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

9-13 May 2011

Reykjavik, Iceland

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB) chaired by Mike Pol, USA, met in Reykjavik, Iceland from 9 to 13 May 2011 to address four Terms of Reference. The main outcomes related to the ToR's are detailed below.

Key Findings

Incorporation of Fishing Technology Issues/Expertise into Management Advice (Section 14)

- Decommissioning continues in some countries (France, Belgium (10% of the fleet) and Sweden), and effort continues to decrease for a variety of reasons. The largest number of vessels leaving a fishery (>50) was reported in the elver fleet in France. Small numbers of vessels were added to fleets in Italy, Netherlands, Sweden, Ireland, and Belgium.
- Vessels are altering gear use in response to high fuel prices, generally away from higher energy gears such as beam trawls and bottom trawls, to gears requiring less fuel, such as Scottish seines and static gears. For example, increasing use of SumWing, a hydrodynamic beam trawl that fish off the bottom was reported by Belgium and the Netherlands. Over 10 large beam trawlers have installed new engines, propellers and Kort nozzles in Belgium.
- Shifts away from mobile high energy gears commonly also reduce bottom impact, and thus the motivations for and benefits of a shift sometimes overlap. Shifts related directly to bottom impact included the use of off-bottom doors in several countries as well as electric pulse dredging.
- In some cases, the benefits of the gear shift were unclear: some French vessels shifted from Nephrops twin trawling to single rig trawling to reduce fuel consumption; conversely in the Mediterranean, French and Italian vessels shifted from single rig trawling to twin trawling.
- Several significant changes for the Mediterranean were reported. Italy in the Northern Adriatic Sea prohibited the use of towed gears within 3 nautical miles from the coast (with some derogations). The implementation of EC regulations requiring a minimum mesh size and shape of 40 mm square, with 50 mm diamond allowed "at the duly justified request of the shipowner" was broadly felt in Spain and Italy.
- Demand from retailers for certified or "green" fish was noted by industry in Belgium.

Redfish fishing technology and physiology (Section 15)

- An inventory of gear specifications (such as mesh size, trawl design, trawl orientation) used in harvesting redfish in member countries was created using the information available during the meeting.
- Redfish selectivity information from Russia, Canada, Norway, Germany and Iceland was summarized by the participants. Different experimental designs and lack of information about codend construction and rigging for some trials require caution in the interpretation of the reported selectivity parameters.

- Morphometric data are available for five species of redfish in the North Atlantic. Applying conclusions from morphometric data for one Sebastes species or population to others was deemed inadvisable based on these data. Collection of cross sectional data following FISHSELECT protocols are planned as part of joint efforts between participants in the topic group for *S. marinus* and *S. viviparous*, and perhaps *S. mentella*.
- The topic group recommended that: further studies on redfish selectivity be carried out on a species-specific basis; morphometric data collection for different redfish species beyond those previously studied be enhanced; initiation of investigations on new gear designs and devices to improve the current rates of escapement of redfish during towing and to reduce stickers. The group will continue its work intersessionally and at the 2012 WG meeting.

Small boat selectivity (Section 16)

- No evidence was found that there are any differences in selectivity of larger/smaller and higher/lower powered vessels from the catch comparison, selectivity and discard data reviewed. However, it was concluded that to prove this lack of difference definitively would require further analysis and ultimately a series of dedicated trials on vessels with a range of engine powers and in controlled conditions.
- A number of parameters were identified that may be influenced by the size or power of a fishing vessel, and lead to differences in the selectivity of larger/smaller and higher/lower powered vessels. These were: size and design of fishing gear; sea state; light levels; towing speed; catch size; codend design; and fishing operations.
- The work of the topic group was concluded.

Innovation in Fishing Gear Technology (Section 17)

- Saving energy coincides well with reducing seabed impact and bycatches, as gear components are designed with less bottom contact and releasing unwanted bycatches avoids the need to drag these inside the net and bring these aboard. Substantial energy savings can be obtained with gear modifications.
- Success of introducing new selective, low impact and fuel efficient gears depends very much on strong (economic) incentives for fishers to use them. Examples are sharp rises in fuel prices, threats of closing areas when selective gears are not used, enforcement by law, and fish products losing markets if not caught in a sustainable manner.
- The scientific community, having specific knowledge of fish behaviour, and not being restricted by the need to earn from catches, proved to be able to develop prototype fishing gears that can play a role in diminishing adverse ecosystem effects and produce better economy, but getting these applied was often difficult.
- It helps when fishers identify themselves with potential solutions, instead of being told what is good for them, and involving them more directly in identifying research needs leads to higher motivation and acceptability.
- Fishers' views and attitudes are changing as the world around them is changing, but they must be enabled to earn their living at sea.

- Best results may be obtained if scientists and fishers are working closely together to avoid the development of unsustainable ecosystem unfriendly technologies and practices. Cooperation between fishers and scientists needs to be stimulated, with emphasis on open-minded attitudes on both sides.

1 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 for bycatch and discard reduction, as well as benign environmentally fishing gears and methods with reduced affect the seabed and other non-target ecosystem components.

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.

2 Introduction

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Venue: Reykjavik, Iceland

Date: 9–13 May 2011

3 Terms of Reference

The **ICES–FAO Working Group on Fishing Technology and Fish Behaviour** (WGFTFB) chaired by Michael Pol, USA, met from 9–13 May 2011 in Reykjavik, Iceland.

Terms of Reference (ToRs)

a) Incorporation of Fishing Technology Issues/Expertise into Management Advice, based on the questionnaire exercise carried out since 2005/2006.

Convener: Michael Pol (MADMF, USA).

b) A WGFTFB topic group of experts will meet in 2011 with the following terms of reference:

i) Create an inventory of gear specifications (such as mesh size, trawl design, trawl orientation) used in harvesting redfish in member countries;

ii) Describe and synthesize research carried out on size selectivity with various mesh sizes and configurations and investigate possible technical measures that could reduce the loss of redfish at the surface due to their developed buoyancy;

iii) Collect morphometric information necessary to predict size selectivity;

iv) Examine habitat use, especially water depth and water columns, by major commercial redfish species and application of the information for selective capture by trawls.

Convener: Bent Herrmann (DTU-AQUA, Denmark).

c) A WGFTFB topic group of experts will meet in 2011 to address the following ToRs:

i) Review available selectivity and catch comparison data from small and larger vessels;

ii) Review gear and operational parameters;

iii) Identify likely causes of differences in selectivity and investigate whether they are real.

Conveners: Barry O'Neill (Marine Scotland - Science, Scotland, UK), Dominic Rihan (BIM, Ireland).

d) A WGFTFB topic group of experts formed in 2010 will meet in 2011 to continue to address the issue of innovation in fishing gear technology and the success of collaboration between fishers and scientists with the following terms of reference:

i) Review current technological developments and initiatives in gear technology and give examples of successful developments both in the EU and in other countries globally.

ii) Discuss the contributions of fishers and scientists in the process of collaboration and identify conditions allowing rapid uptake of new technology, without the risk of introducing new adverse ecosystem effects.

Convener: Bob Van Marlen (IMARES, Netherlands).

4 Participants

A full list of participants is given in Annex 1. The agenda is included in Annex 2.

5 Explanatory note on meeting and report structure

The approach adopted in 2004 of addressing specific TORs was adopted for the 2011 meeting. Individual conveners were appointed during prior meetings to oversee and facilitate work by correspondence throughout the year and at the meeting. The Chair asked the convener of each ToR to prepare a working document, reviewing their progress on their ToRs and recommendations and conclusions based on the topic group's work. Two days were allocated for the conveners and members of the individual Topic Groups to meet, finalize 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. Some topic groups included small numbers of individual presentations based on specific research programmes related to that topic. 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**.

6 Opening of the meeting

The chair opened the session with greetings to the WG and thanked the JFATB chairs for their work. The agenda and terms of reference and the appointment of Antonello Sala (CNR-ISMAR, Ancona, Italy) as rapporteur were reviewed and accepted by the group. A number of meeting details were conveyed to the WG. The chair then described the ICES-FAO partnership of the WG, the mission of the WG and briefly described the history and responsibilities of the WG to both organizations. His vision of the current state of affairs of the WG was described as "a global network of scientists and technologists interested in all aspects of fishing gears", emphasizing the importance of distributed networks in innovation, creativity, and development of knowledge. He reviewed his expectations for the WG.

The chair described his goals for WG as strengthening or clarifying the WG's relationship and responsibilities to FAO, maintaining good communication (including methods of communication) between members, continuing the topic group format with some modifications, and raising awareness and visibility of the group within ICES.

7 Report from SSGESST

Bill Karp, Chair of the Science Steering Group on Ecosystem Surveys, Science and Technology (SSGESST) presented a brief report regarding the work of the steering group and of SCICOM, the ICES Science Committee. He began with a schematic illustration of the ICES organizational structure and used this to emphasize the importance of science and advisory services within ICES, and the roles of ACOM, SCICOM, and the many and various Expert Groups (EGs). Within SCICOM, the EGs are organized under 5 steering groups. WGFTFB and WGFAST are within the SSGESST portfolio. This organization was implemented in 2010, following adoption of the new ICES Science Plan (for 2009–2013). SCICOM membership includes representatives from each of the 20 ICES Member Countries, the chairs of the 5 steering groups, and chair of the publications committee (PUBCOM). The SCICOM chair is Manuel Barange. Bill discussed the function and responsibilities of SCICOM, and its success in implementing the Science Plan. He stressed the importance of the Science Plan and those aspects of the plan which are especially relevant to the work of SSGESST and WGFTFB. In addition he emphasized the importance of strengthening links with stakeholders. He also discussed the SCICOM/ACOM strategic initiatives and their role advancing cross-cutting scientific issues within ICES and among ICES and its international collaborators. Next he presented a brief review of the European Marine Strategy Framework Directive (MSFD) and the role of the ICES Strategic Initiative in support of MSFD. This provided a basis for explaining the new MSFD-related ToRs. He next provided some background on the Strategic Initiative for Area-Based Science and Management and the ToRs provided by this group. Bill closed by asking WGFTFB to consider developing proposals for new symposia and theme sessions for the 2012 ASC. He also asked the WG to pay careful attention when drafting ToRs for their own work in 2012, because greater emphasis will be placed on focused and well-justified ToRs which define specific deliverables.

8 Report from WKSEINE

The Workshop on seine and net selectivity (WKSEINE) reviewed the results of selectivity experiments with seine net gear and assessed methodology for measuring the selectivity of seine nets. It followed on from the work carried out by WGFTFB in 2009 and 2010 (ICES, 2009; 2010) which identified that a need to further analyse existing selectivity data and compare it to trawl selectivity data to assess whether seine nets are more or less selective and therefore should be treated differently when setting mesh size and gear regulations.

Eight sets of seine net selectivity data that hitherto had been either partially analysed or unanalysed were collated. These data were comprised of three sets of trials from Scotland and five from Ireland

The mixed model smoothing methodology of Fryer *et al*. (2003) was used to estimate the catch rate of the test gears relative to the control gear for each species. This methodology makes no prior assumptions on the nature of the relative catch rates and is underpinned by the SELECT model of Millar (1992). It was successfully applied to each of the datasets examined, demonstrating that it is a suitable way to analyse the catch comparison data collected during paired alternate shot trials of Scottish seine gears.

The results of these analyses show, in general, that increasing the mesh size and/or the use of square mesh panels can improve seine net selectivity.

WKSEINE also compared Scottish seine net selectivity estimates with estimates of trawl codend selectivity. The estimates of trawl selectivity come from the model of Madsen and Ferro in the EU Expert Meeting report of April/May 2003. Modelled trawl selection is overlaid on the results of Scottish seine net trials. The comparisons for haddock are broadly similar and those for whiting are remarkably similar. This analysis finds no difference between the selectivity of similar codends in trawl or seine nets with a number of caveats outlined relating to the seine net data.

The initial analysis of seine net fisheries carried out by WGFTFB in 2010 noted evidence of high discarding in several seine net fisheries. WKSEINE carried out an analysis of discarding in seine net fisheries compared to trawl fisheries using the case study of the Irish demersal fleet operating in the Celtic Sea. This case study was based on a detailed analysis of discarding patterns in Irish fisheries carried out by the Marine Institute in Ireland.

Information collected from observers show that substantial quantities of haddock and whiting are discarded each year in the Celtic Sea. Scottish Seine (VIIg, j) demersal fisheries were found to have discard rates of 57% for haddock and 31% for whiting. These rates were compared with the mixed demersal trawl fisheries, which have corresponding discard rates of 40% in VIIj to 46% in VIIg for haddock and 55% in VIIj and 31% in VIIg for whiting.

