2, 3.13, 4.11.3, 4.13, 5.11 (b) Action Item 3.16, 3.18, 4.13, 5.8, 5.12 (c) Action Item 3.2, 3.5, 3.16,3.17,4.13, 5.8 (d) Terms of Reference (a) Some groundfish species or stocks of these species are in low biomass, or overfished, while others are in healthy conditions. Efficient exploitation of healthy stocks while reducing or eliminating the capture of overfished stocks would provide industry and management means for sustainable utilization and management of the resource. Many members of WGFTFB have been involved in the area of research for many years. The topic group will concentrate on behaviour and species separation in commercial species. A summary of the status of knowledge and future directions in research and application would greatly benefit FTFB members and the fishing industry. The topic group will last for two years. The group will work by correspondence a report identifying current knowledge; information gaps and recommendations for future work will be presented at the 2008 WGFTFB meeting. Terms of Reference (b) Fisheries management bodies are often dependant on commercial catch per unit effort for stock assessment purposes and fishery/fleet based advice. Identification of changes in gear usage and fishing practices that affect fishing efficiency (technological creep) is important as this may result in biases in CPUE trends and need to be considered when using commercial catch data for tuning purposes. Recent changes in fishing practices are not generally evident from national data programmes due to time delays in collection, qualitative information relating to newly developing fisheries or changes in effort distribution can provide guidance in selecting suitable short-term forecasts and alert fisheries advisors to important changes in fleet dynamics. Terms of Reference (c) The ICES Static Gear manual has a history extending back to 1988 when it was first suggested to formulate it. The current draft has described procedures for gillnet selectivity but procedures for longlines and pot selectivity are not well developed and this has meant that the manual has not been completed. Given the importance of static gears it is important that this manual is now finished. A topic group will be formed to work by correspondence and to meet and discuss and agreed an Action Plan timetable for completion of the Manual at the 2008 meeting of FTFB. The topic group will identify gaps in the knowledge and review available literature and recent developments pertaining to the measurement of the selectivity of all static gears. Terms of Reference (d) In recent years a growing amount of protected species (turtles, marine mammals, seabirds, and sharks) has been observed as bycatch in several fisheries where they didn't represent a problem before. The global warming and climate change are believed to have probably affected both habitats and biology of protected species; thus they have probably changed their traditional migratory route and it's possible to catch them in unusual areas. The incidental catch of protected species in fisheries directed to other species is a major source of mortality that has raised considerable concern over the last decade. In a number of fisheries mitigation measures have been introduced (e.g. new type of hooks, TEDS, acoustic deterrents etc.) and in many cases bycatch has been reduced but as yet little assessment has been made as to the effects of such devices. Using the methodology adopted by WGFTFB in 2007 to review the efficacy of technical measures in Crangon fisheries in the North Sea, taking several case studies the topic group will apply a similar methodology to assess the efficacy of mitigation measures introduced.
RESOURCE REQUIREMENTS:	The research programmes that provide the main input to this group are already underway, and resources already committed. The additional resource required to

	undertake additional activities in the framework of this group is negligible. Having overlaps with other meetings of expert groups of FTC increases efficiency and reduces travel costs.
PARTICIPANTS:	The Group is normally attended by some 50–70 scientists and invited experts.
SECRETARIAT FACILITIES:	None.
FINANCIAL:	None required. Having overlaps with other meetings of expert groups of FTC increases efficiency and reduces travel costs.
LINKAGES TO ADVISORY COMMITTEES:	The questions of bycatch reduction, fisheries information and survey standardization are of direct interest to ACFM and seabed damage is of direct interest to ACE.
LINKAGES TO OTHER COMMITTEES OR GROUPS:	This work is of direct relevance to the Working Group on Ecosystem Effects of Fisheries, WG on Fishery Systems, WG on International Bottom Trawl Surveys, Baltic Committee, Marine Habitat Committee, Resource Management Committee and Living Resources Committee and the Assessment Working Groups.
LINKAGES TO OTHER ORGANIZATIONS:	The work of this group is closely aligned with the FAO and also the EU Regional Advisory Councils.

19.1.3 Workshops

A **Workshop on the Efficacy of Technical Measures on a Wider Ecological Scale** [WKECOTECH] (Chair: Dominic Rihan, Ireland and Stuart Rodgers, UK) will meet time and date to be arranged:

a) To identify methodologies to assess and quantify the efficacy of technical measures introduced to reduce the environmental impact of fishing.

b) To establish an integrated framework for assessing impacts, taking account of all factors.

WKECOTECH will report by May 2008 to the attention of the Fisheries Technology Committee and ACE.

Supporting Information

PRIORITY:	The current activities of this Group will lead ICES into issues related to the ecosystem affects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Plan No: 1.10, 2.2, 2.3, 3.2, 3.5, 3.17, 4.6, 4.13, 4.15, 5.8, 5.11, 5.12 **Term of Reference a)** The conservation and sustainable use of marine biodiversity is increasingly attracting international attention as scientific information reveals the richness and vulnerability of such biodiversity. Both fisheries management and science are undoubtedly changing in the face of increasing knowledge of the marine environment and pressure from outside interests. Management measures commonly used to protect vulnerable areas and species include spatial and temporal closures, effort reduction and gear restrictions. The requirement for fishing practices to incorporate species selective devices for reduction in unwanted catches, modifications to the gear to minimize the extent of the footprint on the seabed and the elimination of destructive fishing practices is now a prerequisite. It should be remembered though; fishing consists of different gears, deployed in diverse ways for different fisheries (fishing grounds and target species) and with different fishing practices so the need for a balanced approach to assessing impacts that does not differentiate between "normal" effects of fishing practices should not be confused with "destruction." Furthermore, threats to vulnerable marine ecosystems are not specifically limited to fishing practices. To facilitate this it is proposed that WGFTFB and WGECO will seek to hold a joint workshop in 2008 to discuss the efficacy of Technical Measures on a wider ecological scale. Formal terms of references for this joint session to be agreed by the Chairs of WGFTB and WGECO.
RESOURCE REQUIREMENTS:	The research programmes that provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
PARTICIPANTS:	The workshop is expected to attract a large number of participants from WGFTFB and

	WGECO.
SECRETARIAT FACILITIES:	None.
FINANCIAL:	No financial implications.
LINKAGES TO ADVISORY COMMITTEES:	ACFM and ACE
LINKAGES TO OTHER COMMITTEES OR GROUPS:	There is a very close working relationship with all the groups of the Fisheries Technology Committee. It is also very relevant in addition to WGECO but to other benthic ecology Working Groups, WGRED and Assessment Working Groups.
LINKAGES TO OTHER ORGANIZATIONS:	The work of this group is closely aligned with similar work in FAO and EU Regional Advisory Councils and the UN.

19.1.4 Study Groups

It is recommended that a **Study Group on combining gear parameters into effort and capacity metrics (SGGEM)** be established with the following terms of reference:

The **Study Group on combining gear parameters into effort and capacity metrics (SGEM)** (Chair: Dave Reid, Scotland and Norman Graham, Ireland) will be established and will meet at a time and location to be arranged to:

a) Review work carried out on measuring relative/effective effort by gear type;

b) Determine the relationship between vessel construction (tonnage, power, length etc) and the size or quantity of fishing gear deployed.

c) From metiers, which have been identified using formal analytical tools and expert knowledge determine the relationship between key gear parameters and catch.

d) Using the measurements/indicators developed, in conjunction with relevant Assessment Working Groups, apply these to pilot fisheries where different gears are used to target the same species mix e.g. WGNSDS, WGNSSK, WGSSDS, WGHMM.

SGGPM will report by XXXXX for the attention of the Fisheries Technology Committee and the findings of the Study Group will be reported in an *ICES Cooperative Research Report.*

Supporting Information

PRIORITY:	The current activities of this Group will lead ICES into issues related to the ecosystem affects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Plan No: 2.3, 3.2,3.4,3.16,4.13,4.15,5.3, 5.8 **Term of Reference a)** Fishing effort is the product of an individual vessels capacity to catch fish and its activity (FAO, 1999). For management purposes, capacity is generally quantified using some form of vessel characteristic that relates to its physical size and/or power. These capacity metrics are often combined with effort restrictions such as maximum days at sea, to control or limit fishing mortality. However, many studies have shown that the link between capacity, effort and fishing mortality is imprecise. This may be more precisely quantified if fishing capacity indicators also included metrics relating to the size or amount of gear deployed. In order to consider the relationship between vessel construction, gear type, activity and ultimately catch, the SGGEM, will explore the relationships between these and will consider the feasibility of using gear characteristics as indicators of fishing capacity. SGGEM will focus on several case studies including both data rich and data poor fisheries, including both single and multispecies/multi-gear fisheries.
RESOURCE REQUIREMENTS:	The research programmes, which provide the main input to this group, are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants:	The Study Group is likely to attract 15–20 participants from a range of appropriate scientific and technical disciplines including gear technologists, commercial gear manufacturers, mathematical and statistical modellers.

SECRETARIAT FACILITIES:	None.
FINANCIAL:	No financial implications.
LINKAGES TO ADVISORY COMMITTEES:	ACFM and ACE
LINKAGES TO OTHER COMMITTEES OR GROUPS:	There is a very close working relationship with all the groups of the Fisheries Technology Committee. It is also very relevant to the Assessment Working Groups and Working Group on Ecosystem Effects of Fisheries.
LINKAGES TO OTHER ORGANIZATIONS:	The work of this group is closely aligned with similar work in FAO and the EU Regional Advisory Councils.

It is recommended that **The Study Group on Unaccounted Fishing Mortality [SGUFM**] will be renamed the **ICES Working Group on Quantifying All Fishing mortality (WGQAF)** and will meet in Torshavn, Faroe Islands from 8–10 April 2008 to:

a) Maintain an overview of developments in the field and report to relevant ICES WGs (especially AMAWGC, WGFTFB, WGECO);

b) Prioritise and coordinate responses to issues arising from a), for example

  i) Slippage in NEA Mackerel fishery;

  ii) Ghost fishing; and

  iii) Inclusion of escape mortality estimates in stock assessment;

c) Advise on the need for workshops and meetings to address specific issues arising from a) and b); and

d) Liaise as necessary outside ICES in order to access data and influence events.

Supporting Information

PRIORITY:	The significance of UFM has now been accepted by stock assessment scientists, Chairs of assessment WGs and others. Flexible and effective liaison with them and other bodies will be substantially enhanced by the transition from SG to WG. This change and the continuing work related to UFM, or AFM are therefore considered to have a very high priority.
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Plan: 2.2, 3.2, 3.4, 3.6, 3.13, 3.16, 3.17, 3.18, 4.3, 4.13, 4.15, 5.11 **Term of Reference (a)** The innovative work of SGUFM has resulted in a widespread acceptance of the need to identify and quantify all sources of fishing-related mortality. Previously unaccounted-for mortality sources may be greater than that arising from discarding in some fisheries. The new WG will provide the means by which assessment WGs and others can express their priorities and see these communicated to researchers working on fish survival and on related gear technology topics. The expectation is that fishing gear design, and particularly the design of technical conservation devices, can take account of our increasing understanding of previously unaccounted-for sources of mortality. It is anticipated that other sources of data will also become available, particularly commercial operators. The activities of this Group will lead ICES into a more holistic approach towards the management process, where: • previously unaccounted mortality is factored into stock assessment, • management measures reflect a greater understanding of the impacts of fishing operations, • resource wastage can both be reduced and accounted for, and • data from researchers, gear technologists, vessel operators and the supply chain can be incorporated to generate a more global perspective on total fishing mortality.
RESOURCE REQUIREMENTS:	This WG will build on existing, nationally-funded programmes – any additional resource demands will be minimal.
PARTICIPANTS:	The WG will have a relatively small core group of participants, mainly from WGFTFB and draw ad hoc on others from assessment WGs, STECF, environmental

	NGOs, and commercial operators
SECRETARIAT FACILITIES:	None anticipated
FINANCIAL:	None: support from other organisations is anticipated as necessary
LINKAGES TO ADVISORY COMMITTEES:	ACFM and ACME
LINKAGES TO OTHER COMMITTEES OR GROUPS:	WGFTFB, AMAWGC, WGECO, IBTS, SGMS
LINKAGES TO OTHER ORGANISATIONS:	This WG will link to a network of governmental and non-governmental organisations as appropriate in order to build up expertise and sources of data on all causes of fisheries-related mortality.

19.2 Advice requested

See Section 4.

19.3 Proposals for 2008 ASC – Theme Sessions

No proposals made.

19.4 ICES and other Symposia

An International Symposium on Haddock conservation, harvesting and management is scheduled to take place on 25–26 October 2007 in Portsmouth, New Hampshire, US. Full details can be obtained at http://www.seagrant.unh.edu/haddock.html.

19.5 Any other business

The WGFTFB members wish to record their appreciation for the contribution made by Steve Walsh and Wilfried Thiele over the last number of years and wish them both well in their retirement later this year.

FAO will formally approach ICES regarding a proposal to host the 2010 WGFTFB meeting in Thailand, hosted jointly by SEAFDEC and the FAO.

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Annex 2: Recommendations

The following table summarises the main recommendations arising from WGFTFB and identifies suggested responsibilities for action.

RECOMMENDATION	ACTION
1. The ICES-FAO WGFTFB recommend that research and development be supported to develop new technical measures to further reduce discarding in the *C. crangon* fisheries below current levels.	WGFTFB, WGECO, WGCRAN and EU DG FISH to note.
2. The ICES-FAO WGFTFB recommends that any new technical measure, which utilises electrical stimulation of species as an integral part of its operations, should be accompanied by thorough and rigorous evaluations as to its potential environmental impact at the earliest stage.	WGFTFB, WGECO, WGCRAN and EU DG FISH to note.
3. The ICES-FAO WGFTFB recommends that the protocol used to evaluate the efficacy of technical measures in the Crangon fishery be considered as a template / guidance with respect to conducting similar evaluations in other fisheries	WGFTFB, WGECO, Assessment Chairs, ACFM, EU DG FISH to note. FTFB to investigate the possibility of testing this protocol.
4. The ICES-FAO WGFTFB recommend to the ICES PGCCDDBS to facilitate that catch / discard sampling be initiated and maintained in all North Sea *Crangon crangon* fisheries in-line with the EU data collection regulations.	PGCCDDBS to note.
5. The WGFTFB will explore the possibilities to develop scientific collaboration with the General Fisheries Commission for the Mediterranean (GFCM) on fishing technology in the Mediterranean fisheries with focus on the following aspects: Network of Mediterranean technologists; Harmonisation of the legislation related to fishing gear in the Mediterranean; Creation of a selectivity database.	WGFTFB, FAO-GFCM to investigate.
6. Survival studies need to be extended to cover other Mediterranean fisheries with the implementation of a standardised methodology. Studies should be done for other fishing gears and key-species (i.e. hake, red mullet, etc.).	WGFTFB, FAO-GFCM to note.
7. To consider the specific characteristics of Mediterranean fishing gear in conjunction with the preparation of the FAO fishing gear classification (Section 14), as many Mediterranean fishing gear experts indicates that such classification needs to be updated considering all the fishing gear used in the Mediterranean area.	WGFTFB, FAO to note in relation to development of gear classification.
8. With reference to GFCM/ATSELMED-2 recommendations, WGFTFB suggests to standardize fishing terminology used in scientific papers on fishing gear and techniques in order to allow easy comparison of obtained results from different Mediterranean areas.	WGFTFB, FAO to note in relation to development of gear classification.
9. Considering the GFCM resolution GFCM/31/2007/3 on 40 mm square-mesh codends in trawl fisheries exploiting demersal resources and taking into account the conclusions of the GFCM-ATSELMED-2 (Barcelona, 2–4 April 2007), the WGFTFB encouraged the promotion of research programmes on different fishing technology aspects including the impact of implementing 40 mm square-mesh in the Mediterranean trawl fisheries. The WGFTFB also encourages fishing gear technologists to present any related results and works for consideration by the technical Working groups of GFCM/Scientific Advisory Committee.	WGFTFB, FAO-GFCM to note and formulate a ToR to assess the efficiency of 40 mm square mesh codends for 2009 FTFB meeting.
10. WGFTFB gear classification topic group recommends the draft gear classification document to be finalised at or prior to the FTFB meeting in 2008.	WGFTFB, FAO, EU DG FISH to note.

RECOMMENDATION	ACTION
11. WGFTFB will continue to collate fisheries information on an annual basis, based on the issues related above and subject to further revision of the questionnaire and better quantification of the information where possible.	ACFM, AMAWGC, Assessment Chairs to note.
12. WGFTFB should continue to receive feedback from the different Expert Group's and AWAWGC, to assess the usefulness of the information supplied and also target specific areas that are identified of particular importance to individual assessment WG's.	ACFM, AMAWGC, Assessment Chairs to give feedback.
13. WGFTFB recognizes the need to develop a plan to be proactive in its role in the Ecosystem Approach to Fisheries that should concentrate on the environmentally responsible fishing of all gears. WGFTFB propose to hold a joint workshop in 2008 with WGECO to discuss the efficiency of Technical Measures on a wider ecological scale.	FTC, ACFM,ACE, WGECO

Annex 3: Tor (a): Impacts of *C. crangon* shrimp beam trawling in the North Sea

Terms of reference (ToR) (requests from the WGCRAN):

a) WGCRAN recommend that the WG Ecosystem Effects of Fishing Activities provide a summary review of the state of knowledge concerning *Crangon* shrimp beam trawling and its impacts upon benthic habitats and the wider marine ecosystem in the North Sea. *(This ToR has been addressed by WGECO but is included here as it is closely linked to the remaining ToR which are addressed by the WGFTFB below)*

b) WGCRAN recommend that the ICES-FAO WGFTFB review the efficacy of recently introduced (2003) technical measures introduced into the North Sea C. *crangon* fishery (Sieve nets / grids) aimed at reducing discarding of juvenile whitefish

c) WGCRAN recommend that the ICES-FAO WGFTFB evaluate the potential impacts upon target (*C. crangon*) and non-target species if electric shrimp beam trawling were to become widely adopted as a fishing method in the North Sea

Justification by the WGCRAN for these requests

"The C. crangon fishery may become a focus of further attention in the future, particularly in relation to its discarding practices, impacts upon benthic communities, technological innovations (i.e. electric shrimp beam trawl), the efficacy of existing technical measures, economic performance, and the sustainability of stocks. This attention may arise directly from the current process of MSC (Marine Stewardship Council) certification that is now underway, renewed NGO activity and interest, licensing of fisheries activities within the Wadden Sea Marine Protected Areas, etc. It is for this reason that we have made some recommendations to other ICES working groups". ICES WGCRAN 2006

Summary overview of the North Sea *C. crangon* directed fisheries

The *Crangon crangon* is a small crustacean (decapod) and is caught in directed commercial fisheries along large coastal regions of the North Sea. It is targeted by around 500 twin beam trawlers (< 221 kW main engine power) from five North Sea nations using small meshed trawls (cod end mesh size 20 mm). These fisheries straddle the coastlines of the UK, Denmark, Belgium, The Netherlands and Germany and all of these nations have an active fishery. Landings of *C. crangon* have steadily risen for the last three decades with record-high landings recorded of over 37,000 tonnes in 2006. The German and Dutch fleets are together responsible for the greatest proportion of the landings (87% in 2006). Collectively, the North Sea *C. crangon* fisheries are a valuable marine resource, with a market value generally in excess of most flatfish and roundfish species taken from these waters. More detailed descriptions of these fisheries are described in ICES WGECO (2007) ToR (e) and in the report of the ICES WGCRAN 2006.

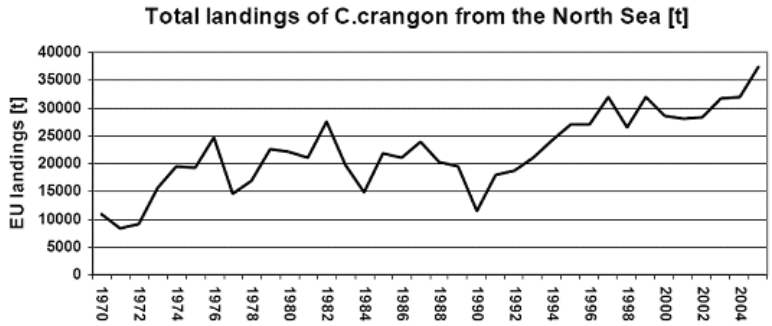

Figure 1. Total landings of C. crangon from the North Sea.

Source: ICES WGCRAN report 2006

Summary findings of the review of the state of knowledge concerning *Crangon* shrimp beam trawling and its impacts upon benthic habitats and the wider marine eco-system in the North Sea (as completed by ICES WGECO ToR (e) 2007)

This review is addressed by the ICES Working Group on "Ecosystem Effects of Fisheries" (WGECO) in Copenhagen in 2007 (ICES, 2007). WGECO has provided an overview of the most recent information on shrimp beam trawl fisheries in the North Sea. The impact of the North Sea shrimp beam trawl fisheries was examined on a comprehensive list of ecosystem components, including *Crangon*. As few specific studies on the environmental impact of the North Sea shrimp fisheries have been conducted, the WGECO assessment is based on limited information or inferred from shrimp beam trawling studies from other areas.

Whilst acknowledging the paucity of studies on many of the environmental impacts of shrimp beam trawling on the structure and function of the North Sea, WGECO considered that the size selective removal of Crangonids was likely to be the most important ecological impact of the fisheries due to the functional importance of *C. Crangon* as a predator and forage species in coastal areas of the North Sea. The stock of *C. crangon* is not formally assessed, but there are no indications of over-fishing (e.g. Temming *et al*., 2000; Welleman and Daan, 2001; ICES, 2006). The unwanted bycatch of juvenile commercial fish was also considered to be a concern, especially as shrimp fishing is permitted within the North Sea Plaice Box which was developed specifically to protect juvenile sole and plaice and in other inshore areas where commercial towed gears are not allowed to operate. Several management measures have been developed and implemented or are being developed. Their efficacy is reviewed here by WGFTFB in this document (see later section).

The protection of biogenic habitats from physical disturbance was considered sensible despite contradictory evidence on the effect of the fishery on Sabellaria reefs. The fishery was considered unlikely to greatly affect the physical and chemical characteristics of the sea floor but this was based on limited information. The effect of shrimp beam trawl fisheries on benthos was also very limited. Shrimp fishing may affect this component directly and indirectly. Based on limited evidence, the direct effects appear minimal on both epibenthic and infaunal invertebrates No North Sea studies on bycatch of benthos were found. The indirect effects are related to the removal of *Crangon* as a structuring component of some benthic communities. Discards from the shrimp fishery of the North Sea may represent a significant food resource to birds in localised areas. Its effect over the whole region is unknown. To the best of our knowledge, there are no significant effects of fishing on plankton (phytoplankton or zooplankton). However, during certain times of the year very large numbers of jellyfish have been observed passing through shrimp fishing gears. Given the considerable uncertainty that remains about the ecological importance of gelatinous zooplankton this

suggests the potential for a local effect on zooplankton dynamics. We are not aware of any studies that allow us to comment on the ecological consequences of this mortality.

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Temming, A., Jansen, S., Welleman, H., Daan, N., 2000, 'Interrelationships between the brown shrimp population and the multi-national brown-shrimp fishery (with emphasis on the recent changes in population structure'. Project No 96/007, Institut fur hydrobiology und Fischereiwissenschaft, Germany and Netherlands institute for fisheries research, Netherlands

Welleman, H.C., Daan, N. 2001. Is the Dutch shrimp fishery sustainable? Senckenb. Marit. 31(2): 321–328.

Summary of the review the efficacy of recently introduced (2003) technical measures introduced into the North Sea C. *crangon* fishery (Sieve nets / grids) aimed at reducing discarding of juvenile whitefish.

In January 2003, legislation was introduced requiring all fishers in the European *Crangon crangon* (brown shrimp) fisheries to use selective gear (sieve net or a selection grid) that reduces the incidental bycatch of juvenile commercial fish species. Each member state was responsible for implementing their own legislation enforceable within their national waters. The efficacy of the UK legislation (The Shrimp Fishing Nets Order) was evaluated in a multi-disciplinary study using social, biological and economic methods.

a) Social analysis

The social analysis was used to identify changes in fleet structure and fishing patterns since the legislations introduction and the extent of compliance and enforcement. A survey of the fleet, first conducted in 1995 was repeated in 2006, at which time, interviews with fishers and with enforcement officers were also conducted.

Table 1: Percentage of vessels using selectivity device (sieve net)

YEAR	% USING SELECTIVE DEVICE
1996	35% (27 of 78)
2000	62% (19 of 31)
2002	80% (Source Defra)
2003	Mandatory usage required
2006	91% (32 of 35)

There was evidence of strong compliance with The Shrimp Fishing Nets Order. In 2006, 91% of skippers reported using sieve nets. No vessels used selection grids. Some skippers disabled the sieve nets when weed was prevalent and some modified the exit hole to retain marketable fish. The full extent of this non-compliant behaviour could not be ascertained. The high level of compliance by UK skippers was apparent despite a low level of enforcement.

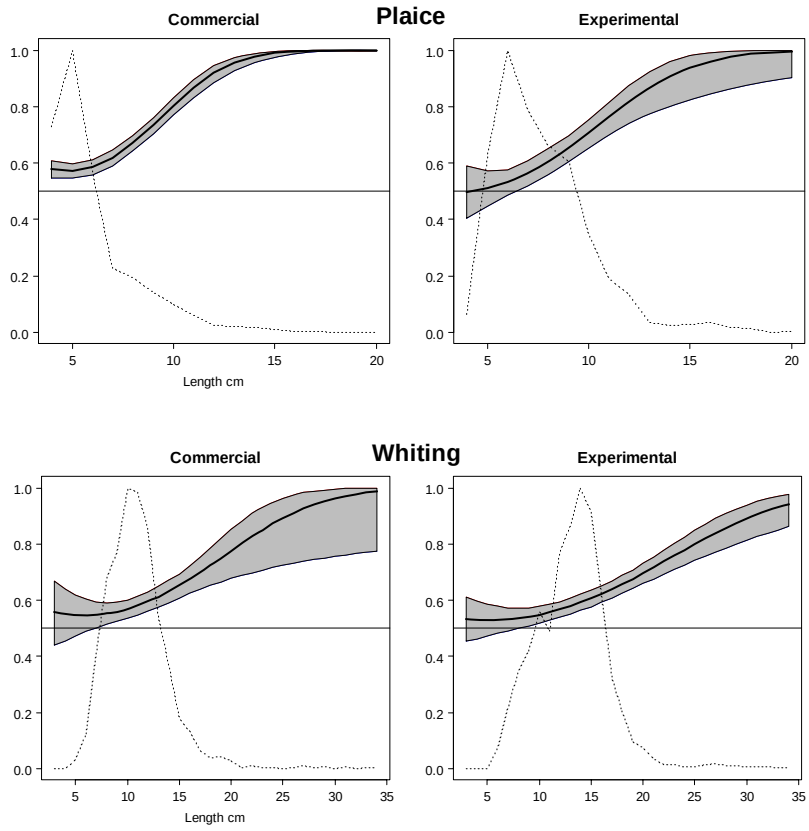
b) Biological analysis

The biological analysis evaluated the performance of commercially used selective gear and also identified changes in fish stocks of bycatch species. A total of 106 hauls were sampled in 2006/07 on board five commercial vessels. Catch comparison trials were conducted whereby

the sieve net in one of two beam trawls was disabled. The sieve was cut away from the exit hole and the hole was closed ensuring the sieve net did not affect the escape of organisms from the trawl. For each haul, the proportions of plaice, whiting, dab and cod at-length in the trawl without the sieve relative to the total number caught by both the trawls (the split parameter) were analysed using a generalised linear mixed model (glmm) model. An equivalent analysis was performed on data from previous gear trials when the experimental sieve designs were first tested.

Percentage differences between the total catch numbers for the beam with the sieve and without were calculated for all other species. Estimates of recruitment were taken from ICES reports and local density estimates from the English young fish survey.

Modelled proportion of the number of plaice, whiting and cod at length caught in trawls without sieves relative to the total in both trawls (with and without sieves) (i.e. 0.5 indicates an equal number caught in both trawls). Grey shaded area is area of significance around the modelled fit; dotted line is length frequency of the population (pooled total catch in trawls without sieves). 'Commercial' data are from commercially used sieve nets (2006/07), and 'Experimental' data are from experimental versions of sieve nets (1999/2000). NB only commercial data were available for cod.



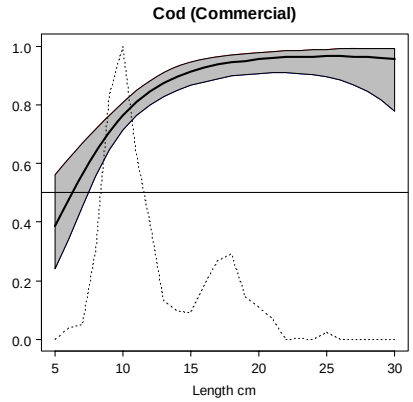


Figure 2. Modelled proportion of the number of plaice, whiting and cod at length caught in trawls without sieves relative to the total in both trawls.

There is no indication that recruitment of North Sea plaice has increased since 2003 or that localised densities of plaice have increased in the study area. Catch comparison trials of sieve nets illustrated a mean loss of 14% (uncooked weight) of target species (*C. crangon*) when compared with trawls without sieves. The commercially used sieve nets worked as effectively as the experimental versions tested in 2000/01 ago before their introduction into the fishery. The number of fish caught by trawls with sieves was significantly less than by trawls without, however, substantial numbers of 0 group fish were still retained when using sieves.

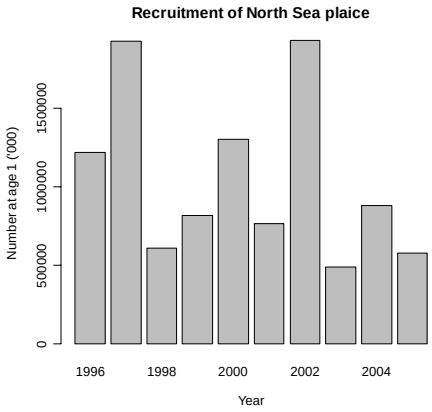


Figure 3. ICES estimates of annual recruitment (age 1) of North Sea plaice.

c) Economic analysis

The economic analysis assessed the economic implications of the legislation. The retrospective change in productivity of the brown shrimp fleet as a consequence of the use of sieve nets was estimated using a production function approach. The analysis utilized vessel logbook data detailing brown shrimp landings by individual trip during the period January 1999 to August 2006. The analysis of the two models was performed using FRONTIER 4.1 and showed a reduction in fleet productivity of 14% following the introduction of the legislation.

Conclusions from the assessment of efficacy of the technical measures

Assuming comparable levels of compliance and gear performance the results from this UK study can be extrapolated to other member states. The prevalence of group 0 fish on the

fishing grounds, suggests that many small fish, in the size range for which the sieves are least effective, are still caught by shrimp beam trawlers in European waters. This is compounded by the exemptions granted in the relevant national legislation, applying to the main EU brown shrimp fleets of Germany and The Netherlands which state that no selection device is required for up to half of the year.

Overall, the legislation reduces the undesirable capture of unwanted marine organisms and, as such, is consistent with the requirements of the precautionary principle and ecosystem-approach as defined in EU legislation. It is particularly effective at reducing bycatch levels of cod and relatively larger fish of all species (>10 cm in length), but less so at reducing 0 group plaice, which make up the largest component of the bycatch. The legislation has had a positive effect, and it represents the best available solution, but it does not sufficiently address the bycatch issue in the *Crangon* fishery.

The above is a summary of: T. L. Catchpole, A. S. Revill, J. Innes and S. Pascoe (2007). Evaluating the efficacy of technical measures – A case study of selection device legislation in the UK Crangon crangon (brown shrimp) fishery, (In preparation).

An evaluation of the potential impacts upon target (*C. crangon*) and non-target species if electric shrimp beam trawling were to become widely adopted as a fishing method in the North Sea

An overview of recent technical developments with this technology

Technical modifications for bycatch reduction focus on catch separation or filtering after species have entered the trawl. Damage incurred by contact, or stress caused during the capture and escape process may lead to higher discard and escape mortality (ICES, 2000). Alternative measures are therefore needed. A proposed measure is the use of electric pulses as means of stimulation for the target species. Whereas formerly tested modifications are based on physical size differences between the target species and the bycatch, the latter is based on different behavioural responses. The purpose is to avoid the entrance of non-target and undersized species.

Experiments with electric pulses have been carried out in the past in many areas in the world. The main purpose of these experiments was to obtain higher commercial catches, but with little attention paid to selectivity and bycatches.

The potential of electric pulses as a means to develop a '*species-selective*' electro-shrimp trawl for *C. crangon* was first studied in Polet (2003). The basic idea was to invoke selective responses for shrimp with electric ticklers and to allow non-reacting species to escape underneath a raised ground rope. A feasibility study, involving sea trials and survival studies was established with the following aims:

- Improving species and length selection;
- Reducing discards;
- Reducing the impact of shrimp trawling on the environment;
- Improving the quality of the commercial catches.

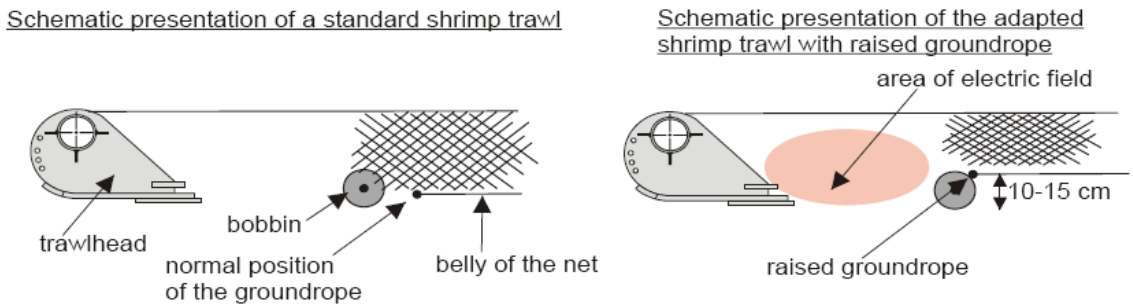


Figure 4. Shrimp beam trawl, altered for electro-fishing (Modified from Polet, 2003).

It was concluded that the experimental electro-trawl with raised ground rope and small meshes in the top panel gave satisfactory results. The losses of commercial shrimp catches were small or even non-existent. Part of the undersized commercial fish catch could escape and especially non-commercial fish and invertebrates were caught in lower numbers compared to standard nets (Polet, 2003).

It should, however, be borne in mind that the sea trials in this project only covered a short time range and a narrow range of conditions such as water temperature, currents, degree of activity of the shrimps etc. For this reason, it was recommended to elaborate this research. An extensive range of sea trials on commercial vessels in different conditions should precede commercial application.

A national, follow-up project was initiated in January 2007 in Belgium, named "Pulskor". The objectives are the further development of an electric shrimp trawl optimised for the use in commercial *C. crangon* fisheries in the North Sea and to overcome the drawbacks of currently used net modifications, such as the sieve net. The objectives are:

- Further reduction of the bycatches, especially the bycatch of very young fish.
- Reduction of bottom-impact.
- Improvement of the catch quality.

The development and construction of a new optimised pulse generator, onboard infrastructure and the modified beam trawl itself is ongoing. Extensive experimental testing at sea in commercial circumstances is planned for 2008. The potential for adverse effects on non-target species by the use of electricity will be further investigated.

Evaluating the potential ecosystem impacts of the electric shrimp beam trawling

We are unable at present to give an evaluation of the likely impacts that might arise if electric-shrimp beam trawling were to become widely adopted as a method used to harvest *C. crangon*. However, work in this field is progressing and accompanies the development of the technology. Such work is presently being undertaken at the Belgian Fisheries Research Institute (IVLO) in Oostende and the University of Gent.

We include an appendix (appendix A), which describes the concerns recently reported on by ICES in respect of the development of the Dutch electro-fishing beam trawl for flatfish. While we recognise that the electro-fishing flatfish beam trawl and the electric-shrimp beam trawl differ widely in design, the ecological concerns are likely to be similar and workers in this field should take account of such concerns at the earliest opportunity.

We add one note of caution, in that electric fishing for shrimp in China has been recently banned as this fishing method proved difficult to regulate and resulted in stock over-fishing and unacceptable environmental impacts.

Conclusions

1) The ICES-FAO WGFTFB acknowledges the principal findings of the WGECO (2007) report (ToR (e) on the 'Ecosystem impacts of *C. crangon* fisheries' which indicates that the two main impacts of these fisheries are:
   i) The removal of the target species (*C. crangon*)
   ii) The discarding of unwanted fish bycatch
2) The ICES-FAO WGFTFB concludes that the ecosystem impact of *primary concern* is the discarding of unwanted fish bycatch. The core purpose of the *C. crangon* directed fishery is the removal of *C. crangon* itself, however long terms trends do not indicate any stock decline or over-exploitation of *C. crangon* stocks at current levels of fishing effort. As such the ICES-FAO WGFTFB considers the removal of *C. crangon* to be a necessary and unavoidable consequence of this fishery and therefore not of primary concern.
3) Based on a study of the UK fishery and assuming that the findings from this study can be applied to the remaining North Sea *C. crangon* fishery, the ICES-FAO WGFTFB conclude that the current technical measures (sieve nets) legislated for use in 2003 in the *C. crangon* fisheries appear to function as intended and do reduce the bycatch of unwanted fish species in these fisheries.
4) The ICES-FAO WGFTFB concludes that the existing technical measures used in these fisheries are the most effective gear-modifications available at present for reducing the bycatch of unwanted fish species in these fisheries. However, the ICES-FAO WGFTFB conclude that these existing technical measures are only partially effective in reducing discards of unwanted fish species, and that there is a clear need to develop further measures to reduce discarding in these fisheries beyond existing levels (i.e. new gears, spatial / temporal measures etc)
5) The ICES-FAO WGFTFB conclude that technical developments with on-board catch processing and deck sorting equipment (i.e. rotary riddles with constant running water) may improve discard survival rates, but that scientific studies are required to confirm this.
6) The ICES-FAO WGFTFB concludes that the protocol used to evaluate the efficacy of these technical measures in the *C. crangon* fisheries is both holistic and effective. The same protocol can potentially be used elsewhere in other fisheries to conduct similar evaluations on the efficacy of technical measures.
7) The ICES-FAO WGFTFB support the research and development of new measures which could be used to effectively harvest *C. crangon* while reducing discards of unwanted species beyond current levels. The ICES-FAO WGFTFB concludes that the electric-shrimp beam trawl may be one such technical measure, but as yet it is in too early a stage of development to be able to evaluate its potential effects on the ecosystem or its fishing efficiency.
8) The ICES-FAO WGFTFB concludes that any new technical measure, which utilises electrical stimulation as a component, should be accompanied by thorough and rigorous evaluations as to their potential environmental impact and fishing efficiency at the earliest stage possible.

Recommendations

1) The ICES-FAO WGFTFB recommend that research and development be supported to develop new technical measures to further reduce discarding in the *C. crangon* fisheries below current levels (*For the attention of: EU DG Fish, Cefas(UK), IMARES (NL), IVLO (BE), BFAFi (DE), DIFRES (DK)*)

2) The ICES-FAO WGFTFB recommends that any new technical measure, which utilises electrical stimulation of species as an integral part of its operations, should be accompanied by thorough and rigorous evaluations as to its potential environmental impact at the earliest stage. (*For the attention of: EU DG Fish, Cefas(UK), IMARES (NL), IVLO (BE), BFAFi (DE), DIFRES (DK)*)

3) The ICES-FAO WGFTFB recommends that the protocol used to evaluate the efficacy of technical measures in the Crangon fishery be considered as a template / guidance with respect to conducting similar evaluations in other fisheries. (*for the attention of EU DG Fish, FTFB members*)

4) The ICES-FAO WGFTFB recommend to the ICES PGCCDDBS to facilitate that catch / discard sampling be initiated and maintained in all North Sea *Crangon crangon* fisheries in-line with the EU data collection regulations. (*for the attention of the ICES PGCCDDBS*)

Appendix A: Concerns raised previously by ICES with regard to electro-fishing

Background information on flatfish beam trawling

The tickler chain beam trawl makes substantial impact to the sea bottom. Tickler chains are iron chains in front of the ground rope attached to the ground rope or the shoes of the beam trawl. They stimulate the fish to leave the bottom and by that increase their catchability. As a side effect, the top layer of the bottom will be disturbed and mortality on various bottom organisms' increase. Also considerable bycatches of bottom organisms can be made. These are usually discarded with a poor chance of survival. The pulse trawl may be an alternative, which could reduce the impact on the sea bottom. Electrical systems have been used as a survey tool in freshwater environments for many decades and in some non-commercial marine fisheries since the 1960's. Until recently, use in commercial fisheries has been held back by technical problems.

Under EC regulation 850/98 (article 31.1) it is illegal to use such an electrical gear. The rationale for this was the potential increase in CPUE with the electrified beam trawl at a time when policy was aimed at reducing fleet capacity. However, the environmental concerns relating to physical impact on the sea floor caused by beam trawling and the increased fuel prices have caused a renewed interest in this technology.

The European Commission (EC) requested ICES to evaluate the possible effect of the use of electrical fishing gear (pulse trawl) to target plaice and sole in beam-trawl fisheries, worded in three questions:

a) What change in fishing mortality could be expected following the adoption of such gear in the commercial fishery, assuming unchanged effort measured in KW-days at sea?

b) What effect would such a widespread introduction have in terms of (i) the mixture of species caught; (ii) the size of fish caught?

c) What, if any, effects would such introduction have on non-target species in the marine ecosystems where this gear was deployed?

These questions and the formulation of the advice were directed to WGFTFB and an *ad hoc* Expert Group met in Izmir, Turkey in 2006. This group produced a report with recommendations, which was discussed by WGFTFB. The Expert Group worked after the meeting by correspondence, fed with documents from the research in the Netherlands.

The findings of the Expert Group were among others:

"There is information to suggest that the stimulus may be capable of damaging (spinal breakage and haemorrhaging) fish species. Further electrical field experiments are needed to determine whether injury is being caused to fish escaping from the gear by the pulse stimulus (van Stralen, 2006). These need to be conducted on a range of fish species that are typically encountered by the beam trawl gear, and with different length classes, both above and below MLS. In these trials it should be ensured that the exposure of the fish matches the situation in situ during the passage of the pulse beam trawl."

"Trials should be conducted on any alternative system being proposed for commercial use in the future. The output capabilities of these systems should also be fixed within the boundaries tested. If changes to the output are proposed, the system should be re-evaluated considering the above comments."

The suggested advice was presented to ACFM and brought out in August 2006.

The ICES advice reads:

"The ICES recommendation on additional data needs

Further tank experiments are needed to determine whether injury is being caused to fish escaping from the pulse trawl gear. The experiments need to be conducted on a range of target and non-target fish species that are typically encountered by the beam trawl gear and with different length classes. In these trials it should be ensured that the exposure matches the situation in situ during a passage of the pulse beam trawl. Fish should be subjected to both external and internal examination after exposure.

If the pulse trawl were to be introduced into the commercial fishery, there would be a need to closely monitor the fishery with a focus on the technological development and bycatch properties."

It is therefore very likely that similar questions will be raised on the application of electric stimuli in other fisheries, *e.g.* electric-shrimp beam trawling

Related literature

Electric fishing

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Annex 4: Evaluation of the escape of fish at towing depth, during haul back and at surface from a diamond-mesh codend, a codend with exit windows and a codend fitted with a sorting grid.

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Abstract

Percentages of escaping cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) from three different selections systems (a conventional diamond-mesh codend, a codend fitted with exit windows and a codend fitted with a sorting grid) were investigated by using the covered codend technique. A MultiSalmpler was attached to the cover in order to collect escaping fish at three phases of the towing process (at depth, during the haul back and at surface).

The results showed that the percentages of escaping fish from the diamond mesh codend were significantly smaller than those calculated for the exit windows and the sorting grid codends. Nearly 60% of cod and 78% of haddock escaped from the diamond mesh codend at depth. The codend fitted with exit windows and the codend with the sorting grid displayed similar percentages of escaping fish in all the towing phases. Around 75% of cod and 95% of haddock escaped from these codends at depth. When the hauls were analysed as entire hauls, the selectivity analysis did not show evidence of sharper size selection between the three codends. However, when the hauls were analysed by towing phases, clear differences between the codends were detected.

Introduction

All fishing gear modifications to improve selectivity are based on the assumption that juvenile fish which escape from fishing gears are undamaged, minimally stressed and able to make a complete recovery. Therefore it is generally expected that the selective devices let the unwanted (non-target) fish escape at the fishing depth in a gentle manner to ensure their survival and future recruitment. Developing effective gear modifications that guarantee high chances of survival for fish escapees should meet two requirements. First, undersized fish (that should escape from the fishing gear) should remain inside the trawl for as short time as possible; and second, fish should not enter into the aft part of the codend where the risk of serious injuries is higher. Diamond mesh codends do not meet any of the above requirements. There is evidence which suggest that the selectivity of this type of codend is associated with the haul back operation and more important yet, that a big proportion of the undersized fish escape close to or at surface (Tschernij and Suuronen, 2002; Suuronen, 2005). In these circumstances, escaping fish are likely to be exposed to far more stress, exhaustion and physical damage, considerably reducing its survival probability. Square mesh codends and sorting grids have a potential advantage over diamond mesh codends. They can be strategically inserted in front of the codend so that undersized fish do not have to enter the rear part of the codend.

Objective

This experiment, apart from evaluating size selectivity, pretends to quantify and document the percentages of escaping fish at depth, during the haul back and at surface. Three different selection systems are compared, a 155 mm diamond-mesh codend, a codend provided with 142 mm exit windows, and a codend fitted with a 55 mm sorting grid.

Materials and Methods

The research trawler 'Jan Mayen' (63.80 m LOA, 4080 HP) was used to perform fishing trials during December, 2006 and February, 2007. The fishing grounds were off the coast of Tromsø and Finmark (northern Norway), at depths that varied between 280 and 390 m. The trawl was a single trawl Alfredo 5, with 38 m headline, 21 m fishing line, and stretched circumference of 81 m (524 meshes of 155 mm) in the body. The wings and the two bellies were built in polyethylene (PE) with a mesh size of 155 mm. The ground gear was composed by 53 cm (21") rubber discs, 53 cm (21") steel bobbins, and the sweeps were 60 m long. The otter boards were Thyborøn T2, 10 m^2 in area and weighed 3000 kg each.

Three selection systems were evaluated:

1) A diamond-mesh codend (built in 8 mm single braided polyethylene twine and with a nominal mesh size of 155 mm.
2) A diamond-mesh codend (built in 8 mm single braided polyethylene twine and with a nominal mesh size of 138 mm) in combination with a sorting grid section.
3) A diamond-mesh codend (built in 8 mm single braided polyethylene twine and with a nominal mesh size of 138 mm) with two 142 mm exit windows (42 meshes in length and 5 meshes in height).

More detailed information about the gears is given in table 1.

Table 1. Gear specifications.

Selection system		Specifications	
Diamond meshes	Codend	Material	8 mm single braided twine polyethylene (PE)
		Nominal mesh size	155 mm
		Actual mesh size (Mean ± SD)[a]	152.2 ± 1.8 mm
		Length	60 meshes
		Circumference	60 meshes
Exit Windows	Exit windows	Material	4 mm double braided twine polyamide (PA)
		Nominal mesh size	142 mm
		Actual mesh size (Mean ± SD)[a]	144 ± 1.85 mm
		Length	42 meshes
		Height	5 meshes
		Hanging ratio	0.7
	Codend	Material	8 mm single braided twine polyethylene (PE)
		Nominal mesh size	135 mm
		Actual mesh size (Mean ± SD)[a]	134.2 ± 3.32 mm
		Length	70 meshes
		Circumference	70 meshes
Sorting grid	Sorting grid	Type	Sort-V
		Material	10 mm stainless steel
		Bar spacing	55 mm
		Length	1650 cm
		Width	1234 mm
	Codend	Material	8 mm single braided twine polyethylene (PE)
		Nominal mesh size	135 mm
		Actual mesh size (Mean ± SD)[a]	132.95 ± 2.5 mm
		Length	70 meshes
		Circumference	70 meshes

([a]) Measured with an OMEGA gauge.

Collection of escaping fish

Cover

The covered-codend method, described by Wileman *et al.*, (1996), was applied to collect escaping fish from the experimental codends. The cover was built of square meshes and had a total length of 7 m when using the diamond-mesh codends and the codend with the exit windows. It was however extended to a total length of 17 m when using the codend with the sorting grid. See figure 1 for details.

The netting of the square-mesh cover was made of 1.4 mm twisted polyethylene twine and with a nominal mesh size of 60 mm. This netting was chosen because of the thin twine and mesh configuration limit the possible visual contrast effect when the net is silhouetted against the light. The skirt at the end of the cover was left open for not disturbing water flow speed inside the cover. A 2-meter long zipper was inserted in its upper panel to enable the manipulation of the experimental codend.

Combining floats, chains and flexible kites expanded the cover. The kites were made of PVC-coated canvas, had trapezoidal shape and were installed in the front, middle and back part of the cover. The cover was towed by four 3 m Spectra ropes that were attached to both trawl selvedges.

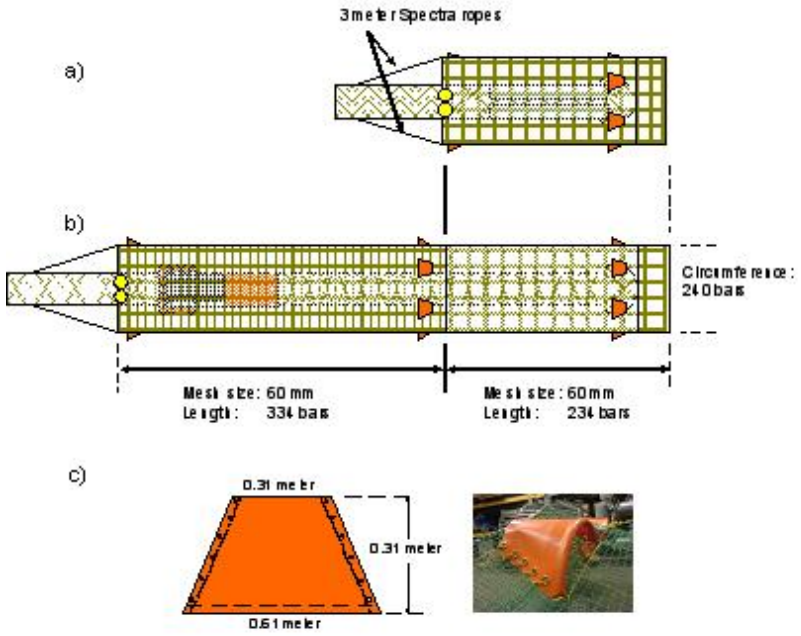

Figure 1. Description of the square-mesh cover, a) when the diamond-mesh codend and the codend with the exit windows were used; and b) expanded when the codend fitted with the sorting grid was used. C) Shows one of the flexible kites, which were used for expanding the cover.

MultiSampler

The rear most part of the cover was attached to a MultiSampler (Engås, *et al.*, 1997). This equipment comprised a stainless steel frame, a release mechanism and three sampling codends. The stainless steel frame was especially mounted (to a 16 meter mesh section) to keep an inclination angle of approximately 45° and was provided with 16 floats (29.9 cm of diameter) to neutralise its weight in the water. The release mechanism was controlled and monitored by a Scanmar HCL hydroacoustic double communication link (sender and receiver). One of the transducers was placed on board the research vessel and the other in the frame of the MultiSampler. The sampling codends were built of 1.2 mm twisted polyamide (PA) twine and had a nominal mesh size of 40 mm. In addition, they were fixed at their top and bottom edges to stainless steel profiles spanning with the width of the Multisampler's frame. These profiles were attached to a response switch and fixed in the upper position of the Multisampler's frame. When an acoustic signal was sent from the vessel, one of the net profiles was released and fell to the lower part of the MultiSampler's frame. In its way it passed the response switch, and a confirmation signal is sent back to the vessel.

Each sampling codend was used to collect fish escapees in the following towing phases:

a) While the trawl was fishing at depth.

b) During the haul back. Measured from the moment in which the ground gear loses contact with the seabed.

c) When the trawl was at surface. Measured from the moment in which the otter boards reached the vessel.

Statistical analysis

Percentages of fish escaping

Differences in the percentages of escaping fish (in each of the towing phases) between the three selection systems were assessed by General Linear Models (GLM) at a 95% significance level. When groups were found different, pair-wise comparisons were performed in order to determine which pairs of means differ significantly.

Selectivity analysis

The Logit model, which is described by Wileman *et al.*, (1996), was fitted to the data set. This model is defined as:

$$r(l;\alpha,\beta) = \frac{\exp(\alpha + \beta(l))}{1 + \exp(\alpha + \beta(l))}$$

where r(l) is the probability that fish of length l will be retained in the experimental codend, and α and β are the two generic selection parameters determining the mean selection length and the selection range.

Towing phases and the entire haul

Selectivity estimates were calculated for the following towing phases:

Towing at depth:	Retained fish = EC + SC_2 + SC_3
	Escaping fish = SC_1
During haul back:	Retained fish = EC + SC_3
	Escaping fish = SC_2
At surface:	Retained fish = EC
	Escaping fish = SC_3
Entire haul:	Retained fish = EC
	Escaping fish = SC_1 + SC_2 +SC_3

where EC is the catch of the experimental codend; SC_1, SC_2 and SC_3 are the catches of the sampling codends when towing at depth, during haul back and at surface, respectively. The CC 2000 program (ConStat) was used for fitting the model to individual data sets. Model checking was achieved by analysing residual plots and standard goodness of fit statistics.

Results

Fifty-two hauls were performed during the experimental period. Of them, 15 hauls were discarded from the analysis because of problems with the gear or problems related with the malfunctioning of the MultiSampler. The remaining thirty-seven hauls (with nearly 55000 kg of fish) were considered as valid hauls and provided enough numbers of cod and haddock for evaluating the percentages of fish escaping and for calculating selectivity estimates in each of the towing phases.

Percentages of escaping fish

The analysis of variance found that the percentages of escaping cod from the diamond-mesh codend (at depth, and at surface) significantly differed ($p<0.05$) from those of the exit-window

codend and the codend fitted with the sorting grid. However, any significant difference ($p>0.05$) was found between the percentages of escaping cod from the exit-window codend and the codend fitted with the sorting grid. Similarly, the percentages of escaping haddock from the diamond-mesh codend (at depth, and at surface) were also found to significantly differ ($p<0.01$) from those of the exit-window codend and the codend fitted with the sorting grid. No differences were found between the percentages of escaping haddock from the exit-window codend and the codend fitted with the sorting grid. Plots of least square means corresponding to the ANOVA main effects, and comparing the three selection systems, are shown in figure 2.