This comparison indicates that the haddock and whiting discard rates of the Irish seine net fleet are comparable with those of the demersal trawl fleet and therefore it is difficult to find a basis for seiners to be treated any differently to trawl gears when setting mesh sizes regulations. A similar analysis of other seine net fisheries compared to trawl fisheries, however, is required to prove this definitively.

Based on these analyses there is no basis for seiners to be treated any differently to trawl gears when setting mesh sizes regulations but further analysis of other seine net fisheries compared to trawl fisheries is required before this conclusion can be definitively verified.

The full report for WKSEINE can be viewed here:

http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=499.

9 Report from SGTCOD

The third meeting of the ICES Study Group on Turned 90° Codend Selectivity, focusing on Baltic Cod Selectivity (SGTCOD) was held 4 – 6 May 2011 at IMR in Reykjavik, Iceland. The meeting was hosted by IMR and was attended by 7 scientists from 5 different nations and partly by 2 members from the local industry (netmaker Hampidjan).

The Study Group, chaired by Bent Herrmann and Waldemar Moderhak, was planned to run for 2009 - 2011. The objectives for the planned three year run of the group are:

- Evaluate the effect of turning diamond netting by 90^0 (T90) on codend selectivity;
- Improve knowledge of the size selection processes in T90 codends compared to T0 codends (normal direction of diamond netting);
- Attempt to quantify the magnitudes of the effects of different factors (construction, generic netting properties, stock specific morphology, catch composition);
- Develop a guide on T90 codend constructions with respect to size selection properties and optimal construction; and,
- Review available data on fish survival and in particular cod escaping from T90 codends.

These objectives were planned to be reached by combining field experiments, laboratory experiments with nettings, laboratory experiments with fish morphology specific to Baltic cod and theoretical approaches (structural mechanics and computer simulations).

A number of presentations were therefore given during the third meeting on new experimental data and the analysis of these data since the second meeting. The importance of considering the number of meshes in the codend circumference for the size selection of cod in T0 and T90 codends based on some of these new data on Baltic cod was demonstrated in a scientific paper (Wienbeck *et al.,* 2011). Comparing these results with results from another set of new data further demonstrated that the effect of turning netting (from T0 to T90) is very dependent on netting twine characteristics. Based on acknowledgement of this new information, an experiment to study the effect of twine characteristics on size selection of Baltic cod in T0 and T90 codends in a systematic way was carried out since the second SGTCOD meeting. This research demonstrated that L50s for both single and double twine codends tend to decrease with twine thickness for traditional diamond mesh codends. For similar T90 codends the effect is not the same.

In January 2010, the mesh regulation for the fishery targeting Baltic cod was changed. Because of this change, size selection results from new experimental fishing with T90 and BACOMA codends complying with the new regulation were also presented at the meeting. An analysis of these results indicated increased evidence of a dual selection process in the BACOMA codend. This dual selection is probably a consequence of an increased imbalance between the window mesh size and the mesh size in the lower diamond mesh panel. A clear dual selection signature could lead to high selection range and could lead to high discard rates or considerable loss of fish of legal size through codend size selection. To be able to investigate selective properties linked to survival rates of escapees, an experimental cruise was carried out to

investigate and compare when during the fishing process Baltic cod escape from the T90 codend and to investigate if this pattern is different from what takes place in the other legal design, the BACOMA codend. The results demonstrated similar escapement patterns between the two types of codends except that more small cod escaped from the BACOMA codend during the towing process along the seabed.

Besides the new experimental data for size selection of Baltic cod in T0 and T90 codends, new data for size selection of cod from T90 codends applied in other fisheries were also presented at the meeting. This information included data from Norway and Denmark. The meeting also revealed that the planned data collection of morphology of Baltic Sea cod had also been carried out in accordance with the planned schedule, but that analysis of these data still remains to be carried out.

In general, much of the progress achieved by the group been possible due to the extensive vessel time provided by Germany for the experimental fishing necessary for the work of the group. Several other members of the group have participated in these cruises through planning the experimental design for the cruises, participating during the cruises, and with analysis of the obtained experimental data. Overall, the meeting concluded that good progress has been made towards achievement of the final goals for the work of the group and that a very good collaboration has been established between the members of the group, but that it will be difficult to complete the work within the planned three year lifespan for the group, therefore the members of the group have agreed to ask ICES to extend the life frame of the group.

10 Report from SGELECTRA

The Study Group on Electrical Trawling (SGELECTRA) met on 7 and 8 May 2011 at the Marine Research Institute of Reykjavik, Iceland. A total of 7 participants attended from Netherlands, Belgium, Germany, Scotland, Russia and Lithuania.

10.1 Summary

Following the ICES Advice on Pulse Trawling on flatfish of 2006, further studies were carried out by IMARES, the Netherlands, on catsharks (*Scyliorhinus canicula* L.), cod (*Gadus morhua* L.) and a range of benthic species (ragworm (*Nereis virens* L.), common prawn (*Palaemon serratus* L.), subtruncate surf clam (*Spisula subtruncata* L.), European green crab (*Carcinus maenas* L.), common starfish (*Asterias rubens* L.), and Atlantic razor clam (*Ensis directus* L.) under pulse stimulation of the Verburg-Holland system. These studies were reviewed and discussed at WKPULSE.

Further studies were conducted on cod in 2010 that were presented and discussed. Juvenile cod (10–12 cm) were affected to a lesser degree by electric pulse stimulation than larger individuals (44–51 cm). By increasing pulse frequency or decreasing pulse amplitude harmful effects on larger cod can be avoided. A remaining question is whether these pulse settings would still enable catching the target species sole and plaice.

A presentation was also given about the development of a pulse trawl for the brown shrimp (*Crangon crangon* L.) fishery in Belgium with recent uptake in the Netherlands.

In addition a report was given on electric fishing for razor clams (ensis) in Scotland, and work in Russia and Lithuania from 1972–1988. A vast body of reports in the Russian language exist that might contain valuable information for this group.

Work done in EU DEGREE-project and study FISH/2009/07 LOT3 for flatfish fishery was extended. A new scenario was run (scenario 2c) with pulse trawling replacing standard beam trawling in the 24–40 m and >40 m métiers of 80–90 mm mesh size using the model of Piet *et al.* (2009). The results indicate that cod landings and discards can be reduced. It was advocated to update the models used with results from new full-scale tests.

Relevant pulse characteristics and other variables were identified such as: amplitude in volts (V), electric field strength in Volts per meter (V/m), pulse frequency in Hertz (Hz), pulse duration in microseconds (μs), pulse form, method(continuous, intermittent), the configuration of the electrodes (diameter, length, insulator/conductor mounting etc.), as well as: species, length in cm, seawater temperature, conductivity of organism, seawater conductivity, position of organism in electric field, sediment characteristics and conductivity, and towing speed. It is hoped that simpler limits can be found, such as capacitor size, which will physically limit any increase in energy a system can deliver. It may be the case that for different species groups (shrimp, flatfish) different limits need to be defined.

The reviewing experts recommended to:

- Continue work on TOR's a), b), c), d), and e)
- Follow the debate in the Dutch Group on Control & Enforcement
- Consider producing an ICES Cooperative Research Report (CRR) on electric fishing, possibly through working by correspondence

- Meet again in Spring 2012 (prior to WGFTFB), possibly in conjunction with WGFTFB
- Consider including other experts (e.g. on fish physiology, modelling effects).

10.2 References

Piet, G.J., van Hal, R., Greenstreet, S. P. R. 2009. Modelling the direct impact of bottom trawling on the North Sea fish community to derive estimates of fishing mortality for non-target fish species. ICES Journal of Marine Science, 66, 14.

11 ICES and FAO enhanced collaboration and communication in WGFTFB

ICES and FAO have enjoyed a fruitful working relationship for many years leading in 1996 to the signing by both organizations of a Memorandum of Understanding (MOU). In 2002 and within the spirit of the MOU, the Bureau and the Consultative Committee of ICES proposed that FAO co-sponsor the ICES Working Group on Fishing Technology and Fish Behaviour on a regular basis to which FAO agreed, effectively giving the working group status as a joint ICES-FAO WG and changing its status from a regional to a global level. Further, in a communication of March 23 2011, the chair of ICES Science Committee requested FAO to consider hosting the ICES-FAO WG every third year and to take on the responsibility of co-chairing the ICES-FAO WG meetings. Since such arrangements would improve and extend the cooperation between the two organizations and their respective members, FAO agreed in principle to the proposal in a communication of April 5 2011.

Under the terms of the 1996 MOU, Article 5 allows for specific arrangements on ways in which cooperation can be further improved and extended. Accordingly, ICES and FAO exchanged letters agreeing to the arrangements as described above. This arrangement comes into effect immediately and the first hosting of the WGFTFB by FAO will take place no earlier than 2013.

12 WGFTFB discussion of future meeting structures (joint- and plenary-session)

WGFTFB held a discussion to consider alternatives on the future of the biannual joint session between WGFTFB and WGFAST. WGFTFB members were encouraged to express their opinion on whether the Joint Session should continue, what terms would be of interest, what chairing structure would be appropriate, and what frequency would be acceptable. WGFTFB was also presented with input from the chair of WGFAST who broadly described the interest of WGFAST in the Joint Session as: "We put sound in the water, and we need WGFTFB's help to know what the sound is bouncing off."

The WGFTFB responded favourably and supported the continuation of the Joint Session; no contrary opinions were expressed. A number of possible topics of interest to FTFB that might be addressed through Joint Session ToRs were developed. The WG cited an interest in learning in general about recent developments in acoustic technology, and their application to understanding and measuring fish behaviour and advancing fishing technology research. Examples were cited of imaging of fish attraction patterns and rates to static gears, and to whole trawl escapement. In addition,

interest was shown in the latest commercial applications of acoustics used in commercial fisheries.

FTFB members further expressed interest in characterization of species assemblages before entering the trawl mouth using acoustics, including species identification, and in the use of acoustics to quantify the impact of fishing gears on the marine environment. It was further mentioned that passive acoustic tags offer a way to study fish behaviour.

Meeting logistics were also discussed. FAO have generously offered to host WGFTFB on a three year cycle. It was suggested that the Joint Session shift to a cycle of every three years to avoid overlapping with the FAO hosted meetings. It was further suggested that the use of separate chairs for the Joint Session continue, and that a careful review of abstracts should be conducted with talks not relevant to both groups excluded. The WG was generally favourable to the suggestion of mutual presentations of basic principles of acoustics and of trawl selectivity.

A similar discussion was held by WGFAST. The general feedback from WGFAST was that it was agreed that themes for future joint sessions should focus on topics that engage both groups. One such item is the need for improved sampling for species identification and size estimation, including micro nekton communities. Methods to evaluate the efficiency of the different gears are instrumental to make further progress, and it was believed that this could be a topic that could be of common interest between the FAST and FTFB. It was proposed by both groups to hold the next joint session in 2014.

13 Update from FAO on fishing technology activities

The mission of the FAO is eradication of hunger. The FAO Fisheries and Aquaculture Department responds to and supports the Committee on Fisheries (COFI), the only global inter-governmental forum where major international fisheries and aquaculture problems and issues are examined. COFI has also been used as a forum in which global agreements and non-binding instruments were negotiated including the Code of Conduct for Responsible Fisheries, and International Plans of Action (IPOAs) on Illegal, Unreported and Unregulated (IUU) fishing, fishing capacity, seabirds and sharks. The Fisheries Department is currently emphasizing activities in climate adaption, reduction on fossil fuels with emphasis on the capture and processing sectors. Life cycle assessment, management collaboration, and bycatch definitions were discussed. Opportunities for WG participation at recent international conferences (for example, on circle hooks and marine debris) that would have been beneficial to all parties were highlighted.

14 ToR a): Incorporation of Fishing Technology Issues/Expertise into Management Advice

14.1 General Overview

This ToR was introduced prior to the meeting via e-mail and at plenary by the chair. The background for the ToR was re-iterated. ICES advice is increasingly holistic in nature, including information on the influence and effects of human activities on the marine ecosystem. This information should include responses and adaptations to changes in regulatory frameworks by fishers. In response to this need, WGFTFB initiated a ToR in 2005 to collect data and information that was appropriate to fisheries and ecosystem based advice. In 2006, the FAO-ICES WGFTFB was formally requested by the Advisory Committee on Fishery Management (ACFM) to provide such information and to submit it to the appropriate Assessment Working Group. This type of information is important at both international and national levels and demonstrates that the WG has an important role to play in this advice and that our expertise is highly valued. Since 2009 this information has been included as an Annex to several stock assessment reports e.g. WGNSSK, WGCSE and WGHMM, although the issue of the appropriate timing for the provision of this information to the assessment working groups remains unresolved.

14.2 Terms of Reference

WGFTFB should explore the means by which it can best provide appropriate information for Assessment Working Groups, ACOM and other management bodies such as GFCM in fishery and ecosystem based advice. This exploration 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. The information focuses on, but is not limited to, areas for which ICES provide stock advice.

14.3 General Issues

The conveners issued a questionnaire to all the WGFTFB members (see Annex 45). The questionnaire was also available as an online form at: http://tinyurl.com/3on54sj. The questionnaire consisted of a series of questions relating to recent observed changes within fleets and also highlighted gear/fleet/fishery related issues that are important but are not currently recognized 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:

- IMARES, Netherlands
- FRS, UK-Scotland

- IEO, Spain
- Ifremer, France
- BIM, Ireland
- AZTI, Spain
- ILVO, Belgium
- CNR-ISMAR – Italy

The information provided was collated and summarized by the chair. All responses are reported below, with preceding summaries. Information tailored for individual ICES Expert Groups is given in Annex 5.

Fleet Dynamics

Fuel prices once again impacted nearly all reporting countries, and this rising cost was manifested in multiple ways: shifts in gear, modifications to fishing practices, changes in vessel powering.

Trends were reported in shifts from higher energy gear to lower energy gears. The SumWing, a hydrodynamic off-bottom beam trawl was adopted broadly in replacement of traditional beam trawls in the Netherlands and Belgium, with benefits seen in fuel consumption and reduced bottom impact. Shifts from twin to single trawling, and from single to twin trawling, were both reported as motivated by fuel saving.

A rising trend was seen in France and Netherlands to convert to Danish seining instead of conventional trawling or beam trawling. Some vessels have completely converted, while some have diversified and have maintained trawling to take advantage of both seining and trawling opportunities.

The Irish fleet expanded on board freezing of *Nephrops,* mainly motivated by strong markets for frozen *Nephrops* as the traditional fresh markets for whole and tailed *Nephrops* still seems to be over supplied.

Decommissioning schemes are less in evidence although significant reductions were seen in Belgium and in France. Varying amounts of effort seemed to have been removed from the fleets involved but there is also some evidence of fleet renewal in small numbers.

All reported changes related to fleet dynamics are summarized below:

- In the Basque country, pair trawling for hake remains limited by market price, as shorter trips yield high freshness and quality. The fleet coordinated landings to supply markets throughout the week, instead of the traditional days of Monday and Thursday.
- A smaller quota of mackerel has reduced the Basque artisanal handline fishery from 3–4 months to 1–2 months. Some boats have started fishing with longlines and gillnets to fill out the year's activity.
- Belgium reported three beam trawl vessels switching to passive fishing, one new fly shooter, 25 vessels now using Sumwing, and a growing interest in pulse fishing. Fuel cost and price issues relating to environmental impact were indicated as causes for changes in the gear.
- Effort, number of vessels and total installed horsepower declined in the Netherlands, although flatfish beam trawlers made a small profit. Increasing use of SumWing in flatfish and shrimp beam trawling, recently with integrated pulse trawl (PulseWing), was observed. Increased use of fly

shooting and twin-rigging and some boats operating static gears increased due to fuel prices. Sole prices also rose.

- France reported a rising trend of shifting from trawls to Scottish seine (3 boats in 2009, 8 in 2010) in the Bay of Biscay driven in part by the presence of Dutch and English seiners. Gillnetters were reported to be diversifying to Nephrops in Area VIIIA or whelk pots in Area VIId; also sole trammelnetters were shifting to crustacean traps in the same area, and otter trawlers targeting flatfish in VIId were shifting to dredges. Shifts were driven by fuel costs and desire to diversify.
- A three week closure was placed on elvers in the Bay of Biscay in February. The porbeagle shark (*Lamna nasus*) longline fishery was also closed.
- In the French Mediterranean, shifts from gillnets targeting tuna to sole were reported, along with an increase in interest in pots both commercially and as part of an experiment. Crawfish gillnetters experimented for one month using crawfish traps.
- There has been shifts in effort from Area VIa (West of Scotland) inside the so-called "French Line", where 120mm+120mm square mesh panels (smp) must be used by vessels> 15m and 110mm+110mm smp for vessels < 15m compared to 100mm+90mm smp in the recent of ICES Zone VI. This area is also included in the EU's cod recovery plan so is subject to effort restrictions in addition. The majority of larger Irish vessels (5–6 over 24m) have tended to concentrate their efforts outside the French Line along the 200m depth contour or have moved to Area VIIb-k in the Celtic Sea where there are no effort or gear restrictions. This has meant effectively that effort on the traditional grounds inside the French Line has been reduced considerably. The traditional grounds are now fished by these vessels perhaps for 15–20% of the year compared to 50–60% previously. However, it is worth noting the end of Q4 in 2010 and Q1 2011 that these vessels did fish the traditional grounds primarily to use up their effort and quota allocations. During this time they had very good fishing for megrim, monkfish and hake particularly on the Stanton Banks even with 120mm+120mm SMP. This shift was driven by management measures.
- A similar pattern has emerged in the Irish Sea (ICES Subarea VIIa). Effort restrictions also apply in this area. Following cuts of 25% in the overall effort allowed in the area in 2009 and in 2010 many vessels have only a limited number of days to fish in the Irish Sea. Many vessels targeting *Nephrops,* the predominant fishery in the area, have been forced to move to other *Nephrops* fisheries in the Celtic Sea. This has included smaller vessels between 12–18m. This change was driven by management measures.
- As reported in previous years up to 20+ Irish vessels are now equipped to freeze *Nephrops* at sea, motivated by market prices. Further 2–3 vessels have since fitted or are in the process of fitting freezing equipment. This undoubtedly has implications for the *Nephrops* fisheries as most of these vessels are efficient 20m+ vessels fishing with twin-rig trawls. The main driver for is this the price of frozen *Nephrops* which has reached as high as €37/kg.
- Overages from 2010 in the Spanish mackerel fishery caused an early closure of the 2011 fishery for both seine and trawl fleets. Fishers shifted timing and location of effort to avoid mackerel.

- The Porcupine bank (ICES VIIc-k) fishing ban provoked a shift in the spatial distribution of the Spanish OTB operating in the area.
- Spanish trawlers operating in NW Iberian waters experienced a 30 day closure as part of the Hake and Nephrops recovery plan.
- A reduction in pairtrawlers from four pairs in 2008 to one in 2010 was reported for the Spanish fleet in the Arctic area (ICES IIa, IIb). The number of trawlers (4) remained unchanged. Pair trawls were recycled to trawlers in some cases. New trawlers which alternate their fishing activities between the Arctic and NAFO areas were introduced in recent years.
- The Atlantic cod fishery in NAFO Division 3M was reopened after a closure of 15 years, inducing Spanish fishing units to fish in the area during the open session last year (90 days were assigned for Spain)
- In the Northern Adriatic, EC Regulation 1967/2006 has led to a prohibition of the use of towed gears within 3 nautical miles of the coast, with derogations in Liguria, Sicilia, and Calabria. Beach seining and boat seining targeting *Aphia minuta* (Gobidae) and juveniles of sardine (*Sardina pilchardus*) will only continue if under a management plan.
- Effort reduction has been implemented by the Italian government by requiring twin trawls to fish one day less than single trawls.
- In response to economic and commercial considerations in Italy, changes from Rapido trawl to midwater pelagic trawls, and from midwater to bottom trawls have been observed. Also, some vessels reduced effort from 5 to 3.5 days/week.
- Only Ireland reported no decomissionings, and added several smaller vessels (12–15 m range).
- The domestic French fleet declined by 3% (from 4985 to 4837 vessels) between 2008 and 2009. Forty-one French elver vessels were decommissioned in 2010, along with 4 trawlers as part of a cod restoration plan.
- Ten per cent of the Belgian fleet (9 vessels) were decommissioned. An estimated twenty per cent of the Basque artisanal fleet targeting tuna with trolling lines and mackerel with handlines were planned for decommissioning in 2012.
- An unknown number of Swedish vessels were decommissioned, and a few smaller (<10 m) trawlers were added.
- Netherlands (2), Belgium, and Italy reported new vessels; Spain and the Basque country reported none.
- Sweden reported no clear shifts.

Technology Creep

The main focus in technology development has been on fuel efficiency measures. In the Netherlands and Belgium uptake of new fuel efficient beam trawl designs (e.g. SumWing), which have been extensively tested and shown to be give fuel savings as well as increased fishing time. Basque and French vessels have been altering steaming speed to directly reduce fuel consumption. The development of off-bottom doors in demersal trawling was noted in several regions. Dynex warp use seems to be spreading.

Alternate gears were noted including electric pulse trawling in Ireland, use of lights and diving in France, and other shifts to static gears. Biodiesel (sunflower oil and diesel) was also noted in France; impact to engine wear will be assessed.

As in previous years there have been a number of developments in gear design to reduce drag. In Italy there has been adoption of twin-rigging instead of traditional single-rig trawls.

All reports of technological creep are given below:

- Belgium reported switches in gear from traditional beam trawls to Sumwing, passive gear (mainly along the Belgian coast), and to flyshooting. Ten large beam trawlers were reported to have installed new engines, propellers and Kort nozzles.
- Basque vessels of all gears focused on slow steaming to reduce fuel consumption and are demanding scientific investigations on fuel consumption, reduction and measurement equipments.
- In addition to changes above, technological creep identified in France included an attempt to use lights to jig for squid in the southern Bay of Biscay (VIIIb), although the technique is not very successful at this moment.
- Two Irish vessels (10–12m) have been involved in an experimental fishery for razorfish (Ensis) using electric pulses dredges in the southern part of the Irish Sea off Rosslare. Vessels in this fishery traditionally use hydraulic dredges. Based on the trials the electric pulse dredge appears to reduce damage to the razorfish catch in the fishery by more than 40% and also has less bottom impact as the pulse dredge does not dig into the bottom. These trials are continuing. Up to 40 vessels participate in the fishery in total in the Irish Sea (VIIa).
- Up to 5–6 of the largest Irish demersal trawlers (24m+/750hp+) have begun to use semi-pelagic trawls doors (Thyboron type 15VF) fished off-bottom. These doors are rigged with a heavy chain clump between the doors and the trawl. The main motivation for using these doors is to reduce fuel consumption (approximated savings of 5–10% are reported by the skippers) but there may be benefits for reduced bottom impact although this maybe partial negating by the chain clump. No affect catchability was noted.
- An Irish demersal vessel (27m/1000hp) is now using Dynex warp instead of standard wire warp. Initial indications are that the Dynex warp gives slight improves in fuel efficiency (~5%) but is easier to handle than standard warp and reduces wear and tear on the towing bocks and winches through the reduced weight. No affect catchability noted.
- In the Netherlands, fuel costs went down in the cutter fleet 2009 from 35% to 25% in 2008 due to adaptations in gear and operation. SumWing can save up to 300 tonnes of fuel per year per boats of 40 LOA; with pulse trawls, savings of 800–1000 tonnes per year per boat can be expected.
- France has taken a number of initiatives taken in to improve fuel efficiency these include: new optimized doors that fish "off-bottom"; optimized shaping of trawls, increasing meshes when possible in the aft part of the trawls and using low drag materials such as Dyneema and Breizline twines. Also, decreasing speed in transit and fishing (for example keeping a constant pressure of the turbo when fishing, without considering the

speed over the ground); and also avoiding transiting against the tide/current where possible, and landing in close by fishing harbours.

- Other experiments in France include testing a mixture of sunflower oil and diesel fuel in a coastal boat. The engine will be disassembled to assess effects of the new fuel. In the Bay of Biscay, the Channel, and the North Sea, experiments are underway to test pelagic doors for bottom trawling using hydrodynamic weights. In the Gulf of Lions, trawlers are reducing nets size or shifting to twin trawling
- Some Italian bottom trawlers of the central-northern Adriatic Sea have switched from single- to twin-rig trawling (named by the Italian fishers "Americana trawl"). Main characteristics of the twin-rig are: four-faces trawl with small or large lateral faces; large meshes in the wing section; Raschel knotless-PA and knotted-PE netting; wings built from two or three panels, which have bar cutting along the fishing and floatline and in the selvedge as opposed to the one-panel wings in the traditional style Italian trawl. This change has been introduced to increase the bosom height as well as the horizontal opening of the trawl.