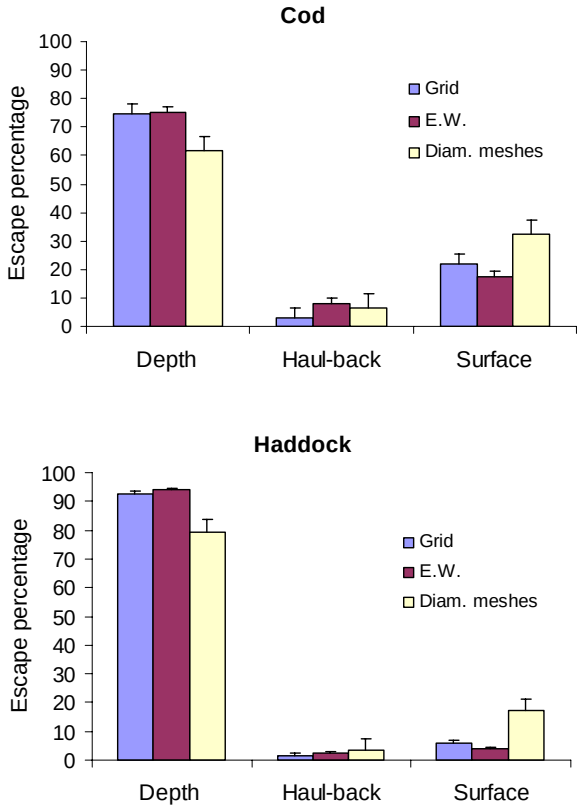

Figure 2. Escape percentage of cod and haddock at three different towing phases.

Selectivity of the towing phases and of the entire haul

The Logit model provided good fits ($p>0.05$) for all the analysed data sets when they were analysed as entire-hauls. At towing phase however, some data sets failed to converge the iteration process and therefore they were not included in further analysis. Few of those hauls that did converge (one haul for cod at depth and when using the diamond-mesh codend; and five hauls for haddock, two at depth and one at surface when using the diamond mesh codend) showed indications of over dispersion or lack of fit. REML mean selectivity parameters were estimated for all towing phases and for the entire haul. The results are listed in Table 2

Table 2. Estimates of mean l_{50} and SR, which were calculated by using the between-haul variability model of Fryer (1991).

Species	Phase	Selection system	Analysed hauls	l_{50}		SR		dof
				estimate	se	estimate	se	
Cod	Depth	Diamond meshes	13	52.5	0.30	9.4	0.14	21
		Exit windows	12	52.8	0.18	8.2	0.11	19
		Sorting grid	12	50.6	0.26	9.3	0.14	19
	Haul back	Diamond meshes	9	42.2	1.01	12.0	0.39	13
		Exit windows	7	45.9	0.67	7.6	0.42	9
		Sorting grid	8	37.1	0.78	9.2	0.47	11
	Surface	Diamond meshes	13	54.6	0.21	8.6	0.18	21
		Exit windows	11	51.8	0.13	5.5	0.18	17
		Sorting grid	11	48.8	0.20	7.7	0.17	17
	Entire haul	**Diamond meshes**	**13**	**58.5**	**0.16**	**7.7**	**0.09**	**21**
		Exit windows	**12**	**55.7**	**0.11**	**6.6**	**0.11**	**19**
		Sorting grid	**12**	**53.7**	**0.14**	**8.0**	**0.10**	**19**
Haddock	Depth	Diamond meshes	13	48.8	0.31	10.3	0.20	21
		Exit windows	12	55.7	0.20	10.1	0.17	19
		Sorting grid	12	48.9	0.17	7.3	0.10	19
	Haul back	Diamond meshes	9	40.6	0.75	7.3	0.48	13
		Exit windows	8	44.1	0.43	6.2	0.52	11
		Sorting grid	6	37.4	0.91	6.5	0.47	7
	Surface	Diamond meshes	13	47.1	0.25	7.3	0.19	21
		Exit windows	10	46.3	0.39	6.3	0.32	15
		Sorting grid	11	42.7	0.21	6.5	0.19	17
	Entire haul	**Diamond meshes**	**13**	**52.6**	**0.17**	**6.5**	**0.11**	**21**
		Exit windows	**12**	**55.9**	**0.14**	**7.3**	**0.16**	**19**
		Sorting grid	**12**	**50.0**	**0.16**	**6.3**	**0.11**	**19**

Mean selectivity curves and 95% confidence regions of the estimated selectivity parameters are shown in figure 3. Accordingly, for cod, the overlapping confidences regions suggest that no significant differences (at a 95% confidence level) could be detected in the selection parameters (which were estimated at depth and during the haul-back) between the three selections systems. At surface, however, the diamond-mesh codend presented significantly larger l_{50} and SR values than those of the exit window codend and of the codend fitted with the sorting grid. For haddock, the only significant difference was found at depth and corresponds to the exit window codend. This codend provided significantly larger l_{50} values than the other selection systems. When considering the entire haul, the diamond-mesh codend and the exit window codend were the systems, which provided the largest mean l_{50} for cod and haddock respectively.

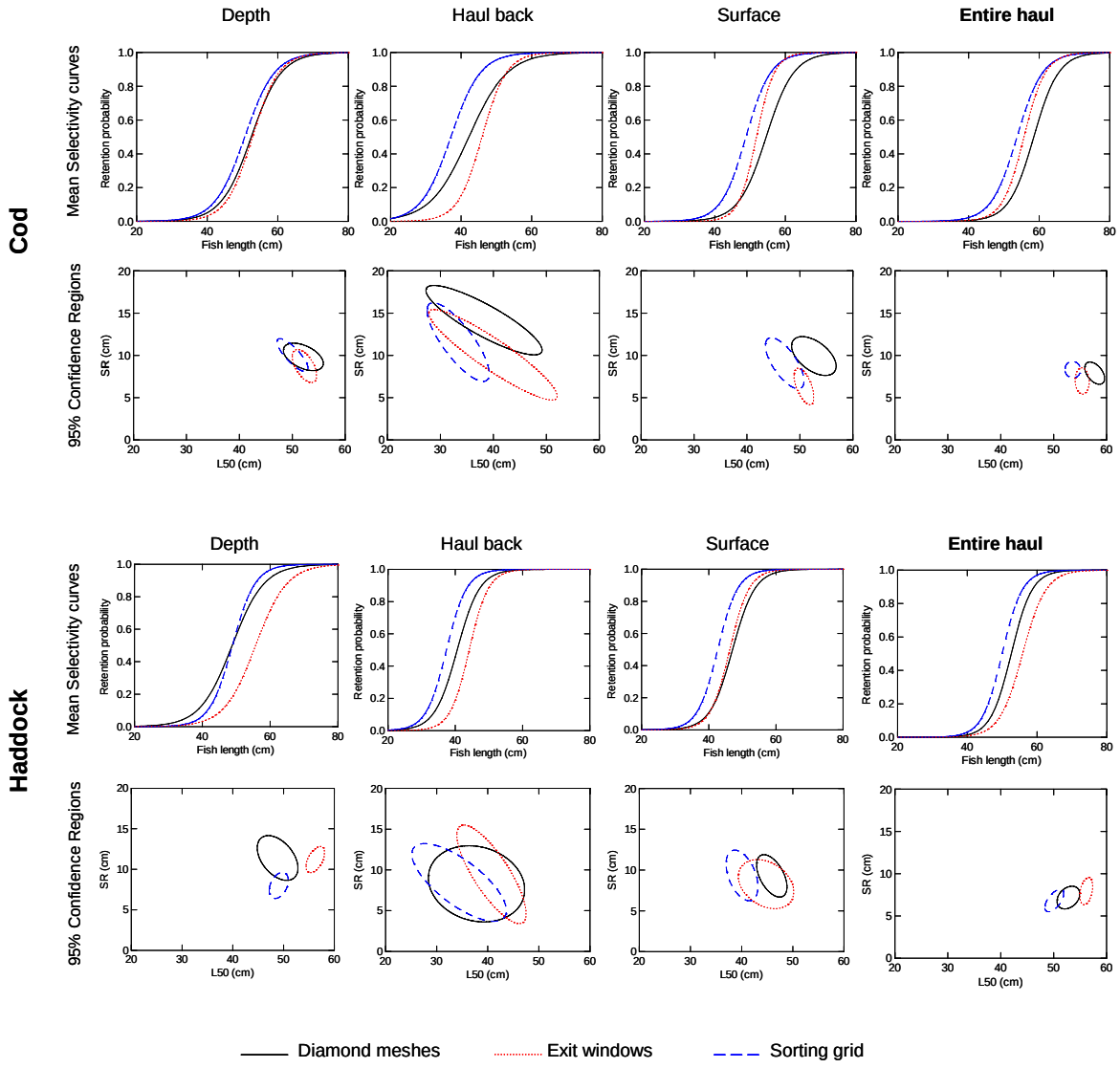

Figure 3. Mean selectivity curves with corresponding 95% confidence regions for cod and haddock in each of the towing phases.

Discussion and conclusions

This experiment has clearly shown that different selection mechanisms were associated with each of the three analysed systems. In addition, this experiment has demonstrated that the escape of all undersized fish do not necessarily occurs at depth, rather, it extends to the last part of the towing process (during the haul back and while the codend is at surface).

Even though no evidence of sharper selection was found between the three experimental codends, an important difference in the proportion of escaping fish (at different towing phases) was observed between them. Accordingly, the diamond-mesh codend showed a clear deficiency for releasing fish at depth. As a consequence, a large proportion of undersized fish escape from this codend at surface. The escape mechanism in the diamond-mesh codend raises the question whether the fish that escaped at the surface survive or not. The fact that fish, which escape near the surface, are exposed to more stress, exhaustion and physiological damage than fish which escape at depth, suggests that they will not survive. In addition, problems associated with the decompression process also reduce the chances of these fish to survive.

The exit-window codend and the codend fitted with the sorting grid are selection systems that not only enhance the escape of fish at depth, but also reduce the time that fish remains inside the trawl. As a consequence, less stress and physical damage is induced to escaping fish.

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Annex 5: Technical Issues relating to the Mediterranean

Annex 5b: GFCM activities in the field of fishing technology in Mediterranean

The purpose of the General Fisheries Commission for the Mediterranean –GFCM– (24 Members) is to promote the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture. More specifically, the GFCM:

- Reviews the state of the Mediterranean resources, including their abundance and
- The level of their exploitation, as well as the state of the fisheries based thereon; and
- Recommends appropriate measures related the rational management of living marine resources in particular by regulating fishing methods and fishing gears.

The Scientific Advisory Committee (SAC) of GFCM has the mandate to prepare management advice for the Commission on the basis of the scientific work done by national scientists and related to the four sub-committees:

- Stock assessment.
- Marine Environment and Ecosystems.
- Economic and Social Sciences.
- Statistics and Information.

GFCM activities on the topic of fishing technology are considered as transversals, requiring a multidisciplinary approach and the implication of biologists, technologists and socio-economists among others.

Selected publications related to the fishing technology issues

1957: Trawling in the Mediterranean. Preliminary observation on Italian trawl. FAO Fisheries Division. *GFCM Studies and Reviews N. 2.*

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1959: Graphic documentation on some fishing gear used in Spanish coastal lagoons, Fernando Lozano Cabo. *GFCM Studies and Reviews N. 9.*

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Annex 5b Review of Mediterranean Legislation

This document describes a comparative study of fisheries laws and regulations covering the entire Mediterranean basin and focuses on one main issue: the Mediterranean technical measures on fishing gears. In the last years the technical aspects of legislation on fishing gears have become an important issue. The new EC Reg. 1967/06 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, which have replaced the EC Reg. 1626/94, implement, some technical parameters very important to selectivity such as the mesh configuration (square mesh codend) and the twine diameter of towed nets and gillnets. Moreover many rules on fishing gears have been changed, thus it is important to define a common point of view on the new situation.

A comparison of the national legislations of EU and non-EU countries was completed with the aim of finding possible alternative solutions and to verify how the different countries have tackled similar problems in the same fishing area.

The document also intends to open a dialog between fishing gear technologists on the technical aspects of fishing gears to be considered important to manage the marine resources in different countries of the same area. The current investigation should support the harmonization of the legislations both for the EU and non-EU countries and define a common point of view for a reasonable management of the resources in the Mediterranean Sea.

Keywords: Mediterranean Sea, management measures, fishing gears legislation, EC Reg. 1967/06.

Introduction

The present document describes a comparative study of fisheries laws and regulations covering the entire Mediterranean basin and focuses on one main issue: the technical measures on fishing gears.

This document does not reflect an official position of the EU Commission or, ICES or National Administrations. The information and advice presented in this document do not describe form the basis of the opinions of the Food and Agriculture Organization of the United Nations. This paper is not a definitive review of Fishing Policy Legislation (to collect information from all the countries it is very difficult). It does not purport to interpret the fishing management measures from a legal point of view.

This document merely intends to focus the attention on gear legislation in light of a New EC Regulation: In the 21 December 2006 the Council of the European Union has adopted the Regulation No. 1967/06 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea. The conservation policy in Mediterranean Sea has traditionally been carried out differently than in other areas. In fact the biological, social and economic characteristics of the Mediterranean fisheries implied, for several years, the need to establish a specific management framework for this basin.

In recent years all fishing sectors have evidenced the need of new technical measures for fishing replacing those originally laid down in Council Regulation (EC) No 1626/94. The new Regulation has changed many rules on fishing gears compared with EC Reg. 1626/94, so that it's important to define a common point of view on the new situation. Thus the document intends to open a dialog between fishing gear technologists on the technical aspects of fishing gears to be considered important to manage the marine resources in different countries of the same basin.

The EC Reg. 1967/06 appears to be very difficult to read and understand in some places; furthermore there are some mistakes in the translation from English to different languages and

finally there are too many derogations. All this makes, in our opinion, the new regulation very difficult to be applied and very complicated for fishery inspectors to control and to enforce the law. Moreover, the complexity of the Mediterranean fisheries, in terms of diversity of fishing gears and practices, together with its economic structure, does not enable fishermen to be flexible, to quickly adapt and to easily accept undesirable effects of external factors, including management measures. The document underlines some possible problems, deficiencies or misunderstandings with the new EC Reg. 1967/06.

Furthermore it compares national legislation of EU and non-EU countries at the aim of finding possible alternative solutions; in fact the comparison of different National legislations is essential to verify how the different countries have tackled similar problems. Thus a description of the situation, also in non-EU countries, could be functional to a possible harmonization of technical and management measures in the Mediterranean Sea.

The goal of the document is to outline the technical issues that need to be investigated in the future and the possible solutions we can suggest to fishery managers.

We believe this is only the first step of a much bigger exercise because many datasets need to be updated or corrected. With the support of the GFCM a more comprehensive analysis could be carried out.

NATIONAL LEGISLATION ON FISHING GEARS (BEFORE THE EC REG. 1967/06 FOR EU COUNTRIES)

The technical aspects of legislation on fishing gears have becoming a very important issue in the Mediterranean Sea where several countries are operating on shared resources and habitats. Comparing different National legislation could be useful to verify how the different countries have faced similar problems with the aim of finding a possible way to harmonize the technical and management measures in the Mediterranean Sea. A similar description of the situation in non-EU countries is also required.

Information was collected with the assistance of national scientists; Available data (mainly for France, Malta and Spain) should be updated.

TRAWL NETS

MESH SIZE

- EU countries: the mesh size of the strengthening bag shall be equal to at least twice that of the codend. Mesh opening of pelagic trawl ≥ 20 mm (if small pelagics represent the 70%).
- Italy: mesh opening of bottom trawl ≥ 40 mm; (derogation for juveniles of sardines and *Aphia minuta* mesh opening ≥ 5 mm). Strengthening bag of bottom trawl: mesh opening ≥ 120 mm. Strengthening bag of pelagic trawl: mesh opening ≥ 40 mm. In Sicily mesh opening of bottom trawl ≥ 26 mm if rose shrimp represents the 75% of the total catch.
- France: mesh opening of bottom trawl ≥ 45 mm. Mesh opening of "Gangui" for fish and prawn ≥ 20 mm, for "oursin" ≥ 80 mm.
- Egypt: mesh opening of bottom trawl ≥ 40 mm.
- Algerian: mesh opening of bottom trawl ≥ 40 mm. Mesh opening of pelagic trawl ≥ 20 mm.
- Turkey: mesh opening of bottom trawl ≥ 44 mm. Mesh opening of strengthening bag ≥ 88 mm in Aegean Sea and Mediterranean sea. Mesh opening of shrimp trawl to catch prawns and shrimps in the Mediterranean ≥ 44 mm. Mesh opening of strengthening bag ≥ 96 mm, of tunnel and belly ≥ 56 mm, of wings ≥ 96 mm. Mesh opening of beam trawls (they are permitted only in the Sea of Marmara) for

deep water pink shrimp ≥ 32 mm, for Rapa whelk ≥ 96 mm in codend and other parts.

- Greece: mesh opening of bottom trawl ≥ 40 mm.
- Albanian: mesh opening of bottom trawl ≥ 40 mm. Mesh opening of pelagic trawl (for sardines and anchovies) ≥ 20 mm.
- Spain: mesh opening of bottom trawl ≥ 40 mm. Spanish fleets are prohibited from using pelagic trawls by national legislation.
- Morocco: mesh opening of bottom trawl in the Mediterranean sea ≥ 40 mm.
- Tunisia: mesh bar of bottom trawl ≥ 20 mm. Mesh bar of pelagic trawl ≥ 20 mm
- Croatia: i) internal fishing areas: mesh bar of bottom trawl ≥ 24 mm; mesh bar of strengthening bag ≥ 48 mm. ii) other fishing areas: mesh bar of bottom trawl ≥ 20 mm; mesh bar of strengthening bag ≥ 40 mm. iii) coastal trawl: mesh bar ≥ 12 mm; mesh bar of strengthening bag ≥ 24 mm. Mesh bar of pelagic trawl for small pelagics ≥ 9 mm.

TRAWL DIMENSIONS

- EU countries: circumference of strengthening bag ≥ codend circumference. Strengthening bags smaller than the dimensions of the codend may be attached to nets having a mesh size equal to or less than 60 mm.
- Italy: in the Tyrrhenian sea the use of bobbins, rollers or spheres mounted on the groundrope is prohibited; the chain must be tight joined to the groundrope; the diameter of the groundrope ≤ 40 mm; specific weight of the groundrope ≥ one.
- France: i) "gangui" for fish and prawn: weight of panels ≤ 90kg; ii) "gangui" for "oursin": mouth ≤ 1.5 m; iii) "petit gangui" for fish and prawn: codend length ≤ 10 m, weight of the gear without net ≤ 30 kg; mouth ≤ 1.5 m; iv) "petit gangui" for "oursin": codend length ≤ 1.5 m; mouth ≤ 1.5 m; weight of the gear without net ≤ 30 kg
- Turkey: Bottom trawl: Shrimp trawl to catch prawns and shrimps in the Mediterranean: maximum permitted codend length is 5 m; tunnel and belly maximum permitted length is 8 m; wings maximum permitted length is 9 m, maximum permitted total length of the trawl is 22 m. In addition to the shrimp trawl net, a maximum total length of 26 m for other trawl net that has no lead on sweep lines between dan-leno (triangle) gear (in front of the wings) and doors is permitted. Beam trawls: they are permitted only in the Sea of Marmara to catch deep water pink shrimp; maximum beam vertical height 50 cm. Twin (doubled) beam trawl (with double-codend); maximum permitted horizontal beam width is 15 m (the beam is divided into two equal parts and two same trawl nets rigged to the beams, separately), maximum permitted codend length is 11 m (6 fathom). Single beam trawl; maximum single permitted horizontal beam width is 5 m; maximum permitted codend length is 11 m (6 fathom). The maximum permitted number of single beam trawl is 3 only at the same time for one beam trawl vessel. For Rapa whelk: maximum permitted horizontal beam width and vertical height are 3 m and 40 cm, respectively, maximum permitted codend length is 1 m.

TWINE THICKNESS

- Morocco: diameter ≤ 4 mm in any part of the net.
- Egypt: in any part of the net the twine thickness shall be ≤ 3.0 mm. In the codend the use of netting materials consisting of multiples twine shall be prohibited. In the codend the single twine shall have a twine thickness ≤ 2.5 mm.

SEINES

- EU countries: beach seines are prohibited from 1 January 2002 (EC Reg. 1626/94), unless the Council, acting by a qualified majority on a proposal from the Commission, decided otherwise in the light of scientific data.

- Italy: boat seine for juveniles of sardines and *Aphia minuta* is allowed: mesh opening ≥ 5 mm; only in Tuscany mesh opening ≥ 3mm. The ground rope can't have chains or teeth to penetrate the sea bottom. Boat and beach seine for juveniles for acquaculture: mesh opening ≥ 1 mm; length of head-line ≤ 40 m
- Croatia: mesh dimension of: i) Summer sardine seine: mesh bar ≥ 8 mm: ii) winter pickarel seine: mesh bar ≥ 12 mm; iii) beach seine "migavica": mesh bar ≥ 12 mm; iv) garfish seine: mesh bar ≥ 10 mm; v) big pelagic seine "sabakun": mesh bar ≥ 28 mm; vi) big scale sand smelt seine: mesh bar ≥ 5 mm; for this kind of seine the length of rope of each wing shall be ≤ 500 m; vii) Tramata Fishing – Ludar: mesh bar: ≥ 32 mm; kvadrun mesh bar: ≥ 22; maximum length of ropes on each side: 2000 m; viii) Tramata Fishing – Zagonica and Tramata Fishing – Fruzata: mesh bar ≥ 32 mm; one wing on the coast, other with maximum length of rope: 2000 m.
- Greece: mesh opening of codend ≥ 16 mm, mesh opening of the rest of bag ≥ 10 mm, wings ≥ 12 mm, final part of wings ≥ 300 mm. The fishing nets can't have leads, chains, stones, white sails. Total length of seine ≤ 80 m. Length of hauling ropes ≤ 700 m.
- Malta: mesh opening ≥ 8.5 mm.
- Egypt: mesh opening ≥ 20 mm. In the codend the use of netting materials consisting of multiples twine shall be prohibited. In the codend the single twine shall have a twine thickness ≤ 5mm.
- Tunisia: mesh bar ≥ 12 mm for small pelagics, ≥ 50 mm for large pelagics
- Turkey: manyat; a kind of boat seines aims to catch mainly deep water rose shrimp in the Sea of Marmara. The allowed minimum mesh size for "Manyat" is 28 mm until 1 September 2007; after this time 32 mm.

BOTTOM-SET NETS

MESH SIZE

- Italy: mesh opening of gillnet and trammel net ≥ 20 mm. In Sicily: mesh opening ≥ 40 mm. In Sardinia only: mesh opening ≥ 50 mm. Drift net (ferrettara): mesh opening ≤ 180 mm (to catch anchovy, sardine, bogue, salema, Greater amberjack, Round sardinella, mackerel, Saddled seabream)
- Greece: no general regulation concerning mesh opening. Only in certain areas there is a regulation concerning mesh dimension [In Thessaloniki and Thermaikos gulfs minimum mesh opening for static nets is 18 mm. It is prohibited the use of nets with mesh opening ≤ 34 mm knot to knot, for fishing *Solea* spp. in the Alexandroupolis area and within 3 NM from the coast. It is prohibited to set fixed net with mesh opening ≤ 32 mm knot to knot, in part of Maliakos Gulf. In other part of the Maliakos Gulf the mesh opening must be ≥ 22 mm. It is prohibited to set fixed net with mesh opening ≤ 40 mm stretched, within 1.5 NM from the coasts of Mesolongi lagoon. It is prohibited to set trammel nets with mesh opening ≤ 48 mm stretched, except during June when mesh opening shall be ≥ 56 mm in Kalimnos-Kos Isl. area]. "Veranda net": Mesh opening ≥ 22 mm. In Thessaloniki and Thermaikos gulfs minimum mesh opening for "veranda" nets is 20 mm. It is prohibited to be used surrounding nets. For combined nets the same legislation described for fixed nets shall be applied.
- Algerian: mesh opening of fixed net ≥ 24 mm. Mesh opening of floating net ≥ 130 mm.
- Morocco: mesh bar of gillnet: ≥ 70 mm. Trammel net: internal panel: mesh bar ≥ 70 mm, external panel: mesh bar ≥ 200 mm.
- Croatia: 10 different gillnets mesh bar depending on target species. Range of mesh bar: 5–130 mm. 5 different trammel nets for various marine organisms, range of inner panel mesh bar: 32–120 mm, range of outer panel mesh bar: 150–350 mm

- Spain: mesh opening of gillnet ≥ 50 mm (not for large pelagics). Mesh opening of drift net ≤ 150 mm (to catch *Sarda sarda* and *Auxis* spp).
- Tunisian: mesh bar of passive gears (Gillnet and Trammel net) ≥ 30 mm. (Derogation: mesh bar ≥ 160 mm for common lobsters). Drift net forbidden from 01/01/2002
- Turkey: mesh opening ≥ 72 mm for sole and sand dab until 1 September 2007 after this time 80 mm. Mesh opening ≥ 48 mm for grey mullets in trammel nets. This legislation only concerns the part of trammel nets (with pikes) set over the surface.
- Egypt: mesh opening of gillnet ≥ 34 mm and ≤ 40 mm?? The mesh opening of the panel of trammel net in the combined net and trammel net shall be: ≥ 150 mm and ≤ 200 mm for the external panels, and ≥ 12 mm and ≤ 16 mm for the internal panel??

DIMENSIONS OF SET-NETS

- EU countries: bottom-set nets: drop ≤ 4m, length ≤ 5 km.
- Italy: length of drift net (ferrettara) ≤ 2.5 km.
- Spain: fixed nets: for each panel length ≤ 50 m, drop ≤ 25 m. Total length ≤ 2.5 km. Drift net: length ≤ 1.5 km.
- Morocco: trammel net: length ≤ 250 m. Gillnet: drop ≤ 30 m, length ≤ 200 m (distance between 2 set of net ≥ 200 m in parallel and 100 m in perpendicular direction). Drift net: length ≤ 2.5 km.
- Egypt: gillnet: height ≤ 12 m; length ≤ 300 m.
- Tunisian: gillnet: length ≤ 2.5 km. Drift nets are prohibited.
- Greece: only one regulation exists concerning the dimension of the gear in part of Maliakos Gulf, where it is prohibited to use any type of nets with width ≥ 13 m.
- Croatia: height of gillnet with mesh bar ≤ 40 mm: ≤ 20 m; other nets ≤ 4 m; length ≤ 5000 m.

TWINE SPECIFICATIONS

- Greece: since 01.07.1978 it is prohibited to use nets made of monofilament.
- Morocco: the use of fixed net made of monofilament is prohibited.