Technical Conservation Measures

Uptake of selective gears continues to be limited and driven primarily by legislation. This year, it was noted that uptake levels appear to be higher where a TCM also reduces fuel use.

Specific examples illustrating the development and uptake of selective gears or strategies follow:

- In Sweden, the use of Swedish grids has increased in the Kattegat between from 48% of total effort in 2009 to 61% in 2010. In the Skagerrak the use of the sorting grid has increased from 50% in 2009 to 53% in 2010 of total effort. This fishery is by far the most important gear category in both Skagerrak and Kattegat constituting 80–90% of total effort. The sorting grid reduces catch of cod to 1.5%, it also severely decreased by catch of both commercial and non commercial species. Almost 100% have opted to use new TCMS.
- In the Basque country, daily and weekly quotas have been universally adopted by industry for the mackerel handline and purse-seine fishery and in anchovy purse-seines, mostly as a market strategy.
- About 20% of industry in Belgium feels pressure from retailers to obtain MSC certification or to otherwise qualify for "green guides".
- Three Irish vessels (~20m/350kw) are now using the "Swedish" sorting grid in the *Nephrops* fisheries in the Irish Sea (Area VIIa). Based on a case submitted by the Irish government these vessels are now exempt from effort restrictions currently in force in this area. The observations carried out showed cod catches with the grid to be consistently less than 0.1% per trip. Further 3–4 vessels have now either fitted grids or are testing them voluntarily.
- Five Irish whitefish vessels (24m+/700hp+) have also been granted an exemption from the effort regime in Area VIa (West of Scotland). This exemption was granted on the basis that these vessels did not fish in an inshore area of the Donegal coast with historically high cod catches. These

vessels must use 120mm mesh size and 120mm (9–12m) square mesh panels inside a restricted area inside the so-called "French Line" but can use 100mm+90mm square mesh panel (SMP) outside this area. These vessels were subject to enhanced coverage by scientific observer sampling which showed on average 0.7% cod in the total catches. The 120mm+120mm smp gear is selective with L50s for haddock, whiting and megrim of 39cm, 46cm and 41cm respectively. Catches of haddock and whiting are reduced by ~40–60% with a reduction in catches of megrim of ~20% mostly in the small size grades which have low economic value.

- Up to 12 Irish *Nephrops* twin-rig vessels have voluntarily fitted ~120mm square mesh panels. These vessels are part of a state-backed responsible fishing scheme and are an attempt at demonstrating good practice in these fisheries.
- Due to the adoption of the OMEGA mesh gauge most Irish *Nephrops* fishers operating in the Irish Sea and on the south coast of Ireland are recorded their codend mesh size in the logbook as 70mm even though the codends are nominally 80mm. Because the OMEGA gauge consistently measures lower than the standard mesh gauge, by recording their mesh size as 70mm they are confident their codends will be measured as legal whereas there is a chance if they record the codend as 80mm they could be found to be using an illegal mesh size.
- In recent years a large-scale fishery for boarfish (*Capros aper*) has been developed by the Irish pelagic fleet with landings of ~78,000 tonnes in 2010. This species prior to 2010 was non-quota and used a mesh size of ~32mm. The EU decided that the vessels should have been using 100mm. Irish authorities argued that this requirement would effectively close the fishery as the large mesh size would make it uneconomic. Following political negotiations in 2011 a quota was set for this species at 33,000 tonnes with an Irish quota allocation of 22,500 tonnes. This allocation represents a significant decrease in the fishing opportunities for the Irish pelagic fleet. In addition new measures to allow targeting of boarfish with the 32mm mesh size seem set to be agreed.
- No new mandatory TCMs were reported for France. Relevant experiments investigating possible TCMs include trials in the Bay of Biscay on square mesh cylinders, Nephrops grids, square mesh panels and combinations of these modifications to separate Nephrops and hake. Separation of cod and whiting using large mesh "Eliminator" trawls and flexible grids is being tested in the Channel and North Sea.
- Selection panels were introduced and supported by the government in Dutch *Nephrops* trawling to decrease bycatches of cod (Botney Gut).
- Italian trawl fishers continue to wrestle with EC regulations requiring a minimum mesh size and shape of 40 mm square, with 50 mm diamond allowed "at the duly justified request of the shipowner." In southern Italy, most were reported not to accept the modification. More collaboration was found in central-northern Italy, but square mesh was still unaccepted: most are choosing 50 mm diamond, despite the special "request" requirement. The effect on size selectivity of this change is unclear.
- In Spain, the minimum mesh size for towed nets in the Mediterranean was implemented on 1 June 2010. Several studies on this topic have been car-

ried out in Mediterranean waters. In the Balearic Islands, a change from 40 mm diamond-shaped mesh to a 40 mm square-shaped mesh resulted in changes in the selectivity parameters (L_{50}) and a reduction in the biomass discarded. The whole fleet has made this change.

- Some fishers (20–40%) of the central Adriatic Sea operating with demersal and pelagic trawl, on a voluntary base started to use the pingers as deterrent for marine mammals, because they believe that the efficiency of their nets can improve.

Ecosystem Effects

Discarding due to quote closures was especially noted in Ireland and Spain. Shifts in discarding rates were linked to population changes in Ireland and France.

Responses relating to discarding:

- During the last quarter of 2010 Irish vessels operating in Area VI discarded large quantities of saithe and hake as the quota was exhausted. Discarding of hake in particular was reported to be very high in this area. Throughout the year there was also a certain amount of highgrading of hake due to the very low market price for hake below 1kg (~40cm in length).
- Discarding of juvenile haddock and whiting has been very high in the Celtic Sea from around quarter 2 onwards in 2010. This is due to very large year classes of these species coming through into the fishery. There are reports of boats catching 2–3 tonnes to every 1 tonne retained. Attempts have been made in Ireland to introduce remedial methods and some positive steps have been taken in relation to some of the *Nephrops* fleet but other vessels (particularly the seiners) are more reluctant to improve the selectivity of their gears on the basis that losses of marketable fish will be too high.
- Spain saw an increase in mackerel discard amounts during 2010 as a consequence of the early closure of the fishery (March), and the inability of the trawlers to avoid catches of mackerel. It is expected that, large amounts of mackerel discarded will be generated in 2011 as a consequence of the quota reduction imposition. This hypothesis will be investigated by analysing 2011 when available. Similar observations were made in the Basque country.
- Rebuilding of cod has led to a probable modification in size and age of cod discards in France.

A number of gear modifications have been tested and in some cases are being used to reduce the bottom impact of towed gears. As reported under Technical Creep there has also been considerable testing of trawl doors rigged to fish off-bottom, primarily driven by fuel prices. Both initiatives potentially have benefits in respect of reduced bottom impact.

Specific examples:

- In Italy, some fishers have introduced a window in the lower panel of the bottom trawl in order to reduce the catch of shellfish, sea urchin, stones etc. However other fishers are continuously increasing the number and weight of chains at the groundrope in the bottom trawl.
- In Spain, closed areas to protect Vulnerable Marine Ecosystems (VME) have been established in 2010 in NAFO areas (NAFO/FC Doc. 10/1)

- France reported experiments with using pelagic doors on bottom trawls and use of fish pots and diving.
- Ireland similarly reported the use of off-bottom doors as well as electric pulse dredging.
- In Belgium, mesh size and twine thicknesses, combined with limited days at sea was thought to have the most effect in impact reduction.
- The uptake of pulse beam trawling for both shrimps and flatfish in the Netherlands and Belgium is continuing. At present in the Netherlands, a total of 42 licences have been given out under derogation from the EU. Pulse trawling has clear advantages in terms of lower fuel consumption and GHG-emissions, lower bycatches of particularly benthos, and lower seabed impact.

Seals and other protected species continue to interact with fishing gear. Specific instances of fisheries interactions with protected species and associated mitigation measures reported:

- As reported in previous years from Ireland predation of fish catches by mainly grey seals from gillnet/tanglenet fisheries continues to be a problem on all coasts of Ireland. Many inshore fishers have now stopped gillnetting as the level of damage is so high. Seals have been reported up to 80–90 miles off the coast. More than 30 vessels in the size range 10–20m are affected by this phenomenon. It has been reported by fishers that seals are not only targeting gillnets but also vessels jigging around wrecks and rough ground for white Pollack as well from lobster and crab pots and even trawls.
- Pingers are still only being used sporadically in Irish gillnet fisheries despite it being mandatory in some areas.
- In France, porpoise catches in gillnets were identified as a possible impact. Tests with existing commercial pingers were unsuccessful up to now, with problems of handling and low efficiency.
- France implemented the use of turtle excluder devices (TEDs) in French Guyana.

Development of New Fisheries

A few new small fisheries were been reported in 2011. Experimentation of static gears as a means for targeting fish continues although the indications are that these fisheries are still not economically viable in most cases. There is one example of a dive fishery for scallop developed in France.

Examples of new fisheries are reported as follows:

- Pot fisheries for cuttlefish, gillnet fisheries for sole, turbot and brill, and a flyshooter fishery were new in small numbers for Belgium.
- No new fisheries were reported for Ireland, although some pelagic vessels are looking at the possibility of targeting pipefish and lanternfish for fishmeal.
- A general shifting of effort away from otter trawls was observed. Six or more French trawl vessels that fish the Bay of Biscay have diversified into Danish seining, while still maintaining their trawl gear. They mainly fish

in the Bay of Biscay (mackerel, whiting, cuttlefish, red mullet, squid, and hake).

- Netters in Area VIIIA in the northern Bay of Biscay who diversified with accessory Nephrops pots have stopped for a variety of reasons: conflict of métiers, low yields, and poor cost–benefit balance.
- In Sweden, there has been an increased fishery for greater weever (*Trachinus draco*) in Kattegat during 2010 and 2011, mainly as a consequence of low catches of Nephrops and cod during the first quarters. The weever is also one of few species that are without limiting quotas and few regulations are attached to it in the Kattegat.
- France reported continued development of a dive fishery for scallops in Northern Brittany.

14.4 Information for individual assessment working groups

Specific information relating to different areas and fisheries to be provided to Assessment Working Groups and other Expert Groups are detailed in Annex 5. Information is provided for the following WG's:

WGCSE	WGHMM
WGNSSK	AFWG
NWWG	WGWIDE
HAWG	WGNEW
WGANSA	WGECO
WGMME	WGSE
SGBYC	GFCM

14.5 Conclusions

WGFTFB concluded that it was worthwhile for the group to continue to collate this information on an annual basis subject to further revision of the questionnaire and better quantification of the information where possible.

15 ToR b): Redfish Fishing Technology and Physiology

15.1 Background

Changes of mesh size alone are not believed to be an effective solution to the problem of redfish selectivity. Codends containing considerable amount of redfish rapidly rise to the surface due to hydrostatic pressures and rather special conditions are thought to develop within the codend that can result in that the codend meshes opening up and which may lead to a considerable release of redfish during the haul back operation of the fishing gear. NAFO Scientific Council (SC) referred the issues of redfish selectivity and the loss of redfish by during the later stages of hauling when the net comes to the surface to the WGFTFB in 2010. NAFO SC proposed to investigate possible technical measures that could reduce the loss of redfish at the surface due to their developed buoyancy. WGFTFB considered this request initially at their 2010 meeting and worked by correspondence to draft a response for the NAFO SC meeting in September 2010. In responding WGFTFB have considered and reviewed available information on redfish selectivity and mitigation measures as well as experiments to assess the level of escapement and survival of escapees during the fishing process. A topic group was created in WGFTFB 2011 to address the issue of redfish selectivity. The present report reviews fishing techniques used in redfish techniques and the selectivity parameters from historical trials shared by group participants. The report also summarizes the expert overview and findings achieved during the meeting on the issue.

15.2 General Overview

Bent Herrmann introduced this ToR at plenary. The participants met 11 - 12 May 2011. During the first day the participants showed presentations in line with the ToRs. Some information on gear specifications in use by member countries was summarized in Table 1. Information from different countries on redfish selectivity was shared to the topic group and is shown in Table 2**Error! Reference source not found.**. Redfish morphometrics was also a relevant issue regarding prediction of species selectivity.

15.3 Terms of Reference

Redfish are primarily harvested by trawls – either pelagic or bottom trawls. Due to their relative small sizes and their distribution in vertical columns, they offer both an opportunity and a challenge to sustainable harvesting. In light of a NAFO request for more information on redfish harvesting, trawl codend selectivity, as well as challenges in under-harvesting of redfish resources in Northeast US, a WGFTFB topic group of experts met in Reykjavik in 2011 with the following terms of reference:

i) Create an inventory of gear specifications (such as mesh size, trawl design, trawl orientation) used in harvesting redfish in member countries;

ii) Describe and synthesize research carried out on size selectivity with various mesh sizes and configurations and investigate possible technical measures that could reduce the loss of redfish at the surface due to their developed buoyancy;

iii) Collect morphometric information necessary to predict size selectivity;

iv) Examine habitat use, especially water depth and water columns, by major commercial redfish species and application of the information for selective capture by trawls.

15.4 List of Participants

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15.5 Individual presentations

15.5.1 A Network to Redevelop a Sustainable Redfish (*Sebastes fasciatus*) Trawl Fishery in the Gulf of Maine (Mike Pol, Mass. Division of Marine Fisheries, USA)

Redfish are being caught in the Gulf of Maine under the current mesh size regulations, but there is a concern that a considerable amount of legal size redfish are being lost on haul-back. The current allocations of redfish cannot be caught because the minimum mesh size is too large to effectively retain legal size redfish; therefore sectors are not maximizing their economic potential which endangers their ultimate success. A redfish network, which draws on wide-ranging expertise to conduct research including bycatch assessment, gear testing, processing-marketing, and outreach-implementation, was created to address the problem. The proposal is to establish and use the resources of the redfish network. Six different components are included in the network:

- Component 1: Network meetings
- Component 2: Baseline catch and Bycatch evaluation
- Component 3: Codend selectivity
- Component 4: Conservation engineering and bycatch reduction
- Component 5: Processing/Marketing
- Component 6: Outreach/Implementation.

The expected starting date for fishing trials from Component 2 is early May 2011. Fishing results will be used in the subsequent components.

Discussion

The author was asked how was inferred the availability of redfish in the area. The explanation was made that there is biological information on redfish availability in the area.

15.5.2 Preliminary review of data on selectivity of trawls for redfish (*Sebastes mentella*; Alexander Pavlenko, PINRO, Russia)

A summary of redfish catches and selectivity parameters obtained by Konstantinov *et al*. (1981), Gorchinsky *et al.* (1993), Lisovsky *et al.* (1995; 2005) and codend designs used in the latest study was shown in the presentation. Trials were carried out in NAFO divisions 30, 3M and 3N. Mesh sizes tested along the different studies range from 88 to 137 mm; L50 estimations range from 24.6 cm (88 mm mesh size tested by

Lisovsky *et al.,* 1995) to 39.7 cm (137 mm mesh size tested by Gorchinsky *et al.* 1995). Morphometric information on the relation between length and maximum girth for beaked redfish in the Barents Sea (Konstantinov *et al.,* 1983) and Flemish cap (Valdés and Fraxedes, 1981) was also presented.

Discussion

Attendees highlighted the unexpected low range of variation concerning L50 estimations over the tested mesh sizes. The author argued that the main factor affecting redfish escapes from the codend could be the towing stage rather than mesh size itself. To support this hypothesis, the author showed a video related to fishing practices by a redfish trawler, where it could be seen high amounts of redfish released during the haul back stage. The participants agreed that it would be useful to directly sample redfish release during the different stages of the fishing operations by applying the Norwegian multi-sampler during a selectivity experiment. Another relevant question was about the codend mesh configuration tested in the studies. The author responded that all studies were carried out using double twine codends with twine diameters of 3.5 mm. The author was asked if cover design and rigging could affect escapement possibilities of redfish. The author indicated that although no rings were attached to the covers used in the trials, the cover dimensions, design and rigging avoided the blocking effect. Concerning data quality, the author was asked if all individuals were sampled or otherwise subsampling from the whole catch took place. The author responded that input data for selectivity models were raised to the total catch. It was noted that the codend designs used in the Russian trial were mainly four or eight panel constructions with a tapering thus these designs differ considerable from the codends applied in other fisheries. Consequently care should be taken when comparing the Russian selectivity results with those obtained by other institutes.

15.5.3 Review of Icelandic redfish fishery (Haraldur A. Einarsson, Marine Research Institute, Iceland)

A short overview of Icelandic redfish fisheries were presented on a spatial basis. Golden redfish (*S. marinus*) is mainly caught with bottom trawls as bycatch in Icelandic waters and the highest catches occurs in the southeast of Iceland. Regulations for codend mesh size for that area is 135 mm. Deep sea redfish (*S. mentella*) is mainly caught with pelagic trawls in the northeast areas. The mesh size is 135 mm inside Icelandic waters but 120 mm outside 200 miles. Golden redfish 1978–2009 Icelandic landings and related 1986–2009 cpue´s were also presented. These data include landings from national waters, East Greenland and Faroese waters. The presentation included spatial information for fishing grounds within Icelandic waters and the Irminger Sea deep and shallow pelagic management units. Finally it was noted that in the years 2003–2006 selectivity surveys for several codend types including redfish data were conducted. No processing of those data has been done, as the species weren't in focus at that time. These data will be looked at as soon as possible and will perhaps give some more information. A selectivity survey is in design stage for next autumn. One of the goals will be collecting further selectivity data for redfish.

Discussion

The author notes that golden redfish length distributions from the Icelandic commercial trawler fleet in 1989–2010 show that the majority of the fish caught are between 30 and 45 cm, a range clearly above the legal minimum size (25 cm), concluding that selectivity of the gears in use is not an issue to be revisited. The author also gives some information on redfish escaping behaviour, obtained by personal views during

experimental campaigns, where it was observed that the fish tend to escape downwards into the area next to the codend extension.

15.5.4 Reconciling mixed demersal fisheries in the North Sea with precautionary conservation needs through adaptive management strategies (Eckhard Bethke, vTI – Institute of Sea Fisheries, Germany)

The 7 main target species of the demersal mixed fisheries in the North Sea, Skagerrak and Eastern Channel are cod, haddock, whiting, saithe, plaice, sole and Norway lobster. Gadoids and Norway lobsters are mainly taken in the northern North Sea by towed gears while the flatfish fisheries are conducted in the southern North Sea mainly using beam trawls. Recently, the central North Sea appears less fished by demersal gears. Towed nets including seines equipped with meshes of more than 100 mm and beam trawls with a mesh opening of more than 80 mm in the codend (inside measure) were identified as the main gears affecting the depleted cod and reduced plaice stocks. The fisheries are managed by TACs and technical measures, i.e. fishing effort and mesh opening. TAC regulations alone are considered inefficient to harvest stocks sustainably by mixed fisheries. Optimal measures were identified for the mixed fishery on these species to derive technical steps for changes, i.e. a stepwise increase towards an optimum mesh size and effort to achieve maximum sustainable profit of the mixed fisheries in total. The optimization method safeguards sustainable management constraints for a minimum spawning-stock biomass through an ecological quality objective. Applying such cost optimized fleet effort and mesh size management could result in increased catch possibilities for some stocks for fleets selecting mainly a few and non-overexploited stocks. The presentation did not provide any specific information related to redfish selectivity.

Discussion

The author was asked if price differences between length classes were considered in the models. The author revealed that the model does not consider this factor. It was noted that the author assumed a knife-edge selection process in the simulations. Questions were raised regarding the validity of results based on such assumptions.

15.5.5 Size Selection of Redfish: collaboration between University of Tromsø, Sintef and Denmark Technical University (Bent Herrmann, DTU Aqua, Denmark)

Three collaborative actions are being carried out by the University of Tromsø, Sintef and Denmark Technical University in order to study size selection in redfish. Data for four important species in Barents Sea demersal trawl fishery including for *Sebastes marinus* were collected during December 2008, by means of the FISHSELECT methodology and tools (Herrmann *et al*., 2009). The collected data are being analysed using the FISHSELECT software and the results obtained are being applied to investigate trawl selectivity through built-in simulation facilities. Redfish fishing data were also collected in experimental trials carried out in 2009. The objective was to estimate the additive redfish selectivity of a 135 mm diamond mesh codend and a 55mm bar spacing sorting grid by using dual-selection techniques (Sistiaga *et al*., 2010). The methodology also enables an estimate of the contact efficiency of the grid setup. Data collected in 1994 by R.B. Larsen and K. Gamst with the Sort-X grid mounted with two different bar spacings (50 mm and 55 mm) and a codend mesh size of 135 mm will be re-analysed in June 2011, with the aim of extracting grid selectivity and codend selectivity separately.

15.5.6 Fishing technology in Spanish redfish fisheries (Juan Santos, Instituto Español de Oceanografía, Spain)

The main trawl models and specifications used in the Spanish pelagic and demersal redfish were presented. Some information on the topic was collected through personal interviews with owners and netmakers involved in the redfish fisheries. The related redfish catch statistics for recent years were also presented showing the relative importance of these fleets in the international redfish landings. The results of these interviews are summarized in technical schemes of the currently used gears and specifications, also reflecting the historical evolutions since the first models available.

15.6 Main Outcomes

An inventory of gear specifications (such as mesh size, trawl design, trawl orientation) used in harvesting redfish in member countries was created using the information available during the meeting.

Table 1 summarizes the provided information.

Table 1. Summary of main gear specifications collected from Russian (RU) and Spanish (ES) fleets.

	Fishing grounds	Trawl type	Target species	Device	Number of panels	Components	Cross Section (n meshes)	Longitudinal section (n meshes)	Mesh size (mm.)	thickness (mm.)	Composition	Twine number
RU	Irminger Sea NAFO	Pelagic 4 panels	Redfish	Codend	4	Lower panel	41–72	337	110	3.1	P/E	2
						Side panel	41–72	337	110	3.1	P/E	2
ES	NAFO	Demersal 2 panels OTB	Greenland halibut	Codend	2	Upper panel	70	166	150	6	P/E	2
						Lower panel	70	166	150	6	P/E	2
				Extension	2	Upper panel	100	30	150	5	P/E	2
						Lower panel	100	30	150	5	P/E	2
				Belly	2	Upper panel	110–320	175	150	4	P/E	1
						Lower panel	110–320	175	150	4	P/E	1
				Square	2	Upper panel	320–380	50	150	4	P/E	1
						Lower panel	-	-	-	-	-	-
				Wings	2	Upper panel	<=85	154	150	4	P/E	1
						Lower panel	-	-	-	-	-	-
ES	Irminger sea	Pelagic 4 panels	Redfish	Codend	4	Upper panel	45	-	130	6	PE	2
						Lower panel	45	337	130	6	PE	2
						Side panel	45	337	130	6	PE	2
				Belly	4	Upper panel			150–4000	1.7–8	PE-DYN-PA	1–2
						Lower panel			150–4000	1.7–9	PE-DYN-PA	1–2
						Side panel			150–4000	1.7–10	PE-DYN-PA	1–2
				Front part	4	Upper panel			16x10^3–64x10^310		DYN	1
						Lower panel			16x10^3–64x10^310		DYN	1
						Side panel			16x10^3–64x10^310		DYN	1
				Wings	4	Upper panel			64x10^3	12	DYN	1
						Lower panel			64x10^3	12	DYN	1
						Side panel			64x10^3	12	DYN	1

Redfish selectivity information from Russian, Canada, Norway, Germany and Iceland trials is summarized in Table 2. Different experimental designs and lack of information about codend construction and rigging for some trials require caution in the interpretation of the reported selectivity parameters. In general, participants agreed that the need for improvement in selectivity is highly dependent on the structure of exploited populations. In Iceland, for example, selectivity is not a factor to consider in the conservation of some stocks, as fleets target populations with larger than MLS. Attendees found it likely that the redfish selectivity is strongly associated with the haul back operation. In this regard, haul back operation produced between 18–30% of redfish escapement during the Russian trials reported by Lisovsky (2006). An experiment conducted by Grimaldo *et al*. (2008) in Norwegian trials investigated the escapement patterns for cod and haddock during three different stages of the fishing operation for different gear configurations. A similar investigation would be relevant to redfish species. Avoiding the problem of stickers was also addressed during the topic discussions. There were indications that the problem with stickers was bigger when using square mesh codends to catch redfish. However at the present time there is no quantitative scientific evidence to support these qualitative observations. It was pointed out that the subject could be investigated scientifically by collecting the stickers separately from the codend catch and the cover catch during selective experiments. Subsequently these data could then be modelled in a special model also considering the length dependent sticking likelihood. In this way it would be possible to assess whether or not the sticking likelihood would be statistically significantly different for different codend designs. The participants comment that T90 codends could be a solution to be tested in future. A comment extracted from the WGFTFB 2004 report (12.2 on the advice requested from FTFB through IBSFC) revealed that many fishers already use T90 meshes to avoid the problem of stickers (e.g. Swedish and Danish herring fishers fishing in the Baltic). Comments regarding selectivity devices were made around the downwards escaping behaviour by redfish observed during Icelandic trials. This behavioural information was seen as relevant by the participants and could be useful in designing future selectivity devices directed to redfish.