SURROUNDING NETS

MESH SIZE

- EU countries: mesh opening ≥ 14 mm
- Italy: derogation for catching juveniles of sardines, juveniles for aquaculture and *Aphia minuta*: mesh opening ≥ 5 mm
- Spain: mesh opening ≥ 120 mm (purse seine to catch bluefin tuna)
- Morocco: mesh bar ≥ 15 mm for surrounding net used with lamps
- Greece: nightly purse seine: mesh opening ≥ 14 mm. Daily purse seine: mesh opening ≥ 40 mm. Without purse line "kouloura": Mesh opening ≥ 22 mm.
- Tunisia: mesh bar ≥ 12 mm for small pelagics. Mesh bar ≥ 50 mm for large pelagics.
- Croatia: i) purse seine for tuna: mesh bar ≥ 40 mm; ii) purse seine for large pelagics: mesh bar ≥ 34 mm; iii) purse seine for small pelagics: mesh bar ≥ 8 mm; iv) purse seine for garfish: mesh bar ≥ 10 mm; v) purse seine for grey mullet: mesh bar ≥ 26 mm; vi) purse seine for big scale sand smelt: mesh bar ≥ 5 mm.
- Egypt: mesh size of the codend for sardine and other pelagics ≥ 60 mm.
- Albanian: surrounding net for small pelagics (where they consist in 85% of live weight of the catch): mesh opening ≥ 20 mm.

- Turkey: mesh size of the bunt (a part of the purse seine net that fishes collected before harvesting) for bluefin tuna ≥ 44 mm.

DIMENSIONS OF SURROUNDING NETS

- EU countries: length ≤ 800 m, drop ≤ 120 m, except in the case of tuna seines.
- Spain: length ≤ 1800 m, drop ≤ 250 m only to catch bluefin tuna
- Morocco: length ≤ 200 m, drop ≤ 30 m for sardines, length ≤ 260 m, drop ≤ 45 m, for mackerel and bonito
- Greece: without purse line "kouloura": net length ≤ 500 m, drop to ≤ 13 m, up to 10 m may be trammel, upper part at least 1 m gill net, lower part at least 2 m gill net.
- Croatia: length ≤ 800 m, drop ≤ ¼ of length

TRAPS and POTS

- Italy: local maritime offices decide the management of traps fishery in each region: number of gears, length etc. Only in Sardinia fyke net: mesh bar of the wings ≥ 14 mm, mesh bar of the body ≥ 12 mm, mesh bar of the codend ≥ 10 mm. Only in Sardinia: for boats ≤ 5 TSL: 300 pots for each fisherman onboard (maximum of 800 pots); for boats ≥ 5 TSL: 300 pots for each fisherman onboard (maximum of 1200 pots).
- Tunisian: mesh bar ≥ 150 mm and ≤ 200 mm for netting panel of body and rooms of "tonnara". Mesh bar ≥ 40 mm and ≤ 50 mm for netting panel of death room of "tonnara". Mesh bar ≥ 20 mm for traps made of square or diamond mesh netting, mesh bar ≥ 30 mm for traps made of triangular mesh netting. For *Anguilla anguilla* mesh bar ≥ 10 mm with square and diamond mesh netting, mesh bar ≥ 15 mm with triangular mesh netting.
- Greece: fyke nets can be set in pairs, total length ≤ 8 m, mesh opening ≥ 40 mm, diameter ≤ 60 cm. Pots: diameter ≥ 12 cm, length: 25–30 cm, they can bear weights inside. Cylindrical traps for fishes: inflexible frame dressed with net, diameter ≤ 1 m, height ≤ 50 cm, opening ≥ 13 cm diameter. Traps for crustaceans: inflexible frame dressed with net with mesh size ≥ 28 mm stretched, with 2 openings, length and width ≤ 80 cm, height ≤ 45 cm. Each vessel can use a number of gears: ≤ 1000 pairs of fyke nets, or ≤ 1500 pots, or ≤ 300 traps for crustaceans or cylindrical traps for fishes. [Regional legislation: It is prohibited to set pots with mesh opening ≤ 40 mm stretched within 1.5 NM from the coasts of Mesolongi lagoon. Only pots for fishing eels can have mesh opening ≥ 10 mm and this type of fishing is allowed from November to February].
- Malta: mesh opening ≥ 25.5 mm
- Croatia: i) fish pots: square mesh ≥ 32 mm (bar), number per boat ≤ 50; ii) Norway lobster pots: square mesh ≥ 18 mm (bar); number per boat ≤ 300; iii) Lobster pots: square mesh ≥ 55 mm (bar); number per boat ≤ 150; iv) fyke net: for eel: ≥ 12 mm; big scale sand smelt mesh bar: 5–12 mm

DREDGES AND RAKES

- Italy: towed gears for molluscs: mesh opening ≥ 50–60 mm (depending of the target species). Breadth of dredges ≤ 1.60 m. Boat rake: Mesh opening ≥ 20mm for clams, ≥ 30 mm for other molluscs. Breadth of dredges ≤ 1.50 m. Length of the net (belly and codend) ≤ 2 m. Hydraulic dredge: Breadth of dredges ≤ 3 m; Pressure on the dredge ≤ 1.8 Bar; Weight of the dredge ≤ 600 kg. Different type of sieve and cage: for striped venus the spacing shall be ≥ 12 mm if the cage consist of bars and ≥ 12 mm if rectangular wire cages, and the hole diameter ≥ 21 mm if a drainer plate. For razor shell only the cage consist of bars shall be allowed and the space between bars shall be ≥ 7 mm. For smooth clam only the cage consist of bars shall be allowed and the space between bars shall be ≥ 25 mm.

- Greece: towed gears for molluscs: the net cannot be metallic; mesh opening ≥ 35 mm. Dredge consist of metallic triangle frame, with maximum intersection 2 cm and base length 1.2 m. In the base: length of teeth ≤ 3 cm, distance between teeth ≥ 15 cm. Weight of the dredge ≤ 12 kg. Total length of the codend of dredge ≤ 1.5 m. Hauling rope is not allowed to be metallic. Only one dredge per fishing vessel. Boat rake: the net cannot be metallic; mesh opening ≥ 35 mm. Base length: 30 cm, width: 2 cm. In the base: length of teeth ≤ 3 cm, distance between teeth ≥ 3 cm. Breadth of dredges ≤ 5m. Rake is towed by hand without the use of any mechanic mean.
- Croatia: for *Pecten jacobaeus*: mesh bar ≥ 40 mm; length ≤ 4 m, n. ≤ 2 per boat; for *Arca noae*: mesh bar ≥ 28 mm; length ≤ 2,8 m, n. ≤ 2 per boat.
- Turkey: the mouth of mechanical dredges cannot exceed 80 cm in width; 20 cm in height and length of the net bag is max 200 cm. The mouth of hydraulic dredges cannot exceed 350 cm in width and 30 cm in height. Bars spacing of the sieve and of the dredges for striped Venus (*Chamelea gallina*) is 9.5 mm. Sieve for golden carpet-shell ≥ 24 mm; sieve for warty venus ≥ 30 mm
- France: mesh opening ≥ 80 mm to catch oyster; mesh opening ≥ 60 mm to catch molluscs other than oyster.
- Malta: dredge for prawns: length ≤ 3.1 m; mesh opening of the net ≥ 6.5 mm.

LONGLINES

- EU countries: 7.000 m for bottom-longline, 60.000 m for drifting longline.
- Greece: [Regional legislation: In Kalimnos-Kos area it is prohibited to set longlines with ≥ 1000 hooks; hooks dimension: ≤ 2 cm length, ≤ 0.9 cm width].
- Italy: only in Sicily the hooks for the catch of large pelagics must be from number 0 to number 2.
- Algerian: 3 types: fixed longline, drifting longline, towed line.
- Croatia: 2.000 hooks for bottom-longline, 500 hooks for surface longline.
- Albanian: hook dimension for *Xiphias galdius*: length ≤ 10 cm, width ≤ 4.5 cm.
- Turkey: hook dimension: for tuna and swordfish: hooks of number 1 and 2; for set longline: hooks of number ≥ 10.
- Egypt: only the hooks from number 6 to number 12 shall be used.
- Spain: surface longline. Length ≤ 25 km; N. ≤ 10.000 hooks (*Auxis* spp, *Thunnus alalunga*, *Euthynnus alletteratus*), length ≤ 60 km; N. ≤ 2.000 hooks (Swordfish, marrajo). Hook dimension:

SPECIES	LENGTH (cm)	WIDTH (cm)
Thunnus thynnus	**7**	**3.6**
Auxis spp	**3**	**1.5**
Sarda sarda	**3**	**1.5**
Thunnus alalunga	**3.7**	**1.7**
Euthynnus alletteratus	**3.7**	**1.7**
Xiphias galdius	**7**	**2.9**
Marrajo	**7**	**2.9**

- Bottom longline: length ≤ 7 km; N. ≤ 3.000 hooks.

CONSIDERATIONS ON THE EC REG. 1967/2006

This section intends to underline some points that are difficult to understand in the New EC Reg. 1967/06. It also aims to evidence some possible defencies in fishing gear legislation in order to suggest potential solutions or technical characteristics that need a more in depth investigation. Most of the following considerations are our personal ideas and suggestions.

EC Reg. 1967/06 implements some technical parameters very important to selectivity such as mesh configuration (square mesh codends) and the twine diameter of towed nets and gillnets. In particular the introduction of a minimum twine thickness is beneficial, mainly in countries where PE netting in the codend makes the net very stiff reducing its selective characteristics. Some papers evidence the importance of twine diameter in improving selectivity and reducing bycatch (Kynoch *et al*., 1999, Lowry and Robertson, 1996; Shevtsov, 1979) also with PA knotless netting codend in the Mediterranean Sea (Sala *et al*., 2007). Nevertheless it is possible to raise a few considerations:

1) The mesh dimensions of fishing gears are generically described as minimum mesh size without specification of mesh opening, length or bar length. The same lack of precision is observed for the mounting of nets defined as the sum of the height of the meshes (including knots).
2) The use of square mesh panels in bottom trawls is not well described. Art. 9 reports: "from 1 July 2008, the net referred to in point 1 shall be replaced by a square-meshed net of 40 mm at the codend or, at the duly justified request of the ship owner, by a diamond meshed net of 50 mm".
3) Shore seines: prohibited from 2002 by the EU reg. 1626/94.
4) The minimum mesh size/opening of combined-nets and trammel net are not defined.
5) Measuring the twine diameter of gillnets (0.5 mm) is problematical.
6) The twine of the trammel net is not defined.
7) What does "fixed, or capable of being fixed by any means to the bottom of the sea" mean? (Gear is fixed or drifting)
8) For EU countries the change in the mounting of gillnets and combined nets from 4 m to 10 m (or 30 m) represents a very large increase, considering that prohibitions about the distance from the coast or bottom depth are not defined.
9) EC REG 1967/06 says: "Bottom-set nets shall not be used to catch the following species: Albacore (*Thunnus alalunga*), Bluefin tuna (*Thunnus thynnus*), Swordfish (*Xiphias gladius*), Ray's bream (*Brama brama*), Sharks (*Hexanchus griseus*; *Cetorhinus maximus*; Alopiidae; Carcharhinidae; Sphyrnidae; Isuridae and Lamnidae): we think that the mounting of gillnets and combined bottom-set nets from 10 m to 30 m (if shorter than 500m) without prohibition concerning the distance from the coast or bottom depth could not to protect those species.
10) Drift nets are not included in the classification and definition of the gears but they are cited in Annex II. EC Reg. 1239/98 prohibits driftnets for large pelagics but in Italy i.e. there is also a regular drift net called "ferrettara" which don't have large pelagics as target species.
11) Many points are, in our opinion, difficult to control from a fishery inspectorate perspective: i.e. Art.4 concerning the fishing activity on Posidonian beds or Maerl beds.
12) Annex II says that "the length of bottom-set and drifting nets may be also defined on the basis of the weight or volume of its mass" but it does not indicate in which way.
13) Too many derogations are included concerning fishing gears and fishing areas, this make the work of fishery inspectors very difficult.
14) No indications are provided for the dimension and characteristics of the cage and sieve of dredges.
15) Only the dimensions of hooks for *Pagellus bogaraveo* are defined.

CONSIDERATIONS ON NATIONAL LEGISLATIONS

The legislation of most Mediterranean countries reflects the morphology of the coast, the diversity of habitats or seabed characteristics, than the situation of local fisheries. Much legislation regarding fishing gears of small-scale artisanal fisheries, such as bottom-set nets, traps or small seines, must have a high level of accuracy. This surely reflects the specific measures needed for the management of the Mediterranean Sea.

Concerning the mesh dimensions of towed nets the solutions adopted in different countries of the Mediterranean Sea seem to converge at 40 mm (mesh opening) for bottom trawl, and to 20 mm (mesh opening) for pelagic trawls targeting small pelagics.

The national legislation of Croatia refers to the mesh bar but is not harmonized with EU legislation. Croatia adopted 10 mm mesh bar length for pelagic trawls. In Tunisia the minimum mesh size of pelagic trawl (20 mm mesh bar) leads to problems because most of the small pelagic fishes are meshed or gilled.

The legislation of Croatia and Turkey reflects the very complicated morphology (many islands, rocky habitats etc) and fisheries of these countries: in fact in Croatia there is a minimum mesh bar of 24 mm for internal fishing areas, 20 mm mesh bar for other fishing areas and a minimum mesh bar of 12 mm for coastal trawl. Turkey has three different mesh sizes for bottom trawl, shrimp trawl and beam trawl.

Turkey has a very sophisticated legislation for shrimp trawl; they regulated the dimension of the codend meshes but also of the extension, belly and wings. Only Turkey defines a maximum dimension for shrimp trawls and beam trawls.

A derogation from the minimum mesh opening is allowed in Italy for authorized fishing vessels to catch juvenile sardines and *Aphia minuta* (mesh opening of 5 mm) and in Sicily to catch rose shrimp (mesh opening 26 mm). In comparison France and Turkey have a minimum mesh opening for the bottom trawls bigger than the other countries: 45 mm and 44 mm respectively.

In France there is a very typical legislation for the gangui both for the mesh opening and the dimensions.

Specific legislation for the footrope is applied in Italy only.

Many countries, mainly those of the North Africa do not apply any regulations on strengthening bags. Morocco and Egypt fix a maximum twine thickness for towed nets.

For different nations the mesh opening of seines is spread over a wide range of sizes depending on the target species. Seine is a very important gear in Croatia and Greece.

Croatia has 6 different minimum mesh bar lengths and as many species. Moreover there are 3 other minimum mesh bar lengths for very typical kinds of seine: traumata fishing Ludar, Zagonica and Fruzata. The Greek legislation on boat seine is very complete and accurate: the mesh opening of codend and other part of the net is regulated. The length of net (total length of seine) and hauling rope are also legislated. A similar approach to the wing ropes is applied in Croatia.

The dimensions of Italian seine targeting juveniles for aquaculture is also regulated: the headline is restricted to a maximum length of 40 m.

For bottom-set nets each country has typical minimum mesh size; in many cases the minimum mesh size of gillnets differ from that of trammel nets. Croatia, as observed for other fishing gears, has the widest range of mesh sizes reflecting both the complexity of habitats and the

importance of small-scale fisheries in that country. In fact in Croatia there are 10 different types of gillnets and 5 kinds of trammel nets.

In Italy there are three minimum mesh opening in different regions. In Greece there is not a general legislation concerning mesh opening. Only certain regions have a regulation fixing mesh dimension.

Morocco has established the biggest mesh size both for gillnets and trammel nets.

Concerning the dimensions of the bottom-set nets, the EU countries have common legislation fixing to 5 km in length and to 4 m the height of fixed nets. In the other countries the height of the nets is generally greater than in the EU nations; it ranges from 12 m (Egypt) to 30 m (Morocco).

Only Greece and Morocco have prohibited the use of nets made of monofilament.

Spain and Italy have a similar approach to regulating drift nets: they fixed a maximum mesh opening (notice that for the other passive nets the minimum mesh opening is regulated) in order to catch species other than bluefin tuna and swordfish (Italian "spadara" used to catch swordfish are prohibited from 2002, had a minimum mesh opening of 350 mm). In other countries a minimum mesh opening is fixed. In Morocco the mesh opening is not regulated.

Two main types of surrounding nets exist: for small pelagics and for large pelagics. The mesh dimensions of small pelagics surrounding net are very similar in the countries of the north side of the Mediterranean Sea: 14 mm mesh opening for EU countries, 20 mm for Albania. In Egypt there are some problems because the mesh size of the codend for sardines and other pelagics is fixed to 60 mm. Tunisia and Morocco fixed the mesh dimension to 12 mm (bar) and 15 mm (bar) respectively. Spain, Croatia, Tunisia, Greece and Turkey have a minimum mesh size also for surrounding nets targeting Bluefin tuna or large pelagics. Croatia, as already observed for other fishing gears, has other minimum mesh bar lengths depending on the target species.

The dimensions of surrounding nets significantly vary from EU countries to not EU countries, except for Croatia. The length and the height of surrounding net are geometrically strongly correlated and we believe that for EU the minimum height necessary to close an 800 m purse seine is at least 130 m.

Many countries have a really complicated but exhaustive legislation about traps and pots concerning mesh dimension (mesh opening or mesh bar), number of traps per fishing vessel, traps dimension, pots diameter etc.

Dredges and rakes legislations are very detailed in Italy, Greece and Turkey. Generally the breadth and height of the cage, frame or dredge is regulated; the dimensions of hydraulic dredges are usually bigger than those of rakes or towed gears.

The mesh dimensions of the net change in relation to different species; generally dredges for oysters have the biggest mesh dimension. In some cases only a maximum length of net is admitted. In Greece the length of teeth and the distance between teeth are regulated in order to reduce the impact on the seabed.

In Greece the material too is legislated because the net cannot be metallic.

In the case of hydraulic dredge the characteristics of the cages or sieves (on board) are regulated: the space between bars and/or the diameter of the holes (if the cage or the sieve are made of a metal sheet) generally depend on the target species.

In Italy the weight of hydraulic cages and the water pressure on the gears are also fixed.

Two main management measures are established until now for longlines: a maximum set dimension and a minimum hooks dimension are defined. The maximum dimensions of longline are evaluated in different countries in two ways: the length of the entire set (surface longline and bottom longline), the number of hooks. The hook dimensions are regulated in the kind of hook number (Sicily, Turkey, Tunisia, and Egypt), length and width of each hook (Spain, Albania).

CONCLUSIONS

- The EC Reg. 1626/94 specifically states in Art. 2: "Member States with a Mediterranean coastline may continue to legislate in the areas covered by paragraph 1 [12 miles], including that of non-commercial fisheries, by adopting measures supplementary to, or going beyond the minimum requirements of, the system established by this Regulation, provided such measures are compatible with Community law and in conformity with the common fisheries policy". The new EC Reg. 1967/06 does not contain a similar provision; for National legislation art 9 and 10 of the EC Reg. 2371/06 should be applied. Art. 9 states: "A Member State may take non-discriminatory measures for the conservation and management of fisheries resources and to minimise the effect of fishing on the conservation of marine eco-systems within 12 nautical miles of its baselines provided that the Community has not adopted measures addressing conservation and management specifically for this area". In summary it is still possible to adopt measures supplementary to, or going beyond the minimum requirements of the system established by the Regulation 1967/06.
- It could be useful to define the term "mesh size" more precisely; Reg. 1967/06 obviously refers to the mesh opening but we think it could be better to clarify that to avoid possible disputes with fishermen.
- In Turkey minimum mesh opening for a codend and other panels and fixing a maximum dimension for towed nets is defined. This is considered a good solution.
- EC Reg. 1967/06 states: "In the case of a square mesh codend, in particular, the circumference of the rearmost part of the trawl body or of the extension piece shall be from two to four times the circumference of the front end of the codend sensu stricto". We believe that the joining of codend with the extension needs a more detailed description, in order to guarantee the right behaviour of the net during towing and to improve selectivity.
- EC Regulation 1967/2006 states that the traditional diamond codend shall be replaced by a square-meshed net of 40 mm: it would be favourable to test more extensively the use of square mesh windows and sorting grids in the Mediterranean Sea.
- It would be useful to establish some restrictions on footrope, mainly for towed nets operating on hard ground.
- In Italy a growing number of fishermen are diversifying from traditional bottom trawls to twin trawls. Some advice in this field could prevent increased fishing effort. We suggest paying attention to this part of the EC Reg. 1967/06 that states: "Technical specifications limiting the maximum dimension of floatline, groundrope, circumference or perimeter of trawl nets along with the maximum number of nets in multi-rig trawl nets shall be adopted, by October 2007…". We believe it is very important to test these gears more extensively in the Mediterranean Sea.
- The use of double codend or separator panels could represent good solutions to reduce discards.
- It would be useful to define a minimum dimension also for towed nets.
- It would be useful to mark towed nets during the fishing operations, at least in shallow waters: in fact in the last years some accidents at sea were caused by the lack of marking of trawl nets (fishermen incorrectly evaluated the position of the boat in respect to the net). Moreover in this way for the fisheries inspectors this

would be useful to evaluate the real position of a trawl net in respect of the vessel.

- To define a minimum distance between different bottom-set gears would be advantageous for management: a passage to allow the escape of juveniles is crucial to guarantee responsible use of resources, mainly in coastal areas, i.e. during the reproduction season of cuttlefish.
- The illegal drift nets targeting swordfishes represents a big problem, mainly in Italy; for this it could be dangerous to allow a floating gillnet, even though fixed to the bottom, with a depth of 30 m, even if the length is shorter than 500 m.
- The minimum height necessary to close an 800 m purse seine is at least 130 m. The regulations should be adjusted in consideration of the specific geometry of purse seines. Moreover it's very difficult for fisheries inspectors to evaluate the real length and height of a purse seine. No practical method exists for measurement of maximum length of purse seines and bottom-set nets. A simple, clear and quick way to estimate the length of purse seine should be suggested for the Mediterranean Sea.
- Soak time is currently unlimited; effort reduction would be more effective if soak time was limited.
- The hanging ratio has been shown to be an important factor in size and species selectivity of static gears and it should be defined in technical measures.
- The number, the dimension and the shape of hooks should be fixed, mainly in longline fisheries. Moreover the hook gap and shape might be a more effective measure than width and length.
- Following the example of national legislations, the EU regulation for the Mediterranean Sea should consider advice on the mesh opening of the traps (the problems of ghost gears).
- In our opinion for the future we have to pay more attention to trap fisheries; in fact they have the most sophisticated legislation reflecting the importance of their management. The use of these selective fishing gears should be tested in new areas and habitats.
- Dredges and rakes imply a high level of physical impact on the seabed and bottom communities; specific and very careful measures for their management are necessary. The EC Reg. 1967/2006 fixes the maximum breadth of dredges at 3 m, but also the weight of the dredge is an important parameter.
- In the case of hydraulic dredges, no measures are contained in EC Reg. 1967/2006 concerning the pressure on the bottom.
- To reduce the impact of dredges or towed net, such as the rapido trawl in Italian waters, the Greek approach would be useful: the length of teeth and the distance between teeth should be regulated.
- In many regions the impact of leisure fisheries is very high (i.e. in Italy the fisheries targeting tunas of swordfishes). More detailed advice is required to ensure proper monitoring of leisure fisheries.

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Unusual values

- Algerian: Towed net mesh opening ≥ 70 mm.
- Tunisia: Mesh bar ≥ 12 mm for small pelagics; mesh bar ≥ 50 mm for large pelagics
- Morocco: drift net: mesh opening ≥ 400 mm
- Egypt: the mesh opening of the gillnet shall be ≥ 34 mm and ≤ 40 mm. The mesh opening of the panel of trammel net in the combined net and trammel net shall be: ≥ 150 mm and ≤ 200 mm for the external panels, and ≥ 12 mm and ≤ 16 mm for the internal panel
- Morocco: the use of fixed net made of monofilament is forbidden.
- Egypt: mesh size of the codend for sardine and other pelagics ≥ 60 mm.
- Greece: without purse line "kouloura": Net length ≤ 500 m, Drop to ≤ 13 m, up to 10 m may be trammel, upper part at least 1 m gill net, lower part at least 2 m gill net.

Annex 6: Preliminary text for FAO-ICES Gear Classification

DRAFT Report on proposed FAO-ICES Classification and Description of Fishing Gears

Note that this is a Draft and as such should not be used to replace the existing 1971 Classification

Gear Categories	Standard Abbreviations	FAO/ICES	ISSCFG
SURROUNDING NETS		01.0.0	01.0.0
Purse seines	PS	01.1.0	01.1.0
One boat operated purse seines	PS1	01.1.1	01.1.1
Two boats operated purse seines	PS2	01.1.2	01.1.2
Surrounding net without purse line	LA	01.2.0	01.2.0
SEINE NETS		02.0.0	02.0.0
Beach seines	SB	02.1.0	02.1.0
Boat seines	SV	02.2.0	02.2.0
TRAWLS		03.0.0	03.0.0
Bottom trawls	TB	03.1.0	03.1.0
Beam trawls	TBB	03.1.1	03.1.1
Single bottom otter trawls	OTB	03.1.2	03.1.2
Twin bottom otter trawls	OTD	03.1.3	
Multiple bottom otter trawls	OTT	03.1.4	
Bottom pair trawls	PTB	03.1.5	03.1.3
Midwater trawls	TM	03.2.0	03.2.0
Single boat midwater trawl	OTM	03.2.1	03.2.1
Midwater pair trawl	PTM	03.2.2	03.2.2
DREDGES	DR	04.0.0	04.0.0
Boat dredges	ORB	04.1.0	04.1.0
Towed dredges	DRT	04.1.1	
Mechanized dredges	DRM	04.1.2	
Hand dredges	DRH	04.2.0	04.2.0
LIFT NETS	LN	05.0.0	05.0.0
Portable hand lift nets	LNP	05.1.0	05.1.0
Boat-operated lift nets	LNB	05.2.0	05.2.0
Stationary lift nets	LNS	05.3.0	05.3.0
FALLING GEARS	FG	06.0.0	06.0.0
Manual cast nets	FCN	06.1.0	06.1.0
Mechanized cast nets	MCN	06.2.0	
Cover pot/Lantern net	FLN	06.3.0	06.3.0
GILLNETS AND ENTANGLING NETS	GN	07.0.0	07.0.0
Set Gillnets	GNS	07.1.0	07.1.0
Driftnets	GND	07.2.0	07.2.0
Encircling gillnets	GNC	07.3.0	07.3.0
Fixed gillnets (on stakes)	GNF	07.4.0	07.4.0
Trammel nets	GTR	07.5.0	07.5.0
Combined gillnets-trammel nets	GTN	07.6.0	07.6.0
TRAPS	TP	08.0.0	08.0.0
Stationary uncovered pound nets	FPN	08.1.0	08.1.0

GEAR CATEGORIES	STANDARD ABBREVIATIONS	FAO/ICES	ISSCFG
Pots	FPO	08.2.0	08.2.0
Fyke nets	FYK	08.3.0	08.3.0
Stow Nets	FSN	08.4.0	08.4.0
Barriers, fences, weirs, etc	FWR	08.5.0	08.5.0
Aerial traps	FAR	08.6.0	08.6.0
HOOKS AND LINES	LH	09.0.0	09.0.0
Hand operated pole and jig lines	LHP	09.1.0	09.1.0
Mechanically operated pole and jig lines	LHM	09.2.0	09.2.0
Set longlines	LLS	09.3.0	09.3.0
Drifting longlines	LLD	09.4.0	09.4.0
Vertical set lines	LTR	09.5.0	
Trolling lines	LTL	09.6.0	09.6.0
OTHER GEARS	OG	10.0.0	10.0.0
Wrenching gear	WOG	10.1.0	10.1.0
Clamps	COG	10.2.0	10.2.0
Rakes	ROG	10.3.0	10.3.0
Tongs	TOG	10.4.0	10.4.0
Spears	SOG	10.5.0	10.5.0
Harpoons	HAR	10.6.0	10.6.0
Electric fishing	EOG	10.7.0	
Towed fyke net	FOG	10.8.0	
Push nets	PUG	10.9.0	
Scoop nets	NOG	10.10.0	
Drive in nets	DOG	10.11.0	
Pumps	HMP	10.12.0	
Diving	DIV	10.13.0	
MISCELLANEOUS	MIS	20.0.0	
NOT CODED FISHING GEARS	NK	99.0.0	

1. SURROUNDING NETS

A surrounding net catches the fish by surrounding them from both the sides and from underneath. It consists of netting framed by lines; a float line along the top at the surface and a weighted line along the bottom.