Morphometric data are available for five species of redfish in the North Atlantic. Cross sectional data have been collected for *S. marinus* by Danish and Norwegian researchers using the FISHSELECT method, and are fully adequate for prediction of selectivity for different codend shapes and sizes. Garabana (2005) used two morphometric techniques: traditional morphometrics that uses interlandmark distances, and the more recently developed geometric morphometrics that uses landmark coordinates as input in the analysis. She examined four species (*S. mentella*, *S. fasciatus*, *S. marinus*, *S. viviparous*). These data, which include meristic measurements and outlines of fish from the lateral view, do not appear useful for prediction of size selectivity (Figure 1). However, her conclusion that the four species, and populations within species, are morphometrically distinguishable indicates that applying conclusions from morphometric data for one Sebastes species or population to others is inadvisable. Two references on *Helicolenus dactylopterus* morphometrics were also shared during the meeting.

Additional data on fish girth-length relationships for *S. mentella* have been collected (Valdes and Fraxedes, 1981; Konstantinov *et al*., 1983). These data show good agreement in length-girth relationships for the Barents Sea and the Flemish Cap, regions far apart in the North Atlantic (Figure 2). Collection of cross sectional data following

FISHSELECT protocols are planned as part of joint efforts between participants in the topic group for *S. marinus* and *S. viviparous*, and perhaps *S. mentella*.

15.7 Recommendations

- FTFB recommends that further studies on redfish selectivity must be carried out in a species-specific basis;
- FTFB recommended to enhance morphometric data collection for different redfish species, including those species not previously studied;
- FTFB recommends initiating investigations on new gear designs and devices to improve the current rates of escapement of redfish during towing and to reduce stickers.

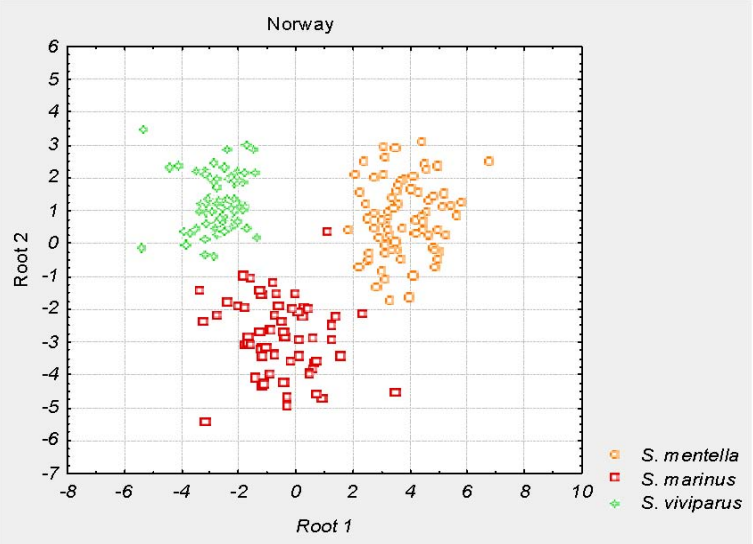

Figure 1. Plot of canonical scores for each case for the first and second canonical roots of the analysis performed with the three species inhabiting Norway (Garabana, 2005).

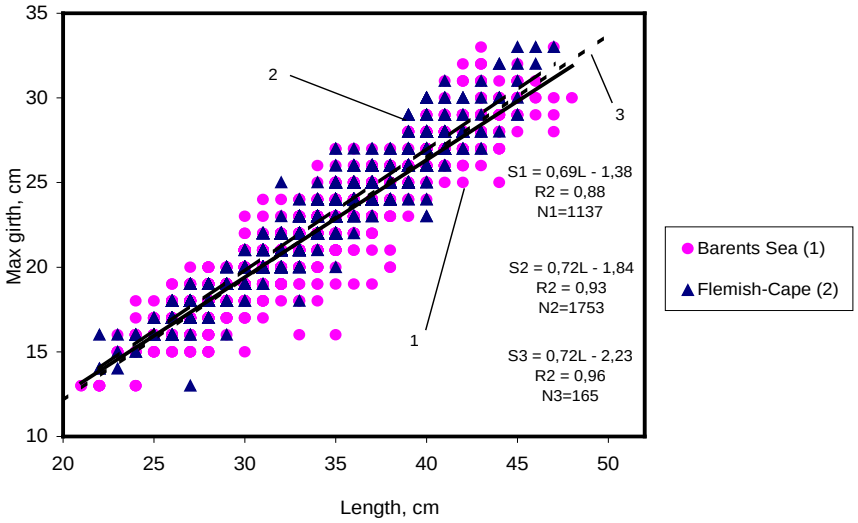

Figure 2. Relationship between the length and maximum girth in beaked redfish in the Barents Sea (ICES Subarea IIa) and Flemish-Cape (NAFO Div. 3M).

Table 2. Summary of selectivity parameters obtained from the trials shared by the participants.

Country	Reported by	Area	Sebastes spp.	Type of gear	Codend mesh size mm	L50	SR	Notes
Russia	Lisovsky *et al*., 1995	NAFO 3N	*mentella*	Midwater	88	24.6	4.4	
Russia	Lisovsky *et al*., 2006	NAFO 30	*mentella/fasciatus*	Midwater	96	25	5.4	
Russia	Lisovsky *et al*., 2006	NAFO 30	*mentella/fasciatus*	Midwater	100	26	4.1	
Russia	Lisovsky *et al*., 2006	NAFO 30	*mentella/fasciatus*	Midwater	106	27.6	5.5	
Russia	Lisovsky *et al*., 1995	NAFO 3N	*mentella*	Midwater	118	29.5	6.6	
Russia	Konstantinow *et al*., 1981	NAFO 3M 3N	*mentella*	Midwater	124	29.8	8.4	
Russia	Gorchinsky *et al*., 1993	NAFO 3M	*mentella*	Bottom	126	36.5	5.6	
Russia	Lisovsky *et al*.,1995	NAFO 3N	*mentella*	Midwater	132	34.3	6.6	
Russia	Gorchinsky *et al*., 1993	NAFO 3M	*mentella*	Bottom	137	39.7	4.3	
Canada	Hickey *et al*., 1995	NAFO 3Ps		Bottom	115	31.5	5	w/o lastridge ropes
Canada	Hickey *et al*., 1995	NAFO 3Ps		Bottom	115	33.2	3	with lastridge ropes
Canada	Hickey *et al*., 1995	NAFO 3Ps		Bottom	110	26.8	6.5	w/o lastridge ropes
Canada	Hickey *et al*., 1995	NAFO 3Ps		Bottom	110	32.1	3.3	with lastridge ropes
Canada	Hickey *et al*., 1995	NAFO 3Ps		Bottom	90	27.2	5.9	w/o lastridge ropes
Canada	Hickey *et al*., 1995	NAFO 3Ps		Bottom	90	26.9	3.3	with lastridge ropes
Norway	Larsen *et al*., 1995	Barents Sea	*marinus/mentella*	Bottom + (grid)	40 + (55)	45.3	12.2	Sort-X (to be recalculated June 2011)
Norway	Larsen *et al*., 1995	Barents sea	*marinus/mentella*	Bottom + (grid)	135 + (50)	40.4	10.8	Sort-X (to be recalculated June 2011)

Country	Reported by	Area	Sebastes spp.	Type of gear	Codend mesh size mm	L50	SR	Notes
Norway	Larsen *et al*., 1995	Barents sea	*marinus/mentella*	Bottom + (grid)	135 + (55)	38.1	10	Sort-X (to be recalculated June 2011)
Norway	Jørgensen *et al*., 2010	Barents sea	*marinus/mentella?*	Midwater + (grid)	130*+(55)	34.2 / 40	5.4 / 5.5	*130mm diamond under and side panel, 125mm square top panel
Germany	Bohl, 1961	S. Greenland	*marinus*	Bottom	122	35.3	10	
Germany	Bohl, 1961	S. Greenland	*marinus*	Bottom	131	33.5	14.5	
Germany	Bohl, 1961	S. Greenland	*marinus*	Bottom	139	37.2	13	
Germany	Bohl, 1961	S. Greenland	*marinus*	Bottom	146	41.2	14.5	
Germany	Bohl, 1961	S. Greenland	*marinus*	Bottom	147	38.4	15	
Iceland	Thorsteinsson, 1974	Iceland	*marinus*	Bottom	132	29.9	2.27	+ Polish chafer

15.8 References

Garabana, D. 2005. The genus Sebastes Cuvier, 1829, (Pisces, Scorpaenidae) in the North Atlantic: Species and stock discrimination using traditional and geometric morphometrics. Doctoral Thesis, Univ. of Vigo, Vigo, Spain. 307 p.

Gorchinsky, K. V., Lisovsky, S. F., Sadokhin, M. K. 1993. Selectivity of Bottom Trawls During the Fishery for Redfish on the Flemish Cap Bank. NAFO SCR Doc. 93/100, Serial No 2293, 9 p.

Grimaldo, E., Larsen, R. B., Sistiaga, M., Madsen, N., Breen, M. 2009. Selectivity and escape percentages during three phases of the towing process for codends fitted with different selection systems. Fisheries Research, 95: 198–205.

Herrmann, B., Krag, L. A., Frandsen, R. P., Madsen, N., Lundgren, B., Stæhr, K. J., 2009. Prediction of selectivity from morphological conditions: methodology and a case study on cod (*Gadus morhua*). Fisheries Research, 97: 59–71.

Hickey, W. M., Boulos, D. L., Brothers, G. 1995. A Study of the Influence of Lastridge Ropes on Redfish Selectivity in a Bottom Trawler. Can. Tech. Rep. Fish. Aquat. Sci., 2076:vii+25.

ICES. 2004. ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB). ICES CM 2004/B:05, Ref. ACE.

Konstantinov, K. G. On some problems of selectivity of a commercial trawl. NAFO SCR Doc.81/VI/72, Serial No 357, 8 pp.

Konstantinov, K. G., Chumakov, A. K., Nikeshin, K. N., Kovalenko, V. G. 1982. On Validity of Trawl mesh size used in Fishing Areas in the Northwest Atlantic. NAFO SCR Doc. 14/VI/ Serial No 502, 30 pp.

Lisovsky, S.F. 2001. On optimal Mesh Size When Fishing Redfish in the Atlantic. NAFO SCR Doc. 01/21, Serial No. 4389, 16 pp.

Lisovsky, S. F., Tretjak, V. L., Kiseleva, V. M., Kotljarov, S. M. 1995. On minimum Mesh-size During Deepwater Redfish Fishery with Mid-water Trawl in NAFO Division 3NO. NAFO SCR Doc. 95/25. Serial No. 2533, 9 pp.

Lisovsky, S. F., Pavlenko, A. A., Vaskov, A. A. 2006. On the Minimal Trawl Codend Mesh Size in the Fishery of Redfish Species in Division 3O of the NAFO Regulation Area. NAFO SCR Doc. 05/18. Serial No. N5099.

Rodríguez-Mendoza, R., Muñoz, M., Saborido-Rey, F. 2011. Ontogenetic allometry of the bluemouth, Helicolenus dactylopterus dactylopterus; (Teleostei: Scorpaenidae), in the Northeast Atlantic and Mediterranean based on geometric morphometrics. Hydrobiologia. DOI 10.1007/s10750-011-0675-7.

Sequeira, V., Rodríguez-Mendoza, R., Neves, A., Paiva, R., Saborido-Rey, F., Serrano Gordo, L. 2011. Using body geometric morphometrics to identify bluemouth, *Helicolenus dactylopterus* (Delaroche, 1809) populations in the Northeastern Atlantic. Hydrobiologia: DOI 10.1007/s10750-011-0655-y.

Sistiaga, M., Herrmann, B., Grimaldo, E., Larsen, R.B. 2010. Assessment of dual selection in grid based selectivity systems. Fisheries Research, 105: 187–199.

Valdes, E., Fraxedas E. I., 1981. Redfish selectivity study on Flemish Cap, May 1981. NAFO SCR Doc. 81/VI/44, 11 p.

16 ToR c): The effect of vessel size on selectivity

16.1 General Overview

Vessel-size, in terms of length and engine power, has long been speculated to have an affect on selectivity and therefore fishers often contend that smaller vessels should be subject to different management measures and in particular technical conservation measures e.g. codend mesh size, size and positioning of square mesh panels, twine thickness. The common opinion among fishers is that catching efficiency of a trawl decreases during bad weather. Smaller vessels are said to be more sensitive to sea-state making them roll and pitch more than larger vessels and also generally have different fishing operations, particularly when hauling their gear which results in increased selectivity. It is speculated that movement of the vessel is transmitted down to the gear and otter doors causing changes in the gear rigging. Polet and Redant (1994) stated that bad weather could affect codend selectivity. Several other studies (Tschernij and Holst, 1999; Bova *et al*., 2009; Kynoch *et al*., 2009) have been carried out, however, which have not demonstrated any major differences in selectivity between vessels of different engine power.

A WGFTFB topic group was set up and met at the 2011 WGFTFB meeting in Reykjavik (Iceland) to review and explore the relationship between horsepower and gear selectivity.

16.2 Terms of Reference

The topic group had the following Terms of Reference:

i) Review available selectivity and catch comparison data from small and larger vessels;

ii) Review gear and operational parameters;

iii) Identify likely causes of differences in selectivity and investigate whether they are real.

16.3 List of Participants

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16.4 Review of available data

The Topic Group reviewed studies carried out in EU waters and internationally that had investigated the relationship between vessel power and selectivity of the towed gears. A number of studies were found and these are summarized below and in Table 3.

16.4.1 R. J. Kynoch, R. S. T. Ferro and R. J. Fryer (2009)

The main aims of these selectivity trials were to assess the differences in performance between square mesh panels (SMPs) placed in the straight extension or in the taper, between 110 and 120 mm SMPs, and between gears towed by vessels of different horsepower. The trials took place on two different vessels, at two different times during 2008 and on different grounds. The *Nephrops* twin trawler the Zenith (BF106), a 500kW vessel, was chartered during April 2008 and fished on North Sea commercial *Nephrops* grounds at the NE Holes, Bressay ground, Skate Hole and the Moray Firth; and the Bountiful (BF79), a 298kW vessel, was chartered during August, 2008 for the second trials, which targeted commercial *Nephrops* grounds approximately 35 nm east of Fraserburgh in the Moray Firth. The analysis did not indicate any significant effect of the vessel on selective performance for any of the gears. Vessel motion has been suggested as a possible cause of differences in selection between large and small vessels - the greater movement of the smaller vessel possibly creating more pulsing of the codend. However, the weather was not severe at any time during the trials (force 2–5) so we would not expect to see the effect during these trials.

16.4.2 D. J. Bova, J. Drewery, R. J. Fryer, R. S. T. Ferro (2009)

A 12 day research charter was commissioned to acquire data on the selectivity of juvenile fish and *Nephrops* when fishing on *Nephrops* grounds off Mallaig. Two local vessels, the Margaret Ann (low engine power, 177 kW) and Ocean Trust (higher engine power, 375 kW), carried out parallel, simultaneous fishing tows using *Nephrops* gear with 80 or 100 mm codends and 200 mm mesh square mesh panels (SMPs) fitted in the extension, 15–18 m from the codline, and extending 8 meshes into the taper of the net. The Ocean Trust used its normal twin-rig and the Margaret Ann its normal single-rig net. All hauls were conducted while the two vessels towed on simultaneous parallel courses, a safe working distance apart, at their normal commercial towing speeds, with the nets fishing on the seabed for the same length of time. A small mesh codend was attached to one net of the twin-rig gears to sample the population being fished while the experimental codends were attached to the other twin-rig net and the single-rig net. The catches of each of the experimental nets were then compared to the catches in the small mesh codend. It was assumed that the populations of fish encountering the 3 nets were similar but that the nets were not necessarily fishing with the same efficiency. There was no evidence that gears towed by a low-powered vessel are more selective for haddock, whiting and *Nephrops* than those towed by a higher-powered vessel. There is also no evidence of a difference in the catching performance of the two codends for haddock, whiting and *Nephrops*.

16.4.3 Cotter, J., Elson, J. Lovewell, S., Lawler, A., Boon, T. (2004)

Cotter *et al*. (2004) describe comparative fishing trials on the Farne Deep grounds. Two vessels were used; 17 m, 169 kW and 8.6 m, 119 kW trawlers towing standard *Nephrops* trawl of different sizes (180 vs. 126 ft). Ten stations were successfully fished in parallel. The larger vessel caught about 70% more *Nephrops*; catches of other fish were in general similar and no differences in size distribution apart from whiting were detectable. The larger vessel caught larger (24–36 cm) whiting while the smaller vessel caught smaller (15–21 cm) whiting. Reasons for this difference are not clear but possibly due to the higher headline of the trawl used by the larger vessel.

16.4.4 D. McDonald, D. Rihan, D. Browne and H. Tan (2011)

In July/August 2010 BIM carried out twin trawl selectivity trials on two under 15 m vessels with different engine power in the mixed demersal fishery in the Celtic Sea in ICES Area VIIf/g. A set of selectivity observations were carried out on the 11m vessel "MFV Providence II" with 150 hp while another set of selectivity observations were carried out on-board the 14 m vessel "MFV Ludovic Geoffray" with 413 hp. Weather conditions during these trials were good. The objective of the trials was to compare the selectivity of a range of gear combinations on both vessels to see if any significant differences could identified and also to see what the effects of introducing these gears would be in the Celtic Sea. The gear options included a range of codend mesh sizes from 80 mm to 120 mm with and without 120 mm square mesh panels (SMP). The results of these trials did not show any clear trends in the L50s obtained indicating that there is no significant difference in selectivity between these vessels with differing horsepower. The selectivity results on both vessels were in fact remarkably consistent. The 80 mm codend for both vessels show little or no differences in L50's for megrim between the two vessels. The 100 mm codends also show similar results L50s for megrim. The L50s for whiting results for a range of gears on both vessels also show very similar results and don't suggest that there is any difference. Selectivity results from these trials were compared with results from larger vessels from previous trials on the West Coast of Scotland by Rihan *et al*. (2009) and trials Rockall Bank by Rihan *et al*. (2008) on much larger vessels. The L50s for megrim with 90 mm, 100 mm, 120 mm codends on the Providence were 33.2 cm, 34.6 cm, and 41.24 cm respectively. The L50s for megrim with a 100 mm codend, 110 mm, and 120 mm codend on the 32 m MFV Catherine R (30.5 m / 709 kW) were 27.9 cm, 31.02 cm, and 41.57 cm respectively and on the 32 m Marliona (32.5 m / 721 kW) at Rockall the L50s for the 100 mm and 110 mm codends were 28.55 cm and 32.04 cm. The L50s for haddock on the Providence II with 90 mm codend with 120 mm SMP, 100 mm codend and 120 mm codend were 34.47 cm, 28 cm and 42.73 cm and the L50 for haddock on the Catherine R with 100 mm codend and 120 mm SMP, 110 codend with 120 mm SMP and 120 codend with 120 mm SMP were 39.17 cm, 34.03 cm and 38.07 cm respectively. The L50s for haddock for the Marliona with 100 mm + 90 mm SMP, 110 mm codend + 90 mm SMP and 110 + 120 mm SMP were 27.17 cm, 29.6 cm and 36.72 cm respectively. Taking account of the difference in gear configurations, weather conditions and areas the indications from these results suggest there is no significant difference in selectivity.

16.4.5 Chosid, D., Pol, M.V., Szymanski, M., Ribas, L.R., Moth-Poulsen, T. (2008)

The primary goal of this project was to reduce Atlantic cod catches while retaining legal-sized yellowtail flounder catches using the Topless and Ribas trawlnets. The Ribas net uses large mesh panels in its top section; the Topless net is distinguished by the removed top section from the wings back to the belly. The proposed testing included comparisons in daylight and night-time conditions on a large, offshore vessel of 650 kW. Previous testing of these gears had been completed on two much smaller vessels of 271 and 272 kW (Pol *et al*., 2003). The new results establish that the Topless net design is effective for avoiding Atlantic cod. The Ribas net did not significantly reduce Atlantic cod catch during day or night. The difference in results between Pol *et al*. (2003) and this study indicate that one, some, or all of the factors of larger net size, greater depths, larger vessels, or day and night conditions impact the ability of these nets to avoid cod compared to the results from the trials on the lower-powered vessels.

16.4.6 Tschernij, V. Holst, R. (1999)

Within the EU-financed BACOMA-project a fishing experiment was designed to assess the effect of vessel size, hauling technology and vessel-gear interaction upon codend selectivity in Baltic cod fishery. Seven commercial trawlers were randomly chosen from specific categories of the active Swedish fishing fleet. In these tests standard 120 mm diamond mesh codends, made of double 4-mm braided green PE-twine were used on all of the vessels and the selectivity of each then measured using covered codends. All skippers were asked to operate according to their normal fishing procedure. All vessels used their normal towing speed, which varied between 2.9 and 3.4 knots and towing warp length (variation 200–283 m).

The vessels ranged in size from 13.4 to 30.1 m and in power from 175 to 750 kW. One vessel was a side trawler (low power), one a ramp trawler (high power) and the remaining 5 stern trawlers. The influence of a number of covariates was assessed by applying a random effects analysis to several different models. The analyses included both covariates at haul-level as well as at vessel level. This analysis showed that, when the vessel size was the only parameter in the variance model, no such effect was found but a significant effect on SR was observed. Larger vessels had a wider SR. This result may very well be a consequence of the relatively calm weather during the experiment. When all the significant covariates were left in the model, a positive effect was found also on L50. Opposite to the expected results, larger vessels showed higher selectivity than small trawlers (See Figure 3).

Tschernij and Holst, (1999) also found that the interaction between vessel propulsion power and total gear drag (VGI) was also found to have a significant effect on selectivity but in a variance model together with vessel size. L50 was found to increase with increasing VGI values whereas SR was decreasing. This difference was not unexpected. They concluded that a higher VGI value means less tension in the mesh bars and consequently a larger mesh opening.

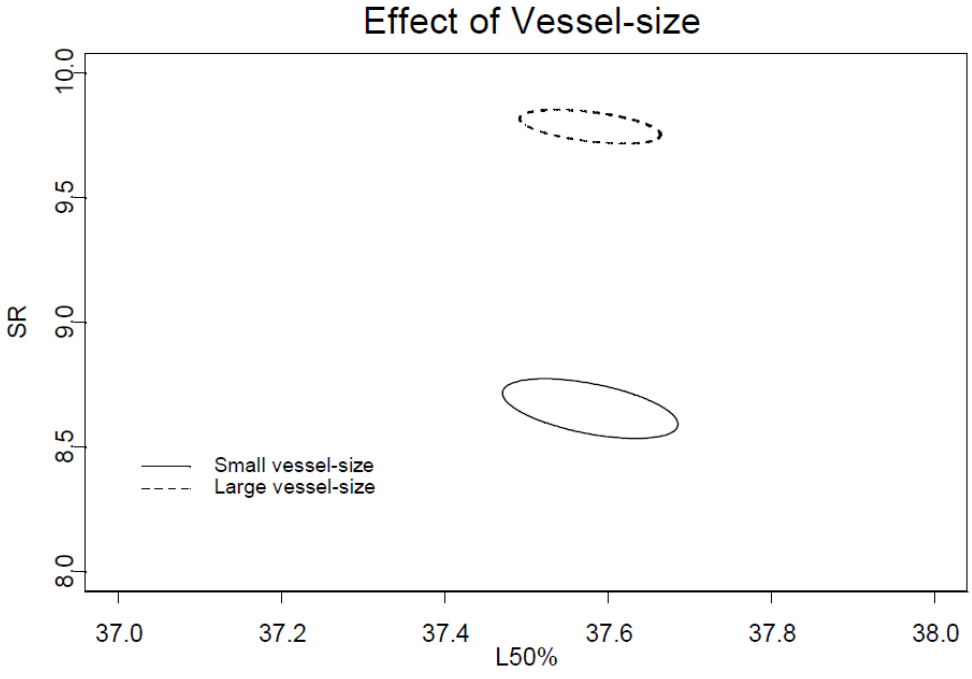

Figure 3. The confidence regions from the vessel-size model when vessel size is the only potential parameter. All other sources of variation are removed from the plot.

Table 3. Summary table of studies carried out that have investigated the relationship between horsepower and selectivity.