1.1. Purse seines

Purse seines are designed to catch schooling fish. A purse seine is made of a long wall of netting framed with a lead line and a float line. The purse seine is set from one or two boats to surround a detected school of fish. A purse line threaded through purse rings spaced along the bottom of the net is drawn tight (pursed) to stop the school of fish escaping downwards under the net.

1.1.1. One boat operated purse seines

This category comprises purse seines operated by a single boat, with or without an auxiliary skiff. The strongest part of the net, the “bunt”, is where the catch is concentrated and is usually placed at one end of the purse seine.

Handling of the gear may be mechanised, e.g. by a hydraulic power block or a net drum.

1.1.2. Two boat operated purse seines

This category comprises purse seines operated by two boats, which set and retrieve one half of the net each. The bunt () is usually placed in the centre of the purse seine.

1.2 Surrounding nets without purse line

Surrounding nets are designed to catch fish near the surface and in shallow waters. The ground rope is much shorter than the float line in order to create a dustpan shape. It can also be designed with wings.

The lampara net is the most representative gear in this category. Its particular design, with the central bunt in the form of a spoon and two lateral wings, makes it possible to retain the shoal of fish when the two wings are hauled up at the same time. The ring net is another fishing gear in this category, which is shaped more like a purse seine and mot often fitted with bridles to help to pull in the leadline. These nets are generally operated by relatively small and simple boats.

2. SEINE NETS

A seine is a gear that is set around a certain area and is hauled either from the shore (beach seine) or from a boat. It comprises a bunt (bag or loose netting) and long wings, in some cases lengthened with long towing ropes or warps.

2.1 Beach seines

A beach seine is set from the shore by hand or from a boat.

One or more fishers or a boat travels out from the shore and completes a semi-circle and on reaching the shore, the seine net ends are pulled by hand or by a mechanized device onto the beach.

The bottom and surface act as natural barriers, which prevent the fish from escaping from the area enclosed by the net. A distinction is made between a beach seine with a bag, and a beach seine without a bag; the latter however, does have a central part (bunt) with smaller meshes and more slack, which retains the fish caught.

2.2. Boat seines

A boat seine is composed of a cone-shaped net ending in a central bunt in the form of a spoon or a bag and with lateral wings extended with two long ropes. The ropes and net are set out by a boat along the seabed in a triangular or diamond fashion. The boat heaves in both ropes, using capstans or winches, while steaming slowly forward or kept stationary with an anchor.

During the fishing operation, the fish are herded into the path of the net by long, heavy ropes. The length of the ropes to a large extent decides the fishing area. The seine is mainly used on the bottom. Most common seining techniques are the Danish and the Scottish seining.

3. TRAWLS

A trawl is a gear whose main component consists of a cone-shaped body of netting, closed at the end by a codend. It is used to catch fish, crustacean or molluscs by towing it steadily. The minimum necessary towing speed is mainly determined by the behaviour and swimming capacity of the target species.

A trawl can be towed through the water by one or two boats on the bottom (demersal) or in midwater (pelagic). The horizontal opening of the net is maintained by beams, otter boards or

by two boats. Floats (or kites), weights or a rigid frame produce the vertical opening of the trawl net. Two or more parallel trawl nets may be rigged between two otter boards. Trawls can be towed from the stern or from outriggers.

3.1. Bottom trawls

A bottom trawl is designed to catch species living on or near the seabed. Components of the trawl have contact with the seabed while fishing.

3.1.1. Beam trawls

A beam trawl is a bottom trawl in which the horizontal opening of the net is maintained by a rigid beam across the net mouth.

Marine animals living close to the seabed are the main targets. The beam trawl catches fish only within the path of the beam. The beam is commonly made of wood or metal, and may be of any length that practically can be handled onboard the towing boat. One beam trawl can be towed from the stern or alternatively two beam trawls from outriggers. Consistent bottom contact is necessary for successful operation and is often achieved by heavy chains attached behind the beam.

3.1.2. Single bottom otter trawls

A bottom otter trawl is operated from a single boat and is designed to catch fish, crustacean, or molluscs living in the vicinity of the bottom.

The horizontal opening of the net is generated by two otter boards (trawl doors). The net is held open vertically by floats or kites along the upper leading edge of the net while ground contact is maintained by a weighted groundrope, which also protects the net from damage. Depending on the species, fish may be herded into the path of the net by the otter boards and by the lines connecting them to the net. The fished area can therefore be greater than the area swept by the net mouth.

3.1.3. Twin bottom otter trawls

Twin bottom trawls comprise two nets towed by one boat.

The twin trawls can be rigged either between two otter boards and a weight in the middle, or rigged separately each with their own sets of otter boards. Such trawls can be towed from the stern of the boat or from each of two outriggers.

3.1.4. Multiple bottom otter trawls

A multiple bottom trawls comprise of more than 2 nets, which are rigged between two or more otter boards and towed by one boat.

Multiple trawl riggings are developed to maximise the horizontal fishing width of non-herded animals like shrimp and prawns. Two nets rigged in parallel and towed from each of two outriggers are common in tropical shrimp fisheries (Quadrig). Three trawls rigged with two otter boards and two weights towed with four towing warps are developed for shrimp fishing (Tripletrawl).

3.1.5. Bottom pair trawls

A bottom pair trawl is towed by two boats, which maintain the horizontal opening of the net during fishing.

The design of the trawl net is similar to a bottom otter trawl net. Long warps or heavy ropes are sometimes used as sweeps in front of the wings to increase the fishing path of the trawl by herding. This technology is sometimes called pair seining.

3.2. Midwater trawls

A midwater (or pelagic) trawl has a cone-shaped net designed to catch marine organisms such as pelagic or semi-demersal fish that stay off the bottom. No components of a midwater trawl are intended to have contact with the bottom while fishing.

Midwater trawl nets are usually much larger than bottom trawl nets and are sometimes made with very large meshes or ropes in the front part, intended to herd the targeted fish, often schooling species. The net depth is controlled by the towing speed and amount of wire paid out. The vertical opening of a midwater trawl is often maintained by weights attached to the lower wing tips. Midwater trawls may be towed by one or two boats.

3.2.1. One boat midwater trawls

A one boat midwater trawl is towed by a single boat, using otter boards, kites, beams or frames to open the trawl horizontally.

Mid-water trawls may also be rigged with four otter boards. Frame- or beam-supported midwater trawls (without otter boards) are used to catch smaller marine organisms such as zoo-plankton or fish larvae, e.g. for scientific studies.

3.2.2. Midwater pair trawls

A midwater pair trawl is towed by two boats, whose distance apart regulates the horizontal opening of the net.

Midwater pair trawls may be rigged with two towing warps from each vessel or alternatively with one towing warp from each boat and a bridle arrangement. Midwater pair trawls are particularly efficient at catching animals close to the sea surface.

4. DREDGES

A dredge is a towed net or metal basket mounted on a frame; the lower part may have a scraper blade, chain, teeth or other arrangements to lift benthic species into the dredge.

Common targets are mussels, oysters, scallops, clams and other molluscs. Some dredge designs are also used to capture flatfish.

4.1. Boat dredges

This category comprises dredges towed by a boat.

Some dredges are mechanised for transporting the catch by pumps or conveyor belts to the deck for sorting.

4.1.1. Towed dredges

This category comprises dredges towed steadily over the bottom by a boat with one or more dredges attached to a towing bar.

Towed dredges have a rectangular metal frame to which is attached a bag composed of metal rings and/or netting with or without teeth along the leading edge of the frame.

4.1.2 Mechanized dredges

Mechanized dredges are large metal cages equipped with a cutting blade and high pressure hydraulic jet pump to wash out bivalves from bottom sediments. The molluscs are either scooped up by the dredge located behind the jets or are passed onto a conveyer belt, which brings them on board. The whole equipment is fixed to the boat.

During the operation, the boat sets a large anchor and by hauling the anchor line the vessel is moved. Several sectors around the anchor position will be fished.

4.2. Hand dredges

These are small, light dredges, towed by hand in shallow waters. Hand dredges are sometimes operated in a similar way from small boats.

5. LIFT NETS

Lift nets consist of a horizontal or a bag shaped netting panel, which are lifted or hauled vertically to collect species accumulated above the net when hauling commences.

A light or bait is sometimes used to attract species above the net.

5.1. Portable hand lift nets

This category comprises small lift nets often supported by frames and operated by hand,

5.2. Boat-operated lift nets

Lift nets operated from one or more boats.

These gears comprise the bag nets ('basnig') and the blanket nets.

The fishing operation is often supported by light (different colours) to attract and/or scare the fish.

5.3. Shore or shallow water-operated lift nets

This category comprises lift nets, which can be relatively large and usually operated from stationary installations situated along the shore or riverbanks.

The lifting systems are sometimes mechanized.

6. FALLING GEAR

These are gears that are brought down quickly from above on the prey.

Wooden cover pots and cast nets made of netting are typical gears belonging to this group.

6.1. Manual operated cast nets

The cast net is a cone shaped net with weights attached to the perimeter. The catching principle is that the net is thrown (cast) flat upon the water surface and then catches the fish by falling and closing in on them. As the net is hauled back the extra mesh forms pockets that stop the fish from escaping.

Cast net is used from the shore or from a boat and the targets are generally fish and shrimp.

6.2. Mechanized cast nets (new category)

(Text to be inserted)

6.3. Cover pots/lantern nets

A cover pot is commonly of a wicker construction like a beehive with an opening at the top, whereas the lantern net is cover pots made of wooden frames covered by netting. The gear is brought down quickly on the prey and any catch, often a single individual, is taken out though the opening on top.

These gears are, generally hand-operated by wading fishers in very shallow waters.

7. GILLNETS AND ENTANGLING NETS

Gillnets and entangling nets are made from single, double or triple netting walls kept more or less vertical by floats on the upper line and mostly by weights on the ground-line. The means of capture is that the target organisms are gilled, entangled or enmeshed in the netting.

Several types of nets may be combined in one gear (for example, trammel net combined with gillnet). These nets can be used either alone or, as is more usual, in large numbers placed in line ('fleets' of nets). Depending on their design, ballasting and buoyancy, these nets may be used to fish in surface layers, in mid water or at the bottom.

7.1. Set gillnets

A set gillnet consists of a single netting wall held vertically in the water by a floatline and a weighted groundline, set on the bottom, or at a certain distance above it and kept stationary by anchors or weights on one or both ends.

The dominant method of capture is by gilling. The size distribution of the catch is very much dependant on the mesh size used in the gillnet.

7.2. Driftnets

A driftnet is any net that is operated on the sea surface or at certain distance below it by floating devices and allowed to drift freely with the current.

Driftnets consist of a string of gillnets, to catch fish and other marine organisms near the surface. They may drift independently, accompanied by a boat, but generally they are fastened to a boat that drifts with them. The predominant method of capture is by gilling, and driftnets are highly size selective.

7.3. Encircling gillnets

These gillnets are set around a fish aggregation, and noise or other means are used to force them to gill or entangle themselves in the netting.

This gear is generally used in shallow water with the floatline on the surface and ground line at the bottom.

7.4. Fixed gillnets (on stakes)

Gillnets stretched between stakes.

Such gillnets are used in coastal waters where there are significant tidal differences. The fish are collected at low tide.

7.5. Trammel nets (*needs further revision)*

A trammel net consists of two or three layers of netting with a slack small mesh inner netting between two layers of large mesh netting. The fish entangle themselves in a pocket of small mesh webbing pushed through a large meshed wall.

7.6. Combined gillnets-trammel nets

A combination of gillnets and trammel nets can be used as bottom-set nets.

The lower part may consist of a trammel net, catching bottom fish, while the upper part may consist of a gillnet part catching semi-demersal and pelagic fish.

8. TRAPS

Traps are stationary gears consisting of a chamber into which the fish are guided with a herding device or lures, but from which it is hampered from coming out by funnel devices or gorges.

8.1. Stationary uncovered pound nets

Stationary uncovered pound nets are usually large nets, anchored or fixed on stakes, usually open at the surface and provided with various types of fish herding and retaining devices. They are mostly divided into chambers closed at the bottom by netting.

These gears are often placed in the migration paths of the target species.

8.2. Pots

A pot is a baited cage or basket made from various materials (wood, wicker, metal rods, metal barrels, wire netting, plastic etc.) and can vary in shape. They might have one or more entrances designed to prevent escape of entered targets.

Pots are usually set on the bottom, mostly with bait, singly or in strings connected to a line. They are common gears to catch crabs, lobster, whelks and hagfish. Pot hauling machines make the catching process more efficient, since a large number of pots can be handled by one boat.

8.3. Fyke nets

A fyke net consists of one or more cylindrical or cone-shaped mesh netting bags mounted on wooden or metal rings or other rigid structures with an opening and one end and a closed funnel at the opposite end. It may or not have wings or leaders, which guide the fish towards the entrance of the bags.

The fyke nets, fixed on the bottom by anchors, ballast or stakes, may be used separately or in groups. The gears are used in rivers, estuaries and ponds. These are common gears to catch eels and other estuarine/river finfish.

8.4. Stow nets

A stationary gear made from netting, usually in the form of a cone or pyramid. The opening is created by stakes or a frame, with or without wings.

These nets are fixed by means of anchors or stakes, placed according to the direction and strength of the current, and may or may not be supported by a boat.

This gear can be used in rivers, estuaries or areas with strong currents. The fish or other organisms entering, more or less voluntarily, are caught by filtering.

8.5. Barriers, fences, weirs, corrals, etc.

A group of gears made of various materials (stakes, branches, reeds, netting, etc.), and they are usually constructed for use in tidal waters. They generally have a narrow slit (doorway) leading to an enclosed catching chamber. From the doorway often a wall of netting (leader) extends to the shoreline.

These gears generally work on the same principle as pound nets. These are common gears used in tidal areas where other types of trap nets may not be suitable and often target small pelagics.

8.6. Aerial traps

Jumping fish (e.g. mullet) and gliding fish (flying fish) can be caught on the surface in boxes, rafts, boats and nets ("veranda nets").

Sometimes the fish are frightened to get them to jump out of the water.

9. HOOKS AND LINES

Hooks and lines are gears where the fish is attracted by a natural or artificial bait (lures) placed on a hook fixed to the end of a line or snood, on which they get caught.

Hooks or metallic points (jigs) are also used to catch fish by ripping them when they pass within its range of movement. Hook-and-line units may be used singly or in large numbers.

9.1. Hand operated pole and jig line

A vertical line equipped with one or more hooks or jigs equipped with baits or lures operated by hand or by using a wheel or a pole.

Hand held jiggers are heavy metal lures with up to four barbed hooks attached or multiple barb-less hooks. The jigs are moved up and down in the water in concentrations of fish and fish are hooked as they pass by. Automated jigging machines work on the same basic principles. Hand lining is carried out with one or two baited hooks on a single line. The line is not 'jigged', so the fish must take the bait to be captured.

While pole fishing, a school of fish is found and attracted to the boat using water sprays and baitfish thrown into the water. When the school is aggregated around the boat and feeding on the bait, the lures are lowered into the water and jigged. When a fish takes the lure, it is swung on-board the boat. Particularly for large fish, a twin pole can be used.

9.2. Mechanically operated pole and jig line

A vertical line with a limited number of hooks equipped with lures or baits operated by a machine.

While the gear has traditionally been hauled by hand, small hydraulic or other mechanized winches are now commonly used. These can be computer controlled, detecting bites and retrieving the fish automatically. Some can be set to jig the line up and down within a selected depth interval of the water column. One boat may operate several jigging machines electrically or hydraulic driven.

9.3. Set longlines

A set longline consists of a main line and snoods (gangions) with baited hooks at regular intervals. The gear is set on the bottom or near the bottom (semi pelagic) with anchoring devices at each end.

The length of a bottom set longline can range from few hundred meters in coastal fisheries to more than 50 km in large-scale mechanised fisheries. The gear may be hauled by hand or by powered reels. The baiting of hooks may be manual or by a machine.

9.4. Drifting longlines

A drifting longline consists of a mainline kept near the surface or at a certain depth by means of regularly spaced floats and relatively long snoods (gangions) with baited hooks.

Drifting longlines may be of considerable length. Some drifting longlines are set vertically, each line hanging from a float at the surface. They are usually worked in groups of several lines operated by a single boat.

9.5. Vertical lines

Vertical lines consist of one or more vertical lines each with a sinker attached, and at least one hook.

The lines may be operated manually or mechanically, using powered reels or drums. They are generally used on medium sized boats, but they may also be used on relatively small boats.

9.6. Trolling lines

Trolling lines consist of one or more lines with baited hooks or lures, trailed near the surface or at a certain depth by a boat.

A number of lines, each with either a lure or bait and hook attached, are towed behind a boat. Boats will often use outrigger poles to increase the number and spread of lines that they can tow. Tow (or trolling) speed depends on target species. The lines can also be weighted to fish deeper in the water column. Handling of trolling lines, including removal of fish from the hooks may be mechanised.

10. OTHER GEARS

In world fisheries a variety of different artisanal gears exists.

10.1.1. Wrenching gear

Scythe-like tools for the harvesting of the sessile underwater algae by divers, and rakes to scrape the seaweed stranded along the beach.

10.2. Clamps

The simplest forms are hand operated sticks with one end into at least two branches. The stick may have a length of as much as nine meters. Clamps can be used for catching fish. In this case stronger implements made of iron, looking like multi-pointed spears, are used.

When a prey is sighted, it is jammed between the branches. To give the grip more security some barbs can help. Clamps are well known in many parts of the world, especially for taking mussels out of the water without injury.

10.3. Rakes

Simple or modern complicated rakes may be employed to catch the aquatic prey

To make easier the capture of mussels, sea urchins etc. by rakes, the prongs are made somewhat differently in that they are either bent, or the rakes are equipped with a wire mesh or twine webbing collecting bag. They are used for raking and digging animals hidden in the mud at the bottom.

10.4. Tongs

Tongs consist of a pair of rakes or rake like baskets attached to two long wooden handles generally joined together like scissors

Used mainly for collecting mussels, clams and oysters. The tong can be made up of two forks (rakes) or also of two scoop nets. The shape of tongs may differ very widely and sometime are mechanized.

10.5. Spears

Spears range from the simple pointed hardwood stick to the more complicated many-pronged spears.

Spears can be used from the shore, onboard boats or by divers.

10.6. Harpoons

In its simplest forms the harpoons are built from a wood pole having a steel point with one or more fixed or movable barbs at its forward end.

Usually the harpoon has a detachable spear tip attached with a flat line, and retrieving line attached to the boat. Harpoons can be hand thrown or shot by guns. Harpoons used for whaling can be electrified or equipped with grenades. Harpoons have become a favourite gear for underwater fishing.

10.7. Electric fishing

Fishing using intermittent electric pulses to stun the fish or otherwise modify its behaviour (e.g. by involuntary muscle contraction) so that it becomes more vulnerable to capture.

10.8. Towed fyke net

(Text to be inserted)

10.9. Push nets

A push net consists of a triangular net, forming a bag-shape; its two sides are fixed to scissors-like crossed sticks (bamboo or wood).

The gear is pushed forward in shallow water either by hand or by boat on bigger scale.

To ensure that the scissor- like cross sticks will glide smoothly over the bottom, they can be provided with special runners.

10.10. Scoop nets

The scoop nets are generally hand held small net bags, with handle or without handle. The opening is provided by a metal or wooden frame of different shape.

10.11. Drive-in nets

Gears into which targets are driven by frightening.

It consists of rectangular netting which is set like a scoop under the current. The prey is driven into the net by scaring lines, pulled by two men or with support of boats.

10.12. Pumps

A pump can be used as a fishing gear only for the harvest of dense concentrations of small species.

Usually the fish is attracted and concentrated by artificial lights. The prey is taken on board by pumping. Because of the limited area of light attraction and effects of suction and performance of the pumps, this technology can be used for only a few species.

10.13. Diving

Collection of animals by hand by an individual diving below the water surface.

Such diving can be free (with mask and snorkel) or assisted by the use of scuba

11. Miscellaneous methods

- Harvesting of seals
- " Miracle hole"

Small square holes (0.5 m deep) dug along the tidal flats and provided with branches of trees. During high tide, they are flooded and some fishes are brought to the shore. The fish seeks shelter in the hole and will be collected by the fishermen during low tide.

Annex 7: WGFTFB information for other ICES Expert Groups – Questionnaire sent to WGFTFB Members

Incorporation of Fishing Technology Issues/Expertise into Management Advice

Rationale:

Over the past few years, the nature of the advice ICES has been requested to provide by the client commissions e.g. Norway, EU, NAFO etc. has changed considerably.

ICES is now asked to provide advice that is more holistic in nature, including information on the influence and effects of human activities on the marine ecosystem.

From the fishing technology perspective this includes information on how fishermen are responding and adapting to changes in regulatory frameworks e.g. the introduction of effort control; technological creep; fleet adaptations to other issues e.g. fuel prices etc.

In response to this WGFTFB initiated a ToR in 2005 to collect data and information that was appropriate for fisheries and ecosystem based advice, co-sponsored by Dominic Rihan (Ireland), Dave Reid (Scotland) and Norman Graham (Ireland).

In 2006, the FAO-ICES WGFTFB was formally requested by the Advisory Committee on Fisheries Management (ACFM) to provide such information and to submit this to the appropriate assessment working group.

This type of information is becoming more and more important at both international and national levels. It demonstrates that the community of gear technologists have an important role to play in this and that our expertise is considered to be highly valued.

Please note that this is intended for WGFTFB members from countries that receive their stock/fisheries advice from ICES.

It would be greatly appreciated if you, in collaboration with whomever necessary, fill out the questionnaire.

Thank you for your time and effort

Norman, Dave and Dominic

Introduction

This contains a series of questions relating to recent changes within the fleets in you particular country that you may have observed. It also gives you the opportunity to raise any issues that you think are important but are not currently recognised.

If at all possible, please try to quantify your statements or state how the information has been derived e.g. common knowledge, personal observations, discussions with industry etc.

a) *Changes in Fleet Dynamics between 2005 and 2007*

Have there been any major shifts between mesh categories (e.g. from 100mm+ to 70 – 90mm) and in which ICES area has this occurred?

- Example – Shift from large mesh whitefish fishery (100mm+) to 70 – 99mm to target mixed fish/*Nephrops* fishery in VIb (Farne deeps).
- What are the principal driving factors for this change? (e.g. effort allocation, fuel costs).
- Effort restrictions associated with large mesh fishery (more days available in smaller mesh band).
- Is there a geographical shift in activity (e.g. between IV to VI – give the subdivision if possible)?
- Effort associated with SW beam trawl fishery (Celtic Sea) has been displaced due to Trevose head cod closure. Redistributed effort to outside cod box, similar pattern noted with static gill net fishery.

Within a particular mesh/gear category, has there been any shift in target species (e.g. from demersal gadoids to anglerfish; sardine to tuna etc)

- Partial switch during winter months from beam trawl fishery for plaice/sole to target cuttlefish and squid (non-pressure stock/high value). Affects approximately 70% of SW beam trawl fleet during December and January.
- Has there been any removal of effort through decommissioning schemes, of so which fleets have been affected and has the decommissioning affected older or newer vessels or a combination of both?
- Decommissioning scheme introduced in 2006 to remove vessels from SW Beam trawl fleet targeted primarily at vessels with highest historic catch rates of sole. Has only affected one segment of the fleet (Brixham vessels) and is expected to remove in excess of 50% of segment capacity in order to reduce fishing mortality on sole. Vessels removed are typically in excess of 20 yrs old, which is reflective of the fleet structure of the area as a whole. Main area of operation VII (?).

What proportion of the fleet has opted for decommissioning (express as a percentage of the total fleet)?

- 50%

b) *Technology Creep*

Include such issues as new gear handling methods/equipment; switch from single to multiple trawling for example; changes in vessel design that could affect effort etc; new fish finding equipment.

Have there been any significant changes in gear usage in specific fisheries, if so what are the changes (e.g. switch from twin to single rig trawling, beam trawl to seine net)?

- A number of Belgium beam trawlers are now towing two sets of smaller trawls from each beam in order to reduce fuel consumption. Approximately 10% of the fleet has switched to this method. No research has been conducted to determine

the effect on catch composition of this measure. 5 vessels have switched to using otter trawls towed from outriggers for the same rational.

- Older Dutch beam trawl vessels are now being replaced with multi-purpose ones capable of operating with a seine net.

In which fishery has this occurred and in what ICES areas?

- VIb (Dutch vessels).
- VIb and VII (Celtic and Irish Seas) for Belgium. Use of otter trawls has now allowed vessels to fish within 12 nm of the coasts around the UK.

Have any other technical changes occurred in particular fleets that will have resulted in changes in catching efficiency (e.g. changes in fishing pattern, new gears or navigational equipment) has the change in catchability been quantified?

- Beam trawlers are increasingly being equipped with 3D mapping sonar, which has opened up new areas to fishing.

c) *Technical Conservation Measures*

Other important information could include what is the level of uptake if voluntary, has the selectivity of these been determined and if so how does it compare with the earlier estimates, are there any other wider benefits e.g. reduced fuel costs, ecosystem benefits etc.

Have any new TCM's been introduced into specific fisheries? If so what are the measures and which fleets and/or areas are affected?

- Voluntary use of benthic drop out panels and full square mesh codends in SW Beam trawl fleet. Prompted by improved catch quality and increasing pressure from multi-national buyers (particularly supermarkets).
- Approximately 20% of the *Nephrops* trawlers operating in the Farne Deeps (VIb) fishery have opted to use 'cut away' trawls, this has been prompted by a switch to targeting *Nephrops* for the live market and the introduction of a UK environmental standard introduced in 2007.
- Pelagic trawlers targeting blue whiting are now mandated to use flexible grids to reduce bycatches of cod and saithe.

Have any incentives been introduced to promote the use of more selective gears? If so which fleets/areas are targeted and what are the incentives (e.g. additional effort allocations for use of Swedish grids/SMPs)

- *Nephrops* trawlers in VI can now opt to use either a 'Swedish' style grid (unlimited days) or 120mm square mesh panels fitted 4 – 9 m from the codend (additional ? days per month). There has been no uptake of the Swedish grid in the fleet, but ~20% have opted to use the 120mm square mesh panel.

Can the changes in selectivity (size or species) be quantified relative to 'standard' gears; if so what are the changes (e.g. shift in L50, % reduction in bycatch)

- Catchpole and Revill (2006) provide selectivity estimates for the Swedish grid and Revill and Dunlin (2006) estimate that reductions in excess of 60% in the bycatch of whiting and haddock associated with the cut away trawl.
- Recent unpublished results show that the 120mm square mesh panel gives selection profiles which are broadly similar to that of a 120mm conventional diamond mesh codend for cod, haddock and whiting.
- Beam trawl drop out panels being used in the Channel and Celtic sea reduce the capture of benthos by 70% while reductions of 50% have been noted for monkfish <20cm.

- Square mesh codends in the beam trawl fleet reduce the retention of sole at MLS and are likely to improve the selection profile of other bycatch species such as plaice, cod and whiting. The extent of this has thus far not been quantified.
- ICES (2006) report that bycatches of cod and saithe in the blue whiting fishery have been reduced by 90%.

What proportion of the fleet has opted to use new TCMs (0–5; 5 highest)

- Drop out panels in SW beam trawl fleet (4)
- Square mesh codends in SW beam trawl fleet (3)
- Cutaway trawls in Farne fishery (2)
- Flexi-grids in Faroese blue whiting fishery (5)

Please specify regulation (national or otherwise) and fishery.

d) *Ecosystem Effects*

Are there any fisheries where there are known impacts on non-target species including birds and marine mammals, ghost fishing etc?

- Ghost fishing associated with the deepwater gill net fishery for monkfish and shark have been demonstrated as a significant problem.
- Are there any mitigation measures in place and how effective have they been?
- Use of square mesh codends and drop out panels have reduced retention of benthos (starfish, urchins etc) by about 70%.
- Nationally funded retrieval programmes have been conducted since 2004 to remove ghost nets.

e) *Development of New Fisheries*

Briefly describe any new fisheries developed?

- Cuttlefish in English Channel are now exploited seasonally (winter) by beam trawl and otter trawl fleets form the SW of England.
- Have these new fisheries removed effort from others, and if so can you provide an estimate (in terms of numbers of vessels) of how many?
- 50% of SW beam trawl fleet switch to cuttlefish

Please return both files prior to the WGFTFB meeting by email to Norman Graham (norman.graham@marine.ie) and use a country code identifier in the file name e.g. Norway.doc. Your information will then be collated during the WGFTFB meeting into a common format.

Annex 8: Information to individual ICES Expert Groups

Annex 8A: FTFB Report to WGNSSK

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the North Sea and Skagerrak.

It should be noted that the information contained in this report does not cover fully all fleets engaged in North Sea fisheries; information was obtained from Scotland, England-UK, Northern Ireland, France, Belgium, Netherlands, Sweden and Norway.

Changes in Fleet Dynamics between 2005 and 2007

- There is a gradual shift in the Dutch fleet from beam trawling for flatfish to twin trawling on other species e.g. *Nephrops*, guards etc. in the fleet. This is driven by TAC limitations for plaice and sole and rising fuel costs. (Netherlands; Quota and Fuel)
- There has been a move by up to 10 of the larger powered vessels in the Scottish whitefish fleet to *Nephrops* in the late summer of 2006. This shift in effort is largely driven by the days at sea regulations and also the limited quota for deepwater species and Rockall haddock. The number of vessels involved is relatively small but the efficiency of these vessels makes this shift in terms of effort high. (UK-Scotland; Days at Sea Regulations/Quota restrictions).
- There has been a shift in the Scottish inshore fleet from squid back to *Nephrops*. This was due to a reduction of squid on the inshore grounds during the 2006 fishery. The number of vessels involved is very high. (UK-Scotland; Lack of Squid).
- Some whitefish trawlers are using 130mm mesh on the eastern side of the North Sea to ensure they comply with regulations (UK-Scotland; Move to TCM).
- Irish inshore fishermen have increased the number of pots in order to make up for lost earnings as a result of the salmon drift net fishery. This action will be widespread and will have a major impact on crab and lobster as well as increasing numbers of these vessels, potentially diversifying into handling for mackerel and white pollack during the summer months. Putting further pressures on quotas for these species. There are approx. 900 licences in Ireland so the cumulative effect could be high. (Ireland; Closure of a fishery).
- In Sweden 70mm diamond mesh codends were banned in IIIa in 2005. Swedish demersal trawlers now either use 90 mm (often in combination with a 120mm square mesh window) or the *Nephrops* grid trawl. 40% of *Nephrops* trawl effort in IIIa is made with sorting grid equipped trawls (Logbook and pers. obs. This is driven by the ban of 70–89 mm diamond and effort restrictions (more days/unlimited days at sea available for SMP/grid trawls) and the obligatory grid use on coastal waters. (Sweden; Changes in Regulations).
- There were temporary shifts observed in the Dutch Beam trawl fleet within the North Sea due to the cod closure some years ago but with the removal of these boxes, vessels have reverted back to previous fishing areas. (Netherlands; Temporary shift)
- Scottish single seiners have been working more inshore waters in IVa to target smaller haddock and whiting. This allows more landings for days at sea. Up to 75% of the Scottish sine fleet are involved. (UK-Scotland; Days at sea)
- More Swedish coastal vessels in IIIa are targeting *Nephrops* 2006 and in the winter of 2006/2007 driven largely by days at sea regulations. (Sweden; Days at sea).

- Approximately 20% of the Northern Irish *Nephrops* fleet transfer activity to the Farne Deeps (IVb) during Q4 (2006) and Q1 (2007). These vessels (along with approximately 10 Scottish vessels) typically use multi-rig trawls whereas the local English fleet typically use single rig nets. (UK-Northern Ireland; Days at sea/Quota restrictions).
- There has been a partial switch from demersal fish towards *Nephrops* and *Pandalus* in the Swedish fleet although this switch is not considered significant at present. (Sweden; Moving Fisheries).
- The Norwegian industrial trawling fleet has reduced effort targeting Norway pout, and increased effort targeting blue whiting in the Norwegian trench with larger trawls. Bycatch of saithe occurs in the blue whiting fishery and trials will be carried out in 2007 using grid to reduce the bycatch problem. (Norway; Moving Fisheries).
- There is a tendency of late in the Dutch fleet to opt for smaller multipurpose vessels replacing the conventional beam trawlers. This is due to increasing fuel costs, quota shortage and pressure from fish buyers hot to buy beam trawl caught fish. (Netherlands; Vessel design).
- No active decommissioning has taken place in Sweden, but the number of *Nephrops* vessel, effort and landings increased in 2006 with high catch rates from a historical perspective. The increase in number of vessels may be attributed to input of new capital due to an introduction of an ITQ-system for pelagic species. (Sweden; Increased effort).
- There has been limited decommissioning of older French vessels previously fishing for anchovy. (France; Decommissioning).

Technology Creep

- A number of Dutch beam trawlers are investigating towing two sets of smaller trawls from each beam in order to reduce fuel consumption, referred to as 'outrigging'. Similar work is being carried out in Belgium. (Netherlands and Belgium; New gear).
- A group of Dutch skippers have experimented with alternative beam shapes e.g. 'fly-beam', and wheels replacing beam trawl shoes to reduce the drag of trawls in order to save fuel. Fuel savings reported are in order of magnitude of 10–15%. Many boats start using fuel economy meters and try to optimise speed to save fuel. All in development phase. (Netherlands; Environmentally Friendly/Fuel Efficient Gear).
- Scottish whitefish vessels have switched from twin trawl to Pair trawl/seine and from twin whitefish to twin *Nephrops* trawling on the Fladen grounds. (UK-Scotland; Gear change for different species)
- There is increased use of double bag trawls to give increased groundgear coverage. The use of the double bag/increase bosom nets is increasing particularly for the new vessels switching to *Nephrops* and some traditional vessels. The indication is that they see approx 33% increase in catches. These trawls are being used primarily for *Nephrops* although possibly 20% of Scottish whitefish trawlers are switching to double bags trawls. (UK-Scotland; New trawl design).
- There is an increase in Sweden in *Nephrops* creel landings in the Eastern Skagerrak was observed since trawling was banned on some national waters in 2004 (creel landings has increased from 139 tonnes in 2003 to 220 tonnes in 2005). (Sweden; New fishing gear)
- Norwegian seine netters in the Norwegian Sea are using smaller gear with more weights on the groundgear to secure proper bottom contact. The effect on the catching efficiency is not quantified, but underwater observation indicates a far higher catching efficiency. (Norway; Modified gear).
- In Norway there is increased use of Danish seines for the coastal fleet traditionally used gillnets and longlines. Main reason is that fish caught with

Danish seines generally have higher quality than fish caught by gillnets and that the price for longline bait has increased. (Norway; Alternative fishing method).

- Most Norwegian trawlers are now using twin trawls for cod, haddock and saithe increases. Experiments indicate no difference in length composition for the three species between single and twin trawl. The increased catch rates found for twin trawl compared to single trawl is approximately proportional to the increase in door spread. (Norway; New gears).
- Norwegian trawlers in the 1800–3000 hp range are using single nets with 400mm mesh in sections of the Top wings and special cutting rates in the belly sections Vessels are switching to these trawls from twin-trawls in periods of bad weather and also to improve fuel efficiency. (Norway; New trawl design).
- The Dutch beam trawler UK153 is currently fishing with electrified pulse trawl, and expansion is possible to more vessels pending positive ICES-advice. The steering board of this project recently gave a negative advice on continuing, because of lower catches and earnings for the new system. The future is uncertain, but the interest remains, also for electrified outriggers. (Netherlands; Environmentally Friendly Gear).
- There is reported widespread use of "compacted twines" (e.g. Cotesi redline) particularly in the Scottish single seine fleet. This twine is considered to increase fuel efficiency (less drag) and also believed to give better retention especially for *Nephrops* and less distortion of meshes. (UK-Scotland; Fuel Efficiency).
- Belgium beam trawlers are increasingly being equipped with 3D mapping sonar which has opened up new areas to fishing (close to wrecks): this was mentioned last year and is most likely still applicable. This 3d system opens more grounds that were previously unfishable. (Belgium; New technologies).
- Norwegian purse seines are using an acoustic instrument to measure distance of the ground line/lead line from the seabed has been developed. This sensor is used by many seiners while fishing for saithe and herring in areas with strong currents and rough seabed (reduced wear and tear). This reduces damage and increases catch efficiency. (Norway; New technologies).
- Norwegian and French demersal trawls are using sensors that measure roll, pitch and stability of trawl doors are developed. The trawlers to optimise the trawl door performance while towing increasingly use the sensor. (Norway/France; New technologies).

Technical Conservation Measures

- Dutch National regulation on reducing bycatches in the brown shrimp fisheries in 2002 have re-enforced the use of 'sieve' nets or sorting grids. (Netherlands; Enforcement of TCM).
- There has been no uptake of the 120mm SMP at 4–9 m from the codline for the *Nephrops* fishery by the Scottish fleet. The loss of marketable haddock and whiting far outweighs the benefit even though the adoption of the measure allows 11 extra days per year. It should be noted that No uptake as there are approx 70 vessels limited by the 5% cod bycatch and only 4 were struggling for days during 2006. (UK-Scotland; Uptake of TCM).
- In Sweden there is a steady increase of *Nephrops* grid uptake since the introduction in legislation in 2004. Approximately 75% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2006 (40% of *Nephrops* trawl landings). Approximately 50% of the *Nephrops* trawl effort (without grid) has opted to use 120mm SMP in their 90mm trawls as a consequence of extra days at sea. Few vessels use larger mesh sizes than 90mm for demersal species (no limits on catch composition for 90mm trawls in IIIa). The vessels that do use larger mesh sizes mainly target witch, cod, haddock and to some extent saithe. Increased interest from demersal (fish and *Nephrops*) trawlers to switch to *Pandalus* trawling, as this fishery is not limited by the cod recovery plan. The use of the *Nephrops* grid is mandatory on coastal waters and unlimited days at sea. It must be stressed that the incentive structure (in terms of

numbers of days at sea) is very different in IIIa than in the North Sea. In IIIa the maximum number of days at sea for a vessel using a 90mm trawl was 103 days, whereas a vessel using an identical trawl in the North Sea was allowed 227 days in 2006. 227 days cannot be limiting for the vast majority of *Nephrops* vessels. (Sweden; Uptake of TCM).

- The Norwegian shrimp fishery in the Barents Sea is conducted by large trawlers operating two or three trawls (presently 3 vessels). Sorting grids are mandatory in the shrimp fishery north of 62ºN. Plastic grids are becoming more popular than grids made from steel. Bycatch of juvenile redfish, cod and haddock sometimes results in closure for shrimp fishing grounds in the Barents Sea. In the shrimp fishery in the North Sea and in Skagerrak, trawlers are using sorting grids voluntarily during periods of high bycatch rates. (Norway; Voluntary use of TCM).
- Approximately 4 UK vessels are using species selective trawls voluntarily in the Farne deeps *Nephrops* fishery, the gears used reduce discarding of haddock and whiting in excess of 50%. Improved catch quality and value. (England: Implication reduced discarding of whiting and haddock). (UK-England; Voluntary use of TCM).
- The Netherlands beam trawl fleet is coming under increased pressure of the market not wanting to buy fish caught with beam trawls due to the bad reputation. This incentive is stimulating the debate on selective nets and diminishing impact, but actual measures still need to be taken. (Netherlands; Voluntary use of TCM).
- Trials in Scotland have shown the 120mm SMP, placed 4–9 m from the codline in *Nephrops* trawls have show that major improvements in L50 for cod, haddock and whiting can be achieved, however, uptake currently is low. (UK-Scotland; TCMs).

Ecosystem Effects

- In the Netherlands the bycatch of benthic fauna and several non-target fish species (e.g. gobies) in beam trawls, are becoming of increasing importance and the marine mammals in pelagic trawls. Voluntarily use of longitudinal release holes in the lower side of the trawl, which open when nets are filled with benthos. Fish excluder and square mesh panels in pelagic trawls, used voluntarily. Effectiveness and optimum design still under study in close cooperation with the industry. (Netherlands; Benthic impact and Marine Mammal bycatch).
- Reduced impact in the Belgium and UK beam trawl fleets through a combination of small round fish from T90 codend; benthos bycatch from Benthic Release panels; round fish catch reduction from big meshes; reduced bottom impact from experimental roller gear, usage of outrigger instead of beam trawls with chain matrix. As uptake is very minor at present, reduction in impact is minimal but numbers of vessels testing this gear voluntarily is increasing. (Belgium and UK-England; Reduced benthic impact).
- The Norwegian's have an annual retrieval programme for lost gillnets in the Greenland halibut and blue ling fisheries in deep waters. There are recent reports by Norwegian vessels of ghost nets in Tampen Bank area of IVa. These are monkfish nets discarded, lost or abandoned and the problem is increasing with increasing effort. (Norway; Ghost Nets).
- Irish vessels have reported a fleet of Russian vessels prosecuting a small mesh fishmeal fishery for haddock both inside and outside the EU 200 mile limit at Rockall including inside the Haddock Box. (Ireland; Small Mesh Fisheries).
- Danish trials have shown the effectiveness of acoustic deterrents for harbour porpoises is maintained with 450m spacing using Aquatech pingers. The regulation states a maximum spacing of 200m. As a consequence of the above, that a derogation has been agreed for Danish fishermen to use AQUAmark 100 pingers at the increased spacing. (Denmark, Acoustic deterrents).

Development of New Fisheries

- Exploitation of cuttlefish in mainly the Eastern English Channel in wintertime by beam trawlers from the UK. There has been an effort shift (<5%) of the fleet (rough estimates: 10 vessels). Landings in 2004: 974 tonnes; 2005: 694 tonnes; 2006: unknown but probably more than 2005. Best catches are expected in period November – February. (UK-England; New fishery).
- Catch composition in Belgium trials with the outrigger trawl have indicated a high bycatch of rays. (Belgium; bycatch species).
- In Belgium 1 catamaran is targeting bass with trammel nets/handline in summer time (May – October): (Not new, same as 2004, 2005, 2006). This is part of a National project for longlining/handlining on seabass ongoing in IVc. This maybe extended to target cod and rays in the future, but very uncertain because of cod stock in IVc and problems with marketing of rays. (Belgium; New fisheries).
- The UK bass fishery has recently been extended into the North Sea. No details are available on the extent. (UK-England; New fishery).

Annex 8B: FTFB Report to WGNSDS

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the Northern Shelf Assessment Area including the Irish Sea.

It should be noted that the information contained in this report does not cover fully all fleets engaged in Northern Shelf fisheries; information was obtained from Ireland, the UK, Belgium, Faroe Islands, Iceland, Netherlands and France.

Changes in Fleet Dynamics between 2005 and 2007

- Of most significance is the reallocation of effort from VIa and VIIa into other ICES areas and switching between mesh categories. There appears to be substantial reductions in effort associated with the larger mesh bands (120mm+) away from the traditional gadoid fishery in the West of Scotland and into *Nephrops* fishery in IVa. Surprisingly, this has affected larger demersal vessels, typically 1000hp+, the main reason appears to be lack of quota and restrictive days allocations in the Cod recovery zone of VIa. While there has been a general decline in VIa, both Irish and Scottish sources suggest that there is an increasing focus in the Rockall fishery in VIb. In addition, a few Scottish fishermen are testing the viability of using paired gear (both seine and trawl), if this proves successful, then there is the distinct possibility that effective effort in VIb will increase considerably. This fishery is particularly attractive given the lack of effort restrictions in this area. (UK and Ireland; Fleet Dynamics).
- Due to restrictive days at sea allocations for Scottish whitefish vessels operating in VIa and lack of Rockall Haddock quota (VIb) a number (up to 10) of larger Scottish vessels have switched to targeting *Nephrops* and have redistributed their effort in the Fladen fishery in IVa. While the number of vessels may be small, these are larger powered (typically in excess of 1000hp) and will therefore result in a considerable reduction in Scottish effort in VIa and a significant increase in the *Nephrops* fishery of IVa which is fished by lower powered vessels. (Scotland - UK; Reduction in effort VIa).
- Information from Northern Ireland indicates that up to 20% of the Northern Irish *Nephrops* fleet now spend most of Q4 and Q1 engaged in the *Nephrops* fishery off the English east coast (Farne deeps). This will have resulted in a drop in effort in VIIa and a corresponding increase in IVb (UK – Northern Ireland; Decrease in effort VIIa)
- Both pair trawls and pair seine teams have been exploring the potential to use paired gear for targeting Rockall haddock (VIb). This has been encouraged due to restrictive days at sea in IV and their absence from VIb. This is a significant development, as up until now this type of method was considered inappropriate in VIb due to topography conditions. If successful this could result in a significant switch in effort from IVa to VIb (UK - Scotland; Increase in Effort VIb)
- Two of the largest Irish whitefish vessels (34m/2000hp) have shifted effort from deepwater species (black scabbard, orange roughy, grenadier) in VIa and VIIb-k to the mixed demersal species (megrim. monkfish, haddock, saithe) at Rockall (VIb). In addition 4–5 other vessels (all 24m+ vessels) have also increased effort in the Rockall fishery in 2006, moving from the monkfish and mixed monkfish, megrim, hake fisheries in Areas VIIb-k. The Rockall fishery has now becoming increasingly important to the larger Irish whitefish vessels and quotas will become restrictive in 2007. (Ireland; Increased effort in VIb)
- 4–5 Irish whitefish vessels (all 24m+ vessels) have increased effort in the Rockall fishery in 2006, moving from the monkfish and mixed monkfish, megrim, hake fisheries in Areas VIIb-k to VIb. (Ireland; Quota restrictions/Changes in fleet Dynamics; 4–5 vessels from a total fleet of approx. 150)

- Irish whitefish vessels participating in the targeted monkfish fisheries in Areas VIIb-k and VIa have reduced during 2006 and in the first quarter of 2007. Vessels have moved to the Porcupine Bank *Nephrops* fishery (see below) or targeted "mixed" demersal fisheries with single trawls for megrim, monkfish, *Nephrops*. Shift from 100mm+ to 70–99 mm. (Ireland; Restrictive quotas and tighter enforcement including the introduction in Ireland of a new Sales Notes management regime; 8–10 vessels from upwards of 20 vessels in 2005)
- A €45 million Decommissioning Scheme was launched in October 2005 and continued in 2006. To date, a total of 36 (includes one in 2005) vessels have been decommissioned at a total expenditure of €15.967 million. This has resulted in the removal of 4,901 GTs and 15,392 kW's from the fleet from the Irish whitefish and scallop fleets. This has removed the few remaining vessels that traditionally target cod on the cape grounds (Via). A recent review has estimated that 40% of the Irish demersal fleet > 18m needs to be decommissioned to maintain viability. A new decommissioning programme will be announced shortly under the EFF 2007–2013 but it is unclear which vessels will decommission given that the fleet structure has changed and improved over recent years. (Ireland; Reduced effort through decommissioning associated with older vessels).
- Several Irish whitefish vessels that have been permanently tied-up have been sold to Gambia in 2006. Another of the larger whitefish vessels (34m/1200hp) has been sold recently to South Africa. This vessel had been active up until mid-2006. (Ireland; Economics; 2 inactive and 1 active 34m demersal vessel).
- Despite quota restrictions, high levels of control and enforcement, increased fuel costs and a major review of the Irish industry, during 2006 and the first quarter of 2007 around 23 new or modern second-hand vessels have entered the Irish demersal fleets. This has been driven by the imminent introduction of the new safety regulations for vessels between 15m and 24m, accelerated as a consequence of the tragic sinking of 4 vessels in the south-east. These regulations will prove onerous and are likely to be similar to the Torrmelinos Convention rules for vessels over 24m. In anticipation of these changes a number of skippers are looking for more modern vessels. The tonnage being taken out to introduce these new vessels is largely inefficient or inactive (< 2 years) tonnage and the Irish whitefish fleet, while reducing in size by numbers has increased in terms of efficiency. This will almost certainly mean that quotas will become even more restrictive, particularly quotas for *Nephrops* (all areas), Rockall mixed fishery, mackerel and herring dry-hold quotas and mixed whitefish (mainly haddock and cod in Area VIIb-k). (Ireland; Increased effort).
- French vessels have switched from anchovy and tuna pelagic trawling to monkfish bottom trawling in recent years. The increase in effort in the monkfish fishery is reported to be high and is expected to increase given the continued closure of the anchovy fishery. (France; Changes in Fleet Dynamics)

Technology Creep

- Two Irish vessels (22m/ 1000hp) have switched to pair trawling to target hake with high opening semi-pelagic trawls (Naberon trawls). These vessels are landing between 9–15 tonnes of hake per 7–10 day trip. One other similar pair of vessels is also considering this fishery VIIj-k and VIII. (Ireland; Pressure on other quota specie; 2 vessels with a further 2 vessels likely).
- Several French vessels have reverted from *Nephrops* twin trawling to single rig trawling in the Celtic Sea due to high fuel and difficulties finding crew. (France; Change in fishing method)
- Several countries report that new gear monitoring equipment fitted to trawls and trawl doors (Scanmar etc) have the potential to increase efficiency. These sensors measure roll, pitch and stability of trawl doors. This type of sensor is being increasingly used to optimise trawl door performance while towing, increasing catch efficiency. (France and England-UK; increased efficiency)
- One Irish vessel is currently testing an automatic *Nephrops* tailing machine. This vessel works almost exclusively in the Irish Sea and this fishery is almost a

targeted tail fishery given the small size of *Nephrops*. Initial indications from the trials being carried out are good. Potentially will increase the efficiency of *Nephrops* vessels targeting tails, given the machine is not subject to the same fatigue as crew. (Ireland; increased efficiency).

- A new trawl with double the length of groundgear (45 m to 90 m) has been introduced into Faeroese fisheries in 2006. This trawl is much more effective for catching monkfish and is now being widely used by trawlers < 500hp fishing on the Fareose Shelf in Area Vb1). (Faroe Islands; New trawl design).
- There is increased use of double bag trawls to give increased groundgear coverage. The use of the double bag/increase bosom nets is increasing particularly for the new vessels switching to *Nephrops* and some traditional vessels. The indication is that they see approx 33% increase in catches. These trawls are being used primarily for *Nephrops* although possibly 20% of Scottish whitefish trawlers are switching to double bags trawls. (UK-Scotland; New trawl design).

Technical Conservation Measures

- Several Irish co-ops have imposed their own market regulations by not selling *Nephrops* tails with a count of over 100/kg. This has largely been respected by vessels and has reduced the targeting of small *Nephrops* in some areas i.e. VIIa, VIIg (Smalls) and VIIb (Aran fishery).
- The Spanish Grand Sol fleet has moved to an ITQ system of management. Catches of megrim from 20–25 cm are limited to 2.5 tonnes per trip and vessels are banned from landing monkfish under 32 cm. (Spain; Voluntary management measures).
- Voluntary use of technical modifications for beam trawls. Main area is the Irish Sea, Bristol Channel (VIIa, f, g), but also some use in the English Channel. Promotion for the voluntary use of technical modifications as mentioned above: workshops, demonstration, project meetings open to all fishermen (Belgian beam trawlers, which are about 95% of the fleet), info-leaflet, and providing info through direct contact/questionnaire. (Belgium; voluntarily use of TCMs).
- A number of Irish *Nephrops* vessels working in the Smalls area have had problems with the UK Navy being strict on measuring mesh size and twine thickness. Fishermen have either replaced codends with a lower twine thickness or moved to the Irish Sea avoid prosecution, improving selectivity. This has involved upwards of 12 vessels at times. (Ireland; Regulation problems)
- Two vessels (20m/650p) fishing in the Irish Sea are working inclined separator panels for the last 3 years in the restricted cod recovery area and also in certain other places e.g. Dundalk Bay when there are a lot of small fish on the grounds. They report them to be very effective. During the closure in 2007 4–5 vessels have fished in the restricted areas with inclined separator panels fitted. (Ireland; Improved species selectivity but access to otherwise closed area)

Ecosystem Effects

- There is evidence of mis-reporting of cod from Area VIIg into area VIIa by Irish vessels in 2007. Fishermen have reported good fishing in this area but the Irish authorities have indicated they will re-allocate approximately 100 tonnes of cod landings in VIIa into VIIg. This quota is now almost depleted and the industry has warned there will be widespread discarding of cod later in the year in the Celtic Sea. (Ireland; Overestimation of VIIa cod catches).
- Vessels that have continued to target monkfish are now discarding 0–500 g and 500–1 kg fish to meet quota restrictions as it is increasing difficulty to sell "black fish" due to the registration of buyers and sellers. This discarding is reportedly at quite a high level. (Ireland; Unaccounted removals of monkfish)
- There are reported to be large quantities of small haddock in the Irish Sea during the first quarter of 2007. One seine net vessel reports consistently catching 40 box bulk catches to sort for 10–15 boxes of marketable haddock. This vessel left the

Irish Sea after a number of weeks due to the high level of discards. (Ireland; High discard rates of haddock)

- Ghost fishing in the deepwater monkfish and hake gillnet fisheries remains a problem in Areas VIB and VIIb, c Quantities of lost monkfish nets were recovered form SE Rockall during an Irish retrieval survey. A joint Irish and English ghost net retrieval programme is scheduled to commence in the autumn of 2007. (Ireland and UK; Ghost fishing).
- Effort in the hake gillnet fishery in the last quarter of 2006 was reported to be very high following the re-opening of the hake fishery and there were repeated claims by Irish fishermen that there was widespread use of 100mm mesh nets, which are illegal in Area VII. Irish vessels recovered many such nets and several French registered vessels were arrested. Several Irish vessels switched back to trawling. It is not clear whether new EU regulations introduced in January 2007 have had an effect. (Ireland; Illegal mesh size).
- The use of blinders has been reported in the Porcupine Bank *Nephrops* fishery, particularly in the hake recovery area where the minimum mesh size is 100mm. Irish boats have recovered several such blinders. Spanish vessels have also been observed using a specially designed chain rigged codends. These codends are legal under EU regulations but from their design would seem to be unselective. (Ireland; Illegal gear attachments).
- Reduced impact in the Belgium and UK beam trawl fleets through a combination of small round fish from T90 codend; benthos bycatch from Benthic Release panels; round fish catch reduction from big meshes; reduced bottom impact from experimental roller gear, usage of outrigger instead of beam trawls with chain matrix. As uptake is very minor at present, reduction in impact is minimal but numbers of vessels testing this gear voluntarily is increasing. (Belgium and UK-England; Reduced benthic impact).
- Danish trials have shown the effectiveness of acoustic deterrents for reductions in bycatch harbour porpoises in gillnet fisheries is maintained with 450m spacing using Aquatech pingers. The EU regulation states a maximum spacing of 200m. As a consequence of the above, that a derogation has been agreed for Danish fishermen to use AQUAmark 100 pingers at the increased spacing. Trials in Ireland have reported similar results (Denmark/Ireland; Acoustic deterrents).

Development of New Fisheries

- A new fishery has developed in Ireland for boarfish (*Capros aper*) during March/April 2007. This is driven by the very short fishing time now on all of the quota pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Two vessels landed upwards of 2,200 tonnes into Denmark in early April at a price of €178 per tonne, which compares favourably with blue whiting (€210 per tonne). A number of the other vessels landed into the local fishmeal factory in Killybegs. Landings may exceed 5,000 tonnes in 2007. Irish vessels are also considering pipefish and lantern fish. (Ireland; New fishery).
- Exploitation of cuttlefish in mainly the Eastern English Channel in wintertime by beam trawlers from the UK. There has been an effort shift (<5%) of the fleet (rough estimates: 10 vessels). Landings in 2004: 974 tonnes; 2005: 694 tonnes; 2006: unknown but probably more than 2005. Best catches are expected in period November – February. (UK-England; New fishery).
- One 24m Irish whitefish vessel targeted John Dory in ICES Area VIIg during July – August 2006 using standard rockhopper trawls. The vessel was catching up to 300–400 kg of Dory per tow and landing up to 3–4 tonnes for 5–7 day trips with a mixture of lemon sole, mixed flatfish, hake. Other vessels are reported to be interested in this fishery and may participate in 2007. (Ireland; New fishery).

- Catch composition in Belgium trials with the outrigger trawl have indicated a high bycatch of rays. (Belgium; bycatch species).

Annex 8C: FTFB Report to WGSSDS and WGHMM

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the Southern Shelf Assessment Area including the Celtic Sea and hake, monkfish and megrim stocks.

It should be noted that the information contained in this report does not cover fully all fleets engaged in Southern Shelf fisheries; information was obtained from Ireland, Belgium, UK, Spain (Basque Country) and France.

Changes in Fleet Dynamics between 2005 and 2007

- There is evidence of French demersal vessels concentrating effort around the edges of the cod box closures (30E4, 31E4, 32E3). Also some French vessels have switched from targeting cod to monkfish (France; Changes in Fleet Dynamics)
- Two of the largest Irish whitefish vessels (34m/2000hp) have shifted effort from deepwater species (black scabbard, orange roughy, grenadier) in Area VIa and VIIb-k to the mixed demersal species (megrim. monkfish, haddock, saithe) at Rockall in Area VIb. (Ireland; Quota restrictions/Changes in Fleet Dynamics; 2 vessels from a total fleet of approx. 150)
- 4–5 Irish whitefish vessels (all 24m+ vessels) have increased effort in the Rockall fishery in 2006, moving from the monkfish and mixed monkfish, megrim, hake fisheries in Areas VIIb-k to VIb. (Ireland; Quota restrictions/Changes in fleet Dynamics; 4–5 vessels from a total fleet of approx. 150)
- Irish whitefish vessels participating in the targeted monkfish fisheries in Areas VIIb-k and VIa have reduced during 2006 and in the first quarter of 2007. Vessels have moved to the Porcupine Bank *Nephrops* fishery (see below) or targeted "mixed" demersal fisheries with single trawls for megrim, monkfish, *Nephrops*. Shift from 100mm+ to 70–99 mm. (Ireland; Restrictive quotas and tighter enforcement including the introduction in Ireland of a new Sales Notes management regime; 8–10 vessels from upwards of 20 vessels in 2005)
- A number of Irish *Nephrops* vessels working in the Smalls area (VIIg) have shifted to the Irish Sea following problems with the UK Navy being unduly strict on measuring mesh size and twine thickness. (Ireland; Increased control and enforcement/Change in Fleet Dynamics; this has involved upwards of 12 vessels at times).
- Some minor shift in effort noted from VII to VIIIa,b,d for the Basque fleet using the Very High Vertical Opening VHVO demersal pair trawling targeting hake, this is likely to be response to the mandatory requirement to use a larger mesh in VII (100mm) in comparison to VIII (70mm). (Spain; Changes in Fleet Dynamics)
- French vessels have switched from anchovy and tuna pelagic trawling to monkfish bottom trawling in recent years. The increase in effort in the monkfish fishery is reported to be high and is expected to increase given the continued closure of the anchovy fishery. (France; Changes in Fleet Dynamics)
- A Decommissioning Scheme was launched in Ireland October 2005 and continued in 2006. To date, a total of 36 (includes one in 2005) vessels have been decommissioned in respect of 35 vessels in 2006. A further decommissioning programme will be announced shortly under the EFF 2007–2013 following governmental review with the aim of removing a further 40% of the whitefish fleet. (Ireland; Pressure on quotas; removal of 4,901 GTs and 15,392 kW's from the fleet from the Irish whitefish and scallop fleets).

- Several Irish whitefish vessels that have been permanently tied-up have been sold to Gambia in 2006. Another of the larger whitefish vessels (34m/1200hp) has been sold recently to South Africa. This vessel had been active up until mid-2006. (Ireland; Economics; 2 inactive and 1 active 34m demersal vessel).
- £5 million has recently been allocated to reduce capacity in the SW beam trawl fleet, aimed primarily at vessels that traditionally target sole in the Celtic Sea and Channel. (UK-England; Sole catch reduction; It is difficult to estimate how many vessels will be removed but on previous experience, it is likely to be sufficient to remove 4 or 5 vessels).
- Despite quota restrictions, high levels of control and enforcement, increased fuel costs and a major review of the Irish industry, during 2006 and the first quarter of 2007 around 23 new or modern second-hand vessels have entered the Irish demersal fleets. This has been driven by the imminent introduction of the new safety regulations for vessels between 15m and 24m, accelerated as a consequence of the tragic sinking of 4 vessels in the south-east. These regulations will prove onerous and are likely to be similar to the Torrmelinos Convention rules for vessels over 24 m. In anticipation of these changes a number of skippers are looking for more modern vessels. The tonnage being taken out to introduce these new vessels is largely inefficient or inactive (< 2 years) tonnage and the Irish whitefish fleet, while reducing in size by numbers has increased in terms of efficiency. This will almost certainly mean that quotas will become even more restrictive, particularly quotas for *Nephrops* (all areas), Rockall mixed fishery, mackerel and herring dry-hold quotas and mixed whitefish (mainly haddock and cod in Area VIIb-k). (Ireland; Increased effort).

Technology Creep

- A number of Dutch beam trawlers are investigating towing two sets of smaller trawls from each beam in order to reduce fuel consumption, referred to as 'outrigging'. Similar work is also ongoing in Belgium. This is experimental at present but the method is more fuel efficient but less effective for sole than conventional beam trawl rigs. (Belgium and Netherlands; Fuel costs; experimental fishery).
- Two Irish vessels (22m/ 1000hp) have switched to pair trawling to target hake with high opening semi-pelagic trawls (Naberon trawls). These vessels are landing between 9–15 tonnes of hake per 7–10 day trip. One other similar pair of vessels is also considering this fishery VIIj-k and VIII. (Ireland; Pressure on other quota specie; 2 vessels with a further 2 vessels likely).
- Several French vessels have reverted from *Nephrops* twin trawling to single rig trawling in the Celtic Sea due to high fuel and difficulties finding crew. (France; Change in fishing method)
- Several French vessels working in the English Channel (VIId & e) have converted from trawling to Danish seine to reduce fuel costs). (France; Fuel costs; several vessels).
- Belgium beam trawlers and French trawlers are increasingly being equipped with 3D mapping sonar which has opened up new areas to fishing (close to wrecks): this was mentioned last year and is most likely still applicable (Belgium and France; Increased efficiency)
- Several countries report that new gear monitoring equipment fitted to trawls and trawl doors (Scanmar etc) have the potential to increase efficiency. These sensors measure roll, pitch and stability of trawl doors. This type of sensor is being increasingly used to optimise trawl door performance while towing, increasing catch efficiency. (France and England-UK; increased efficiency)
- One Irish vessel is currently testing an automatic *Nephrops* tailing machine. This vessel works almost exclusively in the Irish Sea and this fishery is almost a targeted tail fishery given the small size of *Nephrops*. Initial indications from the trials being carried out are good. Potentially will increase the efficiency of

Nephrops vessels targeting tails, given the machine is not subject to the same fatigue as crew. (Ireland; Increased efficiency).

Technical Conservation Measures

- Voluntary use of technical modifications for beam trawls. Main area is the Irish Sea, Bristol Channel (VIIa, f, g), but also some use in the English Channel. Promotion for the voluntary use of technical modifications as mentioned above: workshops, demonstration, project meetings open to all fishermen (Belgian beam trawlers, which are about 95% of the fleet), info-leaflet, and providing info through direct contact/questionnaire. (Belgium; voluntarily use of TCMs).
- A large number of French vessels are reported to be using square mesh panel (100mm inner opening) on the top of the rear-tapered section of the trawl, to decrease catches of juvenile hakes in *Nephrops* fishery in the Bay of Biscay. The incentive is access to fish *Nephrops* in the hake box. The use of the Square mesh panel is mandatory to obtain a *Nephrops* license in the Bay of Biscay. Extensive catch comparison trials between selective and commercial trawl showed an average escape rate of 26,4% for undersized hakes (under 27 cm) with some loss on commercial hakes but the smallest losses of *Nephrops* and the largest reduction of bycatch (up to 35%- blue whiting, horse mackerel mainly). (France; Access to closed area)
- A number of Irish *Nephrops* vessels working in the Smalls area have had problems with the UK Navy being strict on measuring mesh size and twine thickness. Fishermen have either replaced codends with a lower twine thickness or moved to avoid prosecution, improving selectivity. This has involved upwards of 12 vessels at times. (Ireland; Regulation problems)
- The UK beam trawl fleet in the south-west is now using benthic release panels. Research shows that these release about 75% of benthic invertebrates from the catches and there are indications that they also release small monkfish. With increasing consumer and NGO demands specifically targeting this fishing method, the use of these panels is likely to increase further. Full square mesh codends are also been tested on a small number of vessels, these reduce the capture of benthos further and improve the selection profile on gadoids. Due to increasing pressure from NGOs and fish buyers. Uptake is approximately 20% (10 vessels). (UK-England; Voluntary use of TCM)
- A small proportion <10% of the Basque demersal fleet are now using square mesh panels on a voluntary basis in the upper part of the extension of the VHVO demersal trawl fleet fishing hake in ICES VIIIa,b,d aiming at reducing the level of discards. (Spain; Voluntary use of TCM).
- Several Irish co-ops have imposed their own market regulations by not selling *Nephrops* tails with a count of over 100/kg. This has largely been respected by vessels and has reduced the targeting of small *Nephrops* in some areas i.e. VIIa, VIIg (Smalls) and VIIb (Aran fishery).
- The Spanish Grand Sol fleet has moved to an ITQ system of management. Catches of megrim from 20–25 cm are limited to 2.5 tonnes per trip and vessels are banned from landing monkfish under 32cm. (Spain; Voluntary management measures).

Ecosystem Effects

- Ghost fishing in the deepwater monkfish and hake gillnet fisheries remains a problem in Areas VIB and VIIb, c Quantities of lost monkfish nets were recovered form SE Rockall during an Irish retrieval survey. A joint Irish and English ghost net retrieval programme is scheduled to commence in the autumn of 2007. (Ireland and UK; Ghost fishing).
- Irish monkfish vessels are now discarding 0–500g and 500–1kg monk to meet quota restrictions and also as it is increasing difficulty to sell “black fish” with increased traceability. This discarding is reportedly at quite a high level. Some

vessels in fishery are using 120mm+ codends to reduce discards. (Ireland; Discarding)

- Effort in the hake gillnet fishery in the last quarter of 2006 was reported to be very high following the re-opening of the hake fishery and there were repeated claims by Irish fishermen that there was widespread use of 100mm mesh nets, which are illegal in Area VII. Irish vessels recovered many such nets and several French registered vessels were arrested. Several Irish vessels switched back to trawling. It is not clear whether new EU regulations introduced in January 2007 have had an effect. (Ireland; Illegal mesh size).
- The use of blinders has been reported in the Porcupine Bank *Nephrops* fishery particularly in the hake recovery area where the minimum mesh size is 100mm. Irish boats have recovered several such blinders. Spanish vessels have also been observed using a specially designed chain rigged codends. These codends are legal under EU regulations but from their design would seem to be unselective. (Ireland; Illegal gear attachments).
- Reduced impact in the Belgium and UK beam trawl fleets through a combination of small round fish from T90 codend; benthos bycatch from Benthic Release panels; round fish catch reduction from big meshes; reduced bottom impact from experimental roller gear, usage of outrigger instead of beam trawls with chain matrix. As uptake is very minor at present, reduction in impact is minimal but numbers of vessels testing this gear voluntarily is increasing. (Belgium and UK-England; Reduced benthic impact).

Development of New Fisheries

- Exploitation of cuttlefish in mainly the Eastern English Channel in wintertime by beam trawlers from the UK. There has been an effort shift (<5%) of the fleet (rough estimates: 10 vessels). Landings in 2004: 974 tonnes; 2005: 694 tonnes; 2006: unknown but probably more than 2005. Best catches are expected in period November – February. (UK-England; New fishery).
- One 24m Irish whitefish vessel targeted John Dory in ICES Area VIIg during July – August 2006 using standard rockhopper trawls. The vessel was catching up to 300–400 kg of Dory per tow and landing up to 3–4 tonnes for 5–7 day trips with a mixture of lemon sole, mixed flatfish, hake. Other vessels are reported to be interested in this fishery and may participate in 2007. (Ireland; New fishery).
- Catch composition in Belgium trials with the outrigger trawl have indicated a high bycatch of rays. (Belgium; bycatch species).
- Development of electrical fishing in SW Scotland for Razor clams (*Enis spp.)* (UK-Scotland; New fishery).

Annex 8D: FTFB Report to WGBFAS

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes on ecosystem effects in the Baltic. No other relevant information was given.

It should be noted that the information contained in this report does not cover fully all fleets engaged in Baltic; information was obtained from Sweden and Denmark.

Ecosystem Effects

- There has been significant take up of pingers in Sweden where the Council Regulation came into force at the beginning of the year. Manufacturers also report they have received inquiries and orders from other Baltic states – notably Estonia. However, apart from some small orders from some Spanish fishermen at the point when some vessels were being forced to return to port a year or so ago, and one or two small UK orders, we have seen no significant interest from any of the other regions affected by the Council regulation. (All countries; Acoustic Deterrents).
- Danish trials have shown the effectiveness of acoustic deterrents for harbour porpoises is maintained with 450 m spacing using Aquatech pingers. The regulation states a maximum spacing of 200 m. As a consequence of the above, that a derogation has been agreed for Danish fishermen to use AQUAmark 100 pingers at the increased spacing. Trials in Ireland have reported similar results (Denmark/Ireland; Acoustic deterrents).
- Ghost fishing associated with the Baltic cod gill net fishery have been demonstrated as a continuing problem in Sweden. Nationally funded retrieval programmes have been conducted since 2002 to remove ghost nets. (Sweden; ghost nets).

Annex 8E: FTFB Report to AFWG

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the Arctic Fisheries areas.

It should be noted that the information contained in this report does not cover fully all fleets engaged in fisheries; information was obtained from Norway primarily.

Changes in Fleet Dynamics between 2005 and 2007

- The Norwegian industrial trawling fleet has reduced effort targeting Norway pout, and increased effort targeting blue whiting in the Norwegian trench with larger trawls. Bycatch of saithe occurs in the blue whiting fishery and trials will be carried out in 2007 using grid to reduce the bycatch problem. (Norway; Moving Fisheries).
- There has been shift in the Faeroese pelagic fleet from single trawling to pair trawling for herring. For companies with 4–5 vessels this improves efficiency, as there is less changing between fisheries associated as individual vessels or pairs of vessels can target different fisheries depending on quotas. (Faroe Islands; Improved efficiency).

Technology Creep

- Norwegian and French demersal trawls are using sensors that measure roll, pitch and stability of trawl doors are developed. The trawlers to optimise the trawl door

performance while towing increasingly use the sensor. (Norway/France; New technologies).

- Norwegian purse seines are using an acoustic instrument to measure distance of the ground line/lead line from the seabed has been developed. This sensor is used by many seiners while fishing for saithe and herring in areas with strong currents and rough seabed (reduced wear and tear). This reduces damage and increases catch efficiency. (Norway; New technologies).
- Norwegian seine netters in the Norwegian Sea are using smaller gear with more weights on the groundgear to secure proper bottom contact. The effect on the catching efficiency is not quantified, but underwater observation indicates a far higher catching efficiency. (Norway; Modified gear).
- In Norway there is increased use of Danish seines for the coastal fleet traditionally used gillnets and longlines. Main reason is that fish caught with Danish seines generally have higher quality than fish caught by gillnets and that the price for longline bait has increased. (Norway; Alternative fishing method).
- Most Norwegian trawlers are now using twin trawls for cod, haddock and saithe increases. Experiments indicate no difference in length composition for the three species between single and twin trawl. The increased catch rates found for twin trawl compared to single trawl is approximately proportional to the increase in door spread. (Norway; New gears).
- A Faeroese purse seiner/trawler fished successfully in the summer of 2006 for redfish in the Norwegian sector on the basis of reports from Russian vessels. This vessel was holding redfish in RSW tanks on board. Fish were kept on board for up to a week using this method of storage. Other similar Faeroese vessels are looking at this fishery. (Faroe Islands; New technologies).
- Faeroese whitefish vessels have being experimenting with on board processing of waste products from cod and saithe. Products include roes and livers and the vessels tend to concentrate on these by-products when fishing is slow. (Faroe Islands; New technologies).
- Norwegian trawlers in the 1800–3000 hp range are using single nets with 400mm mesh in sections of the Top wings and special cutting rates in the belly sections Vessels are switching to these trawls from twin-trawls in periods of bad weather and also to improve fuel efficiency. (Norway; New trawl design).

Technical Conservation Measures

- The Norwegian shrimp fishery in the Barents Sea is conducted by large trawlers operating two or three trawls (presently 3 vessels). Sorting grids are mandatory in the shrimp fishery north of 62ºN. Plastic grids are becoming more popular than grids made from steel. Bycatch of juvenile redfish, cod and haddock sometimes results in closure for shrimp fishing grounds in the Barents Sea. In the shrimp fishery in the North Sea and in Skagerrak, trawlers are using sorting grids voluntarily during periods of high bycatch rates. (Norway; Voluntary use of TCM).
- To reduce bycatch of saithe, cod and haddock during pelagic trawling for herring, Norwegian vessels are using grids. The use of grids is now mandatory (from 2007) in some areas for small/medium sized vessels. Voluntarily used in other areas where bycatch of especially saithe occur. Vessels targeting herring have no quota for gadoids and no facilities onboard for handling gadoids leading to high discarding. (Norway; Voluntary use of TCMs).

Ecosystem Effects

- A Norwegian Project has been initiated to develop pelagic trawling for gadoids in order to reduce bottom impact. Pelagic trawling for gadoids is banned in Norwegian waters north of 64 degrees north currently. (Norway; Reduction in bottom impact).

Annex 8F: FTFB Report to WGMHSA, HAWG and WGNPBW

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in pelagic fisheries for horse mackerel, mackerel, anchovy, sardine, herring and blue whiting.

It should be noted that the information contained in this report does not cover fully all fleets engaged in pelagic fisheries; information was obtained from Ireland, Netherlands, UK-Scotland, Spain (Basque Country), Norway, Faroe Islands and France.

Changes in Fleet Dynamics between 2005 and 2007

- Irish inshore fishermen have increased the number of pots in order to make up for lost earnings as a result of the salmon drift net fishery. This action will be widespread and will have a major impact on crab and lobster as well as increasing numbers of these vessels, potentially diversifying into handling for mackerel and white pollack during the summer months. Putting further pressures on quotas for these species. There are approx. 900 licences in Ireland so the cumulative effect could be high. (Ireland; Closure of a fishery).
- New national regulations introduced in early 2006 in Ireland have seen an increased number of vessels in the polyvalent sector with mackerel entitlements. This fleet is split into vessels < 65ft and > 65ft. In 2005, this fleet consisted of 11 vessels > 65ft and 7 vessels < 65ft with a total allocated quota of 7,000 tonnes. Effort now in this segment is too high compared to quota entitlements. This displacement of effort by some of these vessels that normal target whitefish has seen a reduction in effort in these fisheries for a 6–8 week period. An additional 6–8 vessels have participated in this fishery in 2006 with a further 4 vessels are being purposely built to fish against it. (Ireland; Increased effort).
- The Irish freezer vessel "Atlantic Dawn" (144m/14,000hp) has been sold to a Dutch company. Given the catching power of this vessel the implications for the Irish fleets on how this vessel's quota entitlements are used in the future are large. Vessel is now fishing off South America – shift from VI and VII to international waters. (Ireland; Shift in effort).
- French vessels have switched from anchovy and tuna pelagic trawling to monkfish bottom trawling in recent years. The increase in effort in the monkfish fishery is reported to be high and is expected to increase given the continued closure of the anchovy fishery. (France; Changes in Fleet Dynamics)
- The Scottish pelagic fleet has dropped from 34 vessels in 2003 to 24 in 2006. Days at sea by this fleet have dropped from around 1700 in 2003/04 to 1044 in 2005 and 382 in 2006. At the same time catch per day absent has almost doubled in the mackerel fishery. Much of this due to forensic accountancy operations and Registration of buyers and sellers. (UK-Scotland; Decrease in effort).
- The Norwegian industrial trawling fleet has reduced effort targeting Norway pout, and increased effort targeting blue whiting in the Norwegian trench with larger trawls. Bycatch of saithe occurs in the blue whiting fishery and trials will be carried out in 2007 using grid to reduce the bycatch problem. (Norway; Moving Fisheries).

Technology Creep

- Norwegian purse seines are using an acoustic instrument to measure distance of the ground line/lead line from the seabed has been developed. This sensor is used by many seiners while fishing for saithe and herring in areas with strong currents and rough seabed (reduced wear and tear). This reduces damage and increases catch efficiency. (Norway; New technologies).

Technical Conservation Measures

- To reduce bycatch of saithe, cod and haddock during pelagic trawling for herring, Norwegian vessels are using grids. The use of grids is now mandatory (from 2007) in some areas for small/medium sized vessels. Voluntarily used in other areas where bycatch of especially saithe occur. Vessels targeting herring have no quota for gadoids and no facilities onboard for handling gadoids. (Norway; Voluntary use of TCMs).
- In response to an industry initiative the potential of incorporating similar flexi-grids systems into the codends of trawls for release of mackerel and horse mackerel have been tested in Ireland. The Irish industry is very positive about these devices given the price differential between different sizes of mackerel and horse mackerel. Two vessels have used these devices voluntarily in 2007. (Ireland; Voluntary use of TCMs).
- In the Faeroese sector it is mandatory for pelagic trawlers targeting blue whiting to use sorting grids from 1. June 2007 to reduce bycatches of cod and saithe. Research made by the Faeroese Fisheries Inspection shows that the bycatch in the BW fishery is in average 1% over the year, mainly saithe. Research made by the Faeroese Fisheries Laboratory shows that the bycatch varies from 0 to 20%. The catch of BW was in 2004 435000t. 1% of this is 4350t. The sorting grid seems to eliminate the bycatch. (Faroe Islands; New technical measure).

Ecosystem Effects

- Management regulations in the Irish scad fishery in 2006 and 2007, restricting the bycatch of mackerel to 5% has lead to widespread slipping in the fishery when catches have been mixed. (Ireland; Discarding).

New Fisheries

- A new fishery has developed in Ireland for boarfish (*Capros aper*) during March/April 2007. This is driven by the very short fishing time now on all of the quota pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Two vessels landed upwards of 2,200 tonnes into Denmark in early April at a price of €178 per tonne, which compares favourably with blue whiting (€210 per tonne). A number of the other vessels landed into the local fishmeal factory in Killybegs. Landings may exceed 5,000 tonnes in 2007. Irish vessels are also considering pipefish and lantern fish. (Ireland; New fishery).

Annex 8G: FTFB Report to WGDEEP

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new deepwater fisheries.

It should be noted that the information contained in this report does not cover fully all fleets engaged in pelagic fisheries; information was obtained from Ireland, Netherlands, UK-Scotland, Spain (Basque Country), Norway, Faroe Islands and France.

Changes in Fleet Dynamics between 2005 and 2007

- Two of the largest Irish whitefish vessels (34m/2000hp) have shifted effort from deepwater species (black scabbard, orange roughy, and grenadier) in Area VIa and VIIb-k to the mixed demersal species (megrim. monkfish, haddock, saithe) at Rockall in Area VIb. (Ireland; Quota restrictions/Changes in Fleet Dynamics; 2 vessels from a total fleet of approx. 150)

Technology Creep

- Norwegian and French demersal trawls are using sensors that measure roll, pitch and stability of trawl doors are developed. The trawlers to optimise the trawl door performance while towing increasingly use the sensor. (Norway/France; New technologies).

Ecosystem Effects

- Ghost fishing in the deepwater monkfish and hake gillnet fisheries remains a problem in Areas VIB and VIIb, c Quantities of lost monkfish nets were recovered form SE Rockall during an Irish retrieval survey. A joint Irish and English ghost net retrieval programme is scheduled to commence in the autumn of 2007. (Ireland and UK; Ghost fishing).
- Effort in the hake gillnet fishery in the last quarter of 2006 was reported to be very high following the re-opening of the hake fishery and there were repeated claims by Irish fishermen that there was widespread use of 100mm mesh nets, which are illegal in Area VII. Irish vessels recovered many such nets and several French registered vessels were arrested. Several Irish vessels switched back to trawling. It is not clear whether new EU regulations introduced in January 2007 have had an effect. (Ireland; Illegal mesh size).
- The Norwegian's have an annual retrieval programme for lost gillnets in the Greenland halibut and blue ling fisheries in deep waters. There are recent reports by Norwegian vessels of ghost nets in Tampen Bank area of IVa. These are monkfish nets discarded, lost or abandoned and the problem is increasing with increasing effort. (Norway; Ghost Nets).

Development of New Fisheries

- A new fishery has developed in Ireland for boarfish (*Capros aper*) during March/April 2007. This is driven by the very short fishing time now on all of the quota pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Two vessels landed upwards of 2,200 tonnes into Denmark in early April at a price of €178 per tonne, which compares favourably with blue whiting (€210 per tonne). A number of the other vessels landed into the local fishmeal factory in Killybegs. Landings may exceed 5,000 tonnes in 2007. Irish vessels are also considering pipefish and lantern fish. (Ireland; New fishery).

Annex 8H: FTFB Report to WGECO

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial cpue estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries that may have an impact on the marine ecosystem.

It should be noted that the information contained in this report does not cover fully all fleets engaged in pelagic fisheries; information was obtained from Ireland, Netherlands, UK-Scotland, UK-England, Northern Ireland, Spain (Basque Country), Belgium, Norway, Faroe Islands, Sweden and France.

Ecosystem Effects

- In the Netherlands the bycatch of benthic fauna and several non-target fish species (e.g. gobies) in beam trawls, are becoming of increasing importance and the marine mammals in pelagic trawls. Voluntarily use of longitudinal release holes in the lower side of the trawl, which open when nets are filled with benthos. Fish excluder and square mesh panels in pelagic trawls, used voluntarily.

Effectiveness and optimum design still under study in close cooperation with the industry. (Netherlands; Benthic impact and Marine Mammal bycatch).

- Reduced impact in the Belgium and UK beam trawl fleets through a combination of small round fish from T90 codend; benthos bycatch from Benthic Release panels; round fish catch reduction from big meshes; reduced bottom impact from experimental roller gear, usage of outrigger instead of beam trawls with chain matrix. As uptake is very minor at present, reduction in impact is minimal but numbers of vessels testing this gear voluntarily is increasing. (Belgium and UK-England; Reduced benthic impact).
- The Norwegian's have an annual retrieval programme for lost gillnets in the Greenland halibut and blue ling fisheries in deep waters. There are recent reports by Norwegian vessels of ghost nets in Tampen Bank area of IVa. These are monkfish nets discarded, lost or abandoned and the problem is increasing with increasing effort. (Norway; Ghost Nets).
- Irish vessels have reported a fleet of Russian vessels prosecuting a small mesh fishmeal fishery for haddock both inside and outside the EU 200 mile limit at Rockall including inside the Haddock Box. (Ireland; Small Mesh Fisheries).
- Ghost fishing in the deepwater monkfish and hake gillnet fisheries remains a problem in Areas VIB and VIIb, c Quantities of lost monkfish nets were recovered form SE Rockall during an Irish retrieval survey. A joint Irish and English ghost net retrieval programme is scheduled to commence in the autumn of 2007. (Ireland and UK; Ghost fishing).
- Irish monkfish vessels are now discarding 0–500 g and 500–1kg monk to meet quota restrictions and also as it is increasing difficulty to sell "black fish" with increased traceability. This discarding is reportedly at quite a high level. Some vessels in fishery are using 120mm+ codends to reduce discards. (Ireland; Discarding)
- Effort in the hake gillnet fishery in the last quarter of 2006 was reported to be very high following the re-opening of the hake fishery and there were repeated claims by Irish fishermen that there was widespread use of 100mm mesh nets, which are illegal in Area VII. Irish vessels recovered many such nets and several French registered vessels were arrested. Several Irish vessels switched back to trawling. It is not clear whether new EU regulations introduced in January 2007 have had an effect. (Ireland; Illegal mesh size).
- The use of blinders has been reported in the Porcupine Bank *Nephrops* fishery, particularly in the hake recovery area where the minimum mesh size is 100mm. Irish boats have recovered several such blinders. Spanish vessels have also been observed using a specially designed chain rigged codends. These codends are legal under EU regulations but from their design would seem to be unselective. (Ireland; Illegal gear attachments).
- Management regulations in the Irish scad fishery in 2006 and 2007, restricting the bycatch of mackerel to 5% has lead to widespread slipping in the fishery when catches have been mixed. (Ireland; Discarding).
- There has been significant take up of pingers in Sweden where the Council Regulation came into force at the beginning of the year. Manufacturers also report they have received inquiries and orders from other Baltic states – notably Estonia. However, apart from some small orders from some Spanish fishermen at the point when some vessels were being forced to return to port a year or so ago, and one or two small UK orders, we have seen no significant interest from any of the other regions affected by the Council regulation. (All countries; Acoustic Deterrents).
- Danish trials have shown the effectiveness of acoustic deterrents for reductions in bycatch harbour porpoises in gillnet fisheries is maintained with 450m spacing using Aquatech pingers. The EU regulation states a maximum spacing of 200m. As a consequence of the above, that a derogation has been agreed for Danish fishermen to use AQUAmark 100 pingers at the increased spacing. Trials in Ireland have reported similar results (Denmark/Ireland; Acoustic deterrents).

- Under the EU funded NECESSITY project, IFREMER from France and St Andrews University (USTAN) carried out trials with specifically designed acoustic deterrent devices fitted to pelagic trawls in the bass fishery during 2006 and Q1 of 2007. Initial reports some reduction in bycatch but more observations are required before a statistically significant result will be obtained. (France and UK; Reduced bycatch).
- Ghost fishing associated with the Baltic cod gill net fishery have been demonstrated as a continuing problem in Sweden. Nationally funded retrieval programmes have been conducted since 2002 to remove ghost nets. (Sweden; ghost nets).

Development of New Fisheries

- A new fishery has developed in Ireland for boarfish (*Capros aper*) during March/April 2007. This is driven by the very short fishing time now on all of the quota pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Two vessels landed upwards of 2,200 tonnes into Denmark in early April at a price of €178 per tonne, which compares favourably with blue whiting (€210 per tonne). A number of the other vessels landed into the local fishmeal factory in Killybegs. Landings may exceed 5,000 tonnes in 2007. Irish vessels are also considering pipefish and lantern fish. (Ireland; New fishery).
- Exploitation of cuttlefish in mainly the Eastern English Channel in wintertime by beam trawlers from the UK. There has been an effort shift (<5%) of the fleet (rough estimates: 10 vessels). Landings in 2004: 974 tonnes; 2005: 694 tonnes; 2006: unknown but probably more than 2005. Best catches are expected in period November – February. (UK-England; New fishery).
- One 24m Irish whitefish vessel targeted John Dory in ICES Area VIIg during July – August 2006 using standard rockhopper trawls. The vessel was catching up to 300–400 kg of Dory per tow and landing up to 3–4 tonnes for 5–7 day trips with a mixture of lemon sole, mixed flatfish, hake. Other vessels are reported to be interested in this fishery and may participate in 2007. (Ireland; New fishery).
- Catch composition in Belgium trials with the outrigger trawl have indicated a high bycatch of rays. (Belgium; bycatch species).
- Development of electrical fishing in SW Scotland for Razor clams (*Enis spp.)* (UK-Scotland; New fishery).
- A 144m/30,000 hp Norwegian vessel designed to target krill is due to be delivered in 2010. Production of krill oil from the first year of operation is projected at 1,200 tonnes. (Norway; New fishery).

Annex 8I: FTFB Report to WGMME

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may have an impact on marine mammal stocks and also interactions of fisheries with marine mammals.

It should be noted that the information contained in this report does not cover fully all fleets engaged in deepwater fisheries; information was obtained from UK, Ireland, Denmark, Sweden and France.

- There has been significant take up of pingers in Sweden where the Council Regulation came into force at the beginning of the year. Manufacturers also report they have received inquiries and orders from other Baltic states – notably Estonia. However, apart from some small orders from some Spanish fishermen at the point when some vessels were being forced to return to port a year or so ago, and one or two small UK orders, we have seen no significant interest from any of the other regions affected by the Council regulation. (All countries; Acoustic Deterrents).
- Danish trials have shown the effectiveness of acoustic deterrents for reductions in bycatch harbour porpoises in gillnet fisheries is maintained with 450m spacing using Aquatech pingers. The EU regulation states a maximum spacing of 200m. As a consequence of the above, that a derogation has been agreed for Danish fishermen to use AQUAmark 100 pingers at the increased spacing. Trials in Ireland have reported similar results (Denmark/Ireland; Acoustic deterrents).
- The bycatch of cetaceans in the Albacore tuna fishery in 2006 was again reported to be very low. This is felt largely due to the fact that fishermen are now dropping their nets to 10–20fm by stropping off the floats mounted on the wings and headline of the trawl. Fishermen report they have seen a reduction in bycatch since they started fishing at deeper depths as opposed to keeping the headline of the trawl on the surface, as was previous practice. (Ireland and France. Implications: Reduced bycatch).
- Under the EU funded NECESSITY project, IFREMER from France and St Andrews University (USTAN) carried out trials with specifically designed acoustic deterrent devices fitted to pelagic trawls in the bass fishery during 2006 and Q1 of 2007. Initial reports some reduction in bycatch but more observations are required before a statistically significant result will be obtained. (France and UK; Reduced bycatch).

Annex 9: Ad hoc Discussion Group on "Calls for global bans on bottom trawling"

Introduction

This document was prepared prior to WGFTFB meeting in April by Jochen Depestele (ILVO) and Dominic Rihan (BIM). It is intended purely for discussion and information purposes and does not purport necessarily to reflect the views of WGFTFB.

What is the current situation?

Increasingly different stakeholders and environmental groups publish statements on bottom trawling impacts in specific contexts, which subsequently often become misreported in the media. Public opinion doesn't always perceive the correct view of the actual impact of bottom trawling. This discussion document aims to provide a summary on the current state-of-the-art and scientific information concerning bottom trawling and its impact.

What requests/initiatives are there for a ban on bottom trawling? (What fisheries are under threat? Which other management measures are proposed?)

Table 1 below outlines some of the current calls being made for bottom trawling bans; the origin of the call; the status; and the criteria being applied. This is by no means a definitive list but gives examples of the types of calls being made and indicates the motivation behind them.

Table 1. Current calls for bottom trawling bans.

WHERE	WHEN	BASIS/ORIGINATOR	STATUS	CRITERIA
The Sensitive habitats of the high seas'	2004	Deep Sea Conservation Coalition	Statement to the United Nations General Assembly	IUU (Illegal, Unregulated and Unreported) fishing ; Threats to vulnerable deep-sea ecosystems (seamounts, cold water corals, etc.)
NE Atlantic	2006	National Parks & Wildlife Service, Department of the Environment, Heritage & Local Government (Ireland)	Request to EU under the Habitats Directive to close designated coldwater coral areas	Protection of coldwater coral reefs
Temporary Closure in High Seas	2006	UN General Assembly	Rejected at UN General Assembly (Nov 06)	
(a) The Hecate and Faraday sea-mounts and a section of the Reykjanes Ridge. (b) The Altair seamounts. (c) The Antialtair seamounts	1/1 /2005 – 31/12 /2007	NEAFC	Recommendation to contracting parties (EU, Faroe Islands, Greenland, Iceland, Norway, Russian Federation)	Protection of vulnerable deep-water habitats; Restrictions on bottom trawling and fishing with static gear (incl. bottom gillnets and longlines)
(a) Hatton Bank (b) Rockall Bank (c) Logachev Mounds (d) West Rockall Mounds	1/1 /2007 – 31/12 /2009	NEAFC	Recommendation to contracting parties	Protection of deep-water corals; Restrictions as above
Global ban	2006	EU Environment Commissioner	Global Ban on bottom trawling	
Southern Indian Ocean	2006	New Zealand Fishing Companies	Voluntary ban on seamounts	Protection of seamounts

WHERE	WHEN	BASIS/ORIGINATOR	STATUS	CRITERIA
NE Atlantic	2006	Seas at Risk Marine Conservation Society and WWF	Request to NEAFC 2006	
Mediterranean Sea	9/10 /2002	EU [COM(2002) 535 final]	Communication of EC in 2002 to direct attention to more sustainable fisheries, bearing in mind the possibility to ban bottom trawling; further development	Better protection of coastal areas where young fish congregate and which harbour sensitive habitats;strengthening the current ban; small-scale fishermen to use more selective gears
'High seas'	2006	Deep Sea Conservation Coalition (DSCC)	Statement to the United Nations General Assembly	Unknown state of the nature and extent of deep-sea biodiversity in high seas, possibly vulnerable deep-sea ecosystems
Vulnerable marine ecosystems	14/07 2006	UN	Advance, unedited text	Actions taken by States and regional fisheries management organisations and arrangements to give effect to paragraphs 66 to 69 of General Assembly resolution 59/25 on sustainable fisheries regarding the impacts of fishing on vulnerable marine ecosystems
Hong Kong Waters	1/12 /2005	WWF- "Save Our Seas"-campaign	Position Paper 2006/7: Introduction of Fishing Licensing Scheme 2006/7: No-take zones in all existing Marine Parks & Fisheries Protection Areas 2008: Phase out stern and pair trawlers 2011: ban on bottom trawling in all Hong Kong waters except for designated shrimp trawling areas 2016: 30% of Hong Kong waters designated as no-take zones	Control of fishing effort; Protection of spawning and nursery grounds; Ban of bottom trawling to allow recovery of soft bottom sea-bed communities, ;monetary compensation and re-training for alternative employment.
Vulnerable marine ecosystems	28/04 /2006	EC	Actions taken by States and Regional fisheries management organisations and arrangements to give effect to paragraphs 66 to 69 of resolution 59/25 of the General Assembly on Sustainable Fisheries, including through the 1995 UN Fish Stocks Agreement, regarding the impacts of fishing on vulnerable marine ecosystems	

WHERE	WHEN	BASIS/ORIGINATOR	STATUS	CRITERIA
Not specified	8/2002	The Ocean Conservancy	Position Paper Restrictions/ban on bottom trawls and dredges in certain areas Closure in all habitat types (marine reserves and protected areas)	Limitations of bottom trawls and dredges to areas where substantive evidence shows impacts to habitat and long-lived organisms are minimal and recovery is rapid; Protection of sensitive or delicate habitats; Insurance against ecosystem collapse by destructive fishing methods and poor management; Enable research on the effects of fishing (separate fishing effects from pollution and climate change)
Pacific Islands	2007	Pacific Islands Forum/CNMI	Temporary ban on bottom trawling agreed at 7th Western Micronesian Chief Executives Summit in Saipan	Protection of coral reefs
Spanish waters inside 12 miles	2006	Federación Cofradias de Pescadores	Support to NGO Oceana through call to Spanish government	Ban bottom trawling in Spanish waters inside 12 miles

What bans on bottom trawling currently exist?

Table 2 below summarises some of the current bans in place; the criteria for the ban; and where possible the regulation or status of the ban. This table is by no means definitive and does not include bans on trawling at local levels or under national byelaws.

Table 2. Existing trawling bans.

WHERE	WHEN	CRITERIA FOR BAN	STATUS/REGULATION
'Darwin Mounds': aggregations of deepwater corals (*Lophelia pertusa*) in NW of Scotland	22/03 /2004	Protection of coldwater coral reefs; Defined as habitats of Community interest in Council; Directive 92/43/EC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora; Deep-water coral reefs are included in a list of endangered habitats in the Framework of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention).	EC 602/2004
Azores, Canary Islands and Madeira	11/10 /2004	Protection of highly sensitive deepwater habitats, hosting important and highly diverse biological communities (see above (EC 602/2004)	EC 1811/2004
High Sea Seamounts – NE Atlantic	2006	Protection of vulnerable deep sea habitats	EC 51/2006 Annex III and EC 41/2006 Annex III
Sula Ridge and Iverryggen Reefs –Norway	2000	Protection of coral reefs	??
Mediterranean, depths > 1000m	2005	Protection of vulnerable deep-sea ecosystems	General Fisheries Commission for the Mediterranean (GFCM)
Hatton Bank/Rockall	2007	Protection of vulnerable deep sea habitats	EC 41/2006 Annex III
Area VIa	2005	Protection of cod stocks in an area in Area VIa	EC 41/2006 Annex III
CCAMLR	2006–2008	Protection of high-seas fisheries	Convention Measure 22–05 (2006)
Chatam Rise, sub-Antarctic Waters and east and west coast of the North islands	2001	19 seamounts closed to protect orange roughy/coral reefs	New Zealand Government
Tasmanian Seamounts	1999	South Tasman Sea to protect seamounts	Australian Government
Great Australian Bight Marine Park near Ceduan	2002	Protection of sensitive habitats	Australian Government
Aleutian Islands	2005	370,000 square mile closure to protect coral reefs	North Pacific Fishery Management Council/NOAA
NAFO	2007–2010	Protection of Orphan Knoll, Corner Seamounts, Newfoundland Seamounts, New England Seamounts	NAFO NAFO/FC Doc. 07/1 Article 12

WHERE	WHEN	CRITERIA FOR BAN	STATUS/REGULATION
Balakrishnan Nair Committee	2006 (19th Year in succession)	45 day ban during monsoon season to protect bio-diversity in Kerala's coastal waters	Balakrishnan Nair Committee
Government of Kenya	2006	Protection of fish stocks and coral reefs in waters around Kenya	Government of Kenya
Oculina Banks	1984	Marine Protected Area to protect Deepwater Coral reefs. Trawling, bottom longlining, dredges, pots or traps is prohibited in these areas.	NOAA Fisheries (Closure extended in 2004)
Gulf of Alaska and Bering Sea	2000	100,000 square miles closure to protect biodiversity	North Pacific Fishery Management Council/NOAA
Great Barrier Reef Marine Park	2004	Marine Protected Area	Australian Government/Government of Queensland
Phoenix islands Protected Area	2006	Marine Protected Area 73,800 square miles	Republic of Kiribati
Hawaii	2001	Management Plan for Coral Reef Ecosystems of the Western Pacific Region	Western Pacific Council
Pacific Canada (Four reef areas located in waters of the Eastern Queen Charlotte Sound and Hecate Strait)	Year round closure to all bottom trawling, amended for 2006	Protection for the four unique sponge reef ecosystems	Canadian management measures
Pacific Canada (sub-areas of Clayoquot Sound)	2006 Year round closure to all trawling	To address shellfish interception and shallow water habitat concerns	Canadian management measures
Pacific Canada [a number of Sub areas within Johnstone, Georgia and Juan de Fuca Straits (Satellite Channel, Gulf)]	2006 Closure to both bottom and mid-water trawling; Satellite Channel is a year round closure, Gulf is a bottom trawl closure by sub-areas (may change in season)	Sensitive ecosystem features, including herring spawn areas, salmon/herring holding areas, conflicts with crab gear, harbour congestion and reduction of harvesting pressure on localized groundfish stocks. Bottom trawling closures reduce the damage that may be caused by bottom gear to sensitive bottom habitats and species	Canadian management measures
Pacific Canada (sub-areas of McIntyre Bay/Masset)	2006 Year round closure	Protecting Sensitive Species, such as juvenile / undersized / sensitive bycatches (to reduce harvesting pressure on localized stocks of fish, minimize the catch of juvenile halibut)	Canadian management measures
Atlantic Canada [Gulf of St.-Lawrence]	2006 Moratorium 1993 – 1996 and 2003 (all fishing gears, incl. bottom trawls)	Protection of cod stock	Canadian management measures

WHERE	WHEN	CRITERIA FOR BAN	STATUS/REGULATION
Atlantic Canada (Northeast Channel Coral Conservation Area; Lophelia Coral Stone Fence Conservation Area; Marine Protected Area - Gully Area)	2006 Closed to all fishing gears	Protection of Sensitive Ecosystem Features (corals: Octocrals (bubblegum and seacorn corals); *Lophelia perusa* reef; rich diversity of marine habitats and species, including deep-sea corals and the northern bottlenose whale)	Canadian management measures
Atlantic Canada (400 nautical mile closure to bottom trawling and gillnetting in 26/09/2002 in the Hawke Channel in NAFO Division 2J; expanded in 2003 to 2500 nautical mile; Funk Island Deep area in NAFO Division 3K in 2004 closed to gill netting and in 2005 to trawling)	2006	to protect cod and crab, but also protected their habitat by reducing bottom damage	Canadian management measures (re-assessment in 2006)

Rationale

How does ICES-WGFTFB view bottom trawling? Can we as a group critically review the calls made on banning bottom trawling? Can we challenge them scientifically ally/economically/technologically? Do we agree in some cases? Do we disagree in some cases?

Ideas to consider:

- ICES/FAO WGFTFB considers a 'global ban on bottom trawling' unrealistic and as a group of internationally recognised gear technologists feel that the following points need to be communicated to the scientific community, fishery managers, NGOs and the general public:
  - Bottom trawling consists of different fishing gears deployed in diverse ways (e.g. chain mat versus tickler chains/ Rockhopper vs grassrope footropes) for different fisheries (fishing grounds and target species) and with different fishing practices (towing speed, duration, etc.).
  - The ecosystem consists of different components and is constituted of different structural and functional processes. Spatial and temporal differentiation needs to be made.
  - Different marine landscapes have different sensitivities to different fisheries. The question is: 'what sort of sensitivities/impacts do we have to fine-tune fishing gears too in different bio-geographical areas and in different time periods?'

Identification of Bottom Trawl Fisheries and their impact

How to evaluate bottom trawl fisheries? What is the minimal required level of knowledge for evaluation?

What are the criteria for evaluation?

- WGECO (2005; 2006) is setting up a framework for assessing the key pressures of human activities on the state of marine ecosystems and is preparing an initial scoping report on the content and methods for developing an assessment of the environmental impact of marine fisheries by 2008. The criteria for evaluation of fisheries impacts are determined in their reports.
- One of the major impacts of marine capture fisheries is the impact on the target species. The status of the target species stock needs evaluation (~ Assessment

WGs). However, overfishing can occur by all fishing methods, depending on the fishing effort. These issues are not discussed in the position paper. Different fishing methods have nevertheless different impacts on the target stock, regarding discards and non-catch mortality.

The current criteria used for an evaluation of bottom trawl fisheries based on WGECO, 2006 are as follows:

Direct effects/pressures on ecosystem components

1) Physical impact (Løkkeborg, 2005), (Auster and Langton, 1999), (Johnson, 2002), (de Groot and Lindeboom, 1994), (Lindeboom and de Groot, 1998)
   - Smothering.
   - Changes in suspended sediment.
   - Change in water flow.
   - Change in turbidity.
   - Change in sound fields.
   - Change in light regime.
   - Abrasion/Physical disturbance (including penetration depth, impact on sensitive habitats e.g. coral reefs, seamounts, sea grasses.

2) Biological Impact: (Løkkeborg, 2005), (Kelleher, 2005), (Auster and Langton, 1999), (Johnson, 2002), (de Groot and Lindeboom, 1994) and (Lindeboom and de Groot, 1998)
   - Introduction of microbial pathogens/parasites.
   - Introduction of non-native species and GMO's.
   - Selective extraction of species.
   - Total discards: target and non-target species, fish and invertebrates, survival rate of discards and susceptibility to predators, etc.
   - Unaccounted mortality or non-catch mortality: target and non-target species, fish and invertebrates, escape mortality, trawl path mortality, survival rate and susceptibility to predators, etc.

3) Chemical impact (ICES 2005, 2006) and (Johnson, 2002)
   - Heavy metal contamination.
   - Hydrocarbon contamination.
   - Radionuclide contamination.
   - Changes in nutrient levels.
   - Changes in oxygenation.
   - Indirect effects on ecosystem components.

4) Indirect effects on ecosystem components (Camphuysen *et al*., 1995)
   - Ecological consequences of discarding.
   - Ecological consequences of non-catch mortality.
   - Ecological consequences of physical impact.
   - Others?

5) Community level metrics of the effects of fishing on ecosystem properties
   - Biological Diversity.
   - Ecological Functions.
   - Others?

Gaps in our knowledge

The most apparent direct effects of bottom trawl fisheries have been studied to a certain extent, i.e. for certain target species and/or on certain fishing grounds (mud, sand, rock

bottom) (e.g. effects of fishing on the North Sea Ecosystem (ICES, 2006)). The effects include physical effects (abrasion/physical disturbance), biological effects (discards and unaccounted mortality) and some chemical effects such as changes in nutrient levels. Indirect effects however, have less been studied, as have community level metrics of effects on ecosystem properties.

What conclusions can be made on the environmental impact of bottom trawl fisheries?

What constitutes sufficient scientific evidence? What sort of impacts are (un)acceptable and in which bio-geographical areas and time periods? What are plausible management measures?

These issues can be illustrated by specific examples as shown in table 3 below.

Table 3. Examples of closures.

FISHERY	IMPACT	MEASURE(S)
Bottom trawling in the Sula Ridge in Norway	Unacceptable impact: destruction of coral reefs	Ban on bottom trawling (plausible, because of alternative: longliners)
Bottom trawl fisheries on the Great Barrier Reef	Unacceptable impact: destruction of coral reefs	Ban on bottom trawling
Beam trawl fishery in Southern North Sea	Main impacts: physical perturbation, but in a highly dynamic area (acceptable) Mortality of benthic invertebrates and demersal fish (mixed fishery)	Partial ban for promotion of alternative gears/protection of sensitive habitats Temporary closure in the framework of cod recovery plan… TCM's to reduce discards
Bottom Trawl Ban Aleutian Islands	Unacceptable impact: destruction of coral reefs	Ban on bottom trawling in certain areas. Most areas not fished by fishermen. Precautionary ban to stop expansion by fishermen into new areas.
Hawaii and the US Pacific Islands	Protection of coral reef ecosystems	Designation of zoned MPA's for coral. Permit and reporting system inside MPAs. Ban on no-selective/destructive fishing gears and conditions and type and uses of allowable gears.

How should the problem of bottom trawling impact be tackled?

If actions are needed (based on scientific evidence), how can the problems be tackled?

The alternatives can broadly be classified as:

- No action;
- Technical Conservation/Mitigation Measures to ensure that fishing practices conform to specific habitat conservation requirements (Lokkeborg, 2005) and (Valdemersen and Suuronen, 2001);
- Permanent/temporary closures/Establishment of MPAs e.g. Great Barrier Reef;
- Partial bans on certain gear types/use of alternative low impact gears e.g. Sula Ridge in Norway

What actions are plausible in which cases?

Habitats where according to scientific evidence, recovery from trawl gear damage is either impossible or very difficult and slow should be protected by trawling bans e.g. cold water corals.

Habitats, however, where impact can be shown to be temporary or minor can be protected through the use of technical measures including gear modifications or the use of alternative low impact gears e.g. shrimp trawl fisheries.

What are the socio-economic and ecological consequences of management measures?

- Socio-economic consequences for fleets need to be taken into account, prior to legislation.
- Alternative fishing methods may not be economically viable in many existing fisheries or for commercially targeted species.
- The Sula Ridge in Norway is a clear example of an area, which is closed to trawling. This seems to be a gear conflict/sensitive habitat/access to quota "closure" all rolled into one. The area is open to longlining, which means there's a valid, economic alternative to bottom trawling and there's a reduction of the environmental impact.
- Closures can force fishermen to concentrate fishing activities in smaller and smaller areas.
- Bans on bottom trawling undoubtedly cause a substantial reduction in the overall economic return of fisheries in the short-term, therefore there is a need for monetary compensation and re-training for alternative employment.
- Financial compensation (if even available) generally is not sufficient from an industry perspective where bans have been enforced.

Conclusion

In the future decision frameworks used for fisheries need to be more comprehensive and objective-based than in the past. Decisions about potential impacts on ecosystems, including sensitive areas, must be guided by scientific information, socio-economic considerations and the evolving principle of precaution within an ecosystem framework. A more systematic approach for sensitive marine area management should include:

- Identifying areas based on explicit biological/ecological criteria;
- Identifying the extent and degree of threat or harm posed by existing or planned human activities in the area;
- Determining the scope of protection required to maintain a sufficient contribution to the overall ecosystem, based on science advice; and
- Determining management actions based on the above and weighing in socio-economic considerations.

(*Taken from Canada's submission on efforts and actions taken pursuant to paragraphs 66 to 69 of United Nations General Assembly Resolution 59/25 to Identify, Manage and Protect sensitive Marine Ecosystems and Species*).

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