Country	Area	Date	test Gears	Vessel Length/HP	Target Species/Fishery	Method	Reference
Ireland	Celtic Sea (VIIf,g)	July–August 2010	80mm x 4mm; 80mm x 4mm + 120mm smp; 90mm x 4mm; 90mm x 4mm +120mm smp; 100mm x 6mm; 100mm x 6mm +120mm smp; 110mm x 6mm; 120mm x 4mm	11m/150hp 14m/413hp	Mixed demersal	Twin-trawl (selectivity analysis)	McDonald *et al*., 2011
UK (Scotland)	West of Mallaig (VIa)	2009	80mm x 4mm + 200mm smp; 100mm x 5mm + 200m smp	17m/177kw 18m/375kw	Nephrops	Catch comparison	D. J. Bova, J. Drewery, R. J. Fryer, R. S. T. Ferro, 2009
UK (Scotland)	North Sea (IVa)	April 2008 August 2008	80mm x 4mm + 110mm smp; 80mm x 4mm + 120m smp	500kw 298 kw	Nephrops	Catch comparison	R. J. Kynoch, R. S. T. Ferro, and R. J. Fryer, 2009
UK (England)	Farn Deeps (IVa)	Spring 2004	80mm with 20mm liner	17m/169 kw 8.6m/119 kw	Nephrops	Parallel hauls	Cotter, J., Elson, J. Lovewell, S., Lawler, A., Boon, T. 2004
Sweden	Baltic Sea	August 1998	120mm x 4mm	14m/175kw 14m/202kw 18m/420kw 22m/463kw 24m/670kw 25m/496kw 30m/750kw	Cod	Covered codend	Tschernij and Holst, 1999
US	Georges Bank	2003–2006	Topless and Ribas Trawls	15.2m 18.3m 27m/653kw	Cod and Atlantic Flounder	Twin-trawl; Alternate Hauls	Choisid *et al*. 2008;

16.5 Gear, Environmental and Operational Parameters

The Topic Group also considered the mechanisms by which the size or power of a vessel may affect the selectivity of the gear it fish and identified the following:

- Size and Design of Fishing Gear;
- Sea State;
- Light Levels;
- Towing Speed;
- Catch Size;
- Codend design;
- Fishing Operations.

16.5.1 Size and Design of Fishing Gear

The correct performance of the trawl gear depends on its design and rigging (Sala and Lucchetti, 2010; 2011), and on the speed the gear is towed through the water (Sala *et al*., 2007). In practice, however, existing trawl gears are often not fully matched to the propulsion power of the vessel that is towing them. Kynoch and Penny (2006) suggest that some lower-powered vessels in the Scottish whitefish fleet fish as large a net as possible using more of their available power but with less in reserve. These vessels are weather limited and have a limited range, fishing relatively close to their home port so that their optimum strategy is to fish a larger net and tow harder all the time. The reverse is the case for larger powered vessels where with a wider range of fishing opportunities available, a size of net is used which leaves a reserve of engine power allowing it to fish in deeper water and during poorer weather.

16.5.2 Sea State

Larger vessels will be able to fish in more exposed waters and in poorer conditions. There are several studies including Polet and Redant (1994) and O'Neill *et al*. (2003) that have looked at the effect of sea state on selectivity. The first study showed changes in sea state caused 20% deviations from the mean L50 (L50 increased with sea state). The second study established that the pulsing of the codend is a response to sea state induced vessel motion and established a direct link between sea state induced vessel motion and codend selection. Neither of these studies, however, showed that this effect is proportionally any greater for smaller vessels.

16.5.3 Light Levels

In many fisheries smaller boats only fish on a daily basis or at particular times during the day while larger vessels may fish for prolonged periods of time. Many authors have found that factors such as light levels and diel cycles can significantly affect the catchability of fishing gears (Engås and Soldal, 1992; Michalsen *et al*., 1996; Sangster and Breen, 1998) and hence, depending on the timing of fishing operation may influence the selectivity of smaller and larger boats differently.

16.5.4 Towing Speed

In general, the higher the engine power of a vessel the faster it can tow and the easier it can maintain its optimal towing speed. Changes in towing speed of a trawl will affect the hydrodynamic forces acting on the netting and thus change the net tension, mesh opening, gear geometry and possibly the water flow pattern. Two of the datasets analysed in the study by Dahm *et al*. (2002) revealed a significant relationship

between tow speed and selectivity, but with contradictory results for different species, with increasing towing speed decreasing the L50 of haddock, while increasing the L50 of cod. A more recent study, predominantly focusing on haddock, found a positive relationship with increasing towing speed resulting in increased L50 (Jones *et al*., 2008). Observations made in this study found an increase in the number of fish making contact with the net at increased tow speeds, which may explain the increased number of escapes associated with higher levels of selectivity

Sala *et al*. (2007) reported for some species a significant decrease in L50 with increased speed. Overall, empirical evidence to support the hypothesis that tow speed does have an effect on size selectivity has been inconsistent. However, it has been stated that towing speed should not be seen as an insignificant factor in selectivity, despite lack of conclusive results (Wileman *et al*., 1996).

16.5.5 Catch Size

Larger gears will fish a larger swept-area and have larger catches. Several studies have found a relationship between catch weight and selectivity. O'Neill and Kynoch (1996), Campos *et al*. (2003), Herrmann (2005a; 2005b) find that the 50% retention length increases as codend catch size increases whereas several other studies have shown the opposite effect (Suuronen *et al*., 1991; Erikson *et al*., 1996; Madsen *et al*., 1998). Studies with smaller catch sizes (for the studies mentioned above, below 500 kg) tend to show an increase in 50% retention length with increasing catch size, while studies with larger overall catch sizes tend to find a decreasing effect of catch size on selectivity. O'Neill and Kynoch (1996) suggest that the trend of increasing selectivity with increasing catch size is likely to reach an upper bound, where the selectivity plateaus or decreases in response to further increases in catch size.

16.5.6 Codend design

Parameters such as numbers of meshes around, twine thickness, and netting material can differ between smaller and larger vessels. In particular, in areas where these parameters are not specified in regulations, e.g. in Icelandic and Norwegian waters, larger vessels will use heavier materials, thicker twine and codends whose diameters are limited by the width of the stern ramps.

16.5.7 Fishing Operations

The study by Tschernij and Holst (1999) considered hauling technology effects for side trawlers making a full stop during hauling (usually by low power vessels); vessels hauling over the stern partially stopped during hauling (low to medium horsepower) or up a stern ramp hauling without any interruption (large, high horsepower). The results from this work showed that L50 differed between hauling operations with the lowest selectivity (smallest L50 and largest SR) recorded from the vessel hauling with the stern ramp and the largest L50 and smallest SR recorded from the two side trawlers. The authors concluded from this study that hauling technology had a significant effect on selectivity; however, they pointed out that even though hauling technology is connected with a certain type or size of vessel, it will ultimately be more dependent on the gear handling procedure: that is, even smaller vessels can potentially modify their hauling procedure to maintain higher mesh tension during haul-back, which reduces selectivity. This conclusion may not be applicable to side trawlers but this method is rarely used nowadays.

An interesting question not addressed in their study is whether it is better to have a lower L50 and little haulback/surface selection or higher L50 and perhaps increased

escape mortality i.e. is it better to improve selectivity when towing or during haul-back to maximize survival of escaping fish. The study by Tschernij and Holst (1999) indicated a substantial post-towing escape process during haul-back. It is noteworthy to point out that the survival of these escapees is poorly understood apart from a few isolated studies by Madsen *et al*. (2008) and Grimaldo *et al*. (2009). Apparently the survival depends on the time the escapement takes place. If the gear is still on the seabed the survival probability can be assumed similar to that during towing. However, if a major part of the catch does not escape until the gear is on or close to the surface, the physiological damages of a rapid and large change in water pressure can be lethal. Therefore if low powered vessels have higher selectivity as a result of escapement during haul-back, this observation implies their higher L50 is not necessarily desirable.

16.6 Gear regulations for low-horsepowered vessels

16.6.1 Current definitions

In considering whether different regulations should apply for smaller powered vessels on the basis of differences in selectivity, it is first important to define what is meant by "small" vessels. This definition is not a particularly easy task. For example small vessels are captured under the heading Small Scale Coastal Fisheries (SSCF) by the EU but not universally defined. Currently arbitrary cut-offs of 10 metres, 12 metres or 15 m in length depending on the regulation is used but the basis for any of these is unclear.

An analysis carried out by Ifremer (2007) showed the mean fishing vessel length in the EU fleet and Norway was 9.4 m and the nominal engine power 82.7 kW. With the exception of the Netherlands and Belgium, the mean vessel length was between 7 and 12 m in all Member States and also for Norway. The report concluded that a technical limit of 10 metres long appears as a restrictive boundary for the definition of a European small-scale vessel. A limit of 12 meters seems to be more relevant or could be extended to 15 meters insofar as the majority of the under 15 m vessels are operating inshore. The study went on to conclude that a useful and operational definition of SSCF must include at least vessel size, gear polyvalence, degree to which gear is active or passive and the level of dependence on national territorial waters.

In the EU technical measures regulations 850/1998 specific measures are defined on the basis of power. For instance the length of square mesh panels is defined for vessels < 112 kW (2 m) and vessels greater than 112 kW (3m). This distinction takes into account differences in the sizes of gears used and the difficulties of installing square mesh panels into small trawls. Additionally in the Plaice Box in the North Sea there is a general prohibition of vessels greater than eight metres from fishing in this area except for listed vessels with a horsepower of 221 kW and not exceeding 24 metres. Similarly there is a general prohibition for fishing within 12 miles of the coasts of the UK and Ireland with beam trawls > 221 kW. In Annex III(6) of Regulation 43/2009 different mesh sizes of codends and square mesh panels are applied to vessels < 15m and over 15 m, with the smaller vessels allowed to use a smaller mesh size and square mesh panel.

16.7 Discard data

16.7.1 Swedish discard data

Two datasets are presented; the first set is the Baltic Sea cod fishery between 1996 and 2008, and the second on Nephrops fishery in Kattegat and Skagerrak between 2002 and 2010. Both datasets are from the Swedish discard data collecting program and discard rates is calculated as discard / (landing + discard), for each target species.

16.7.2 Swedish Baltic Cod Dataset

Vessel size varies between 10 and 35 m, horsepower between 110 and 846 kW. Data are collected in ICES Subdivisions 24 to 28. Landing size below 200 kg per haul is excluded from the plot. No pattern or clear effect could be observed by simple linear regression analysis. Mean discard rate was 9% (Figure 4).

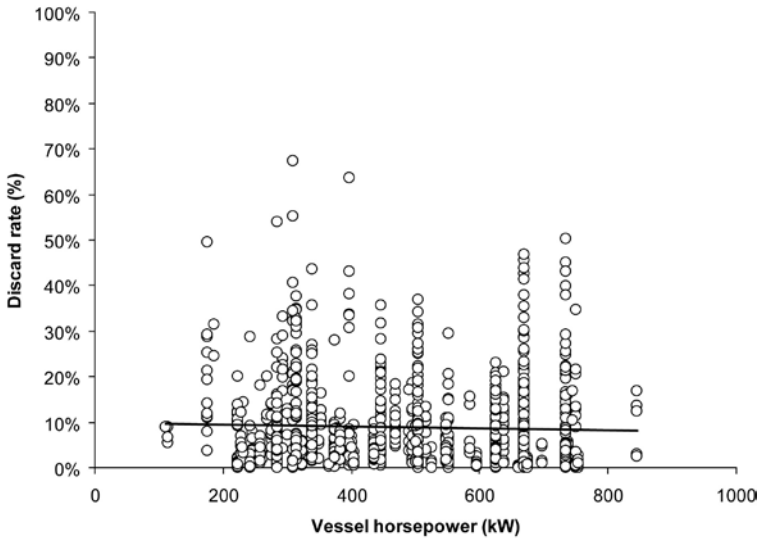

Figure 4. Vessel power plotted against discard rate (n=1086).

16.7.3 Swedish Nephrops dataset

Vessel size varies between 10.4 and 34.1 m, horsepower between 66 and 647 kW. Data are collected in Skagerrak and Kattegat. Landing size below 25 kg per haul is excluded from the plot, since we concluded that Nephrops was not the target species. Data are divided between mesh sizes of 70 and 90 mm and all other mesh sizes are excluded in the analysis (Figure 5). No pattern or clear effect could be observed by simple linear regression analysis in relation to vessel horsepower. However, discard rates were significantly higher (d.f., 1, 532, $p<0.001$) with 70 mm mesh size (mean: 49%) compared to 90 mm mesh size (mean: 41%).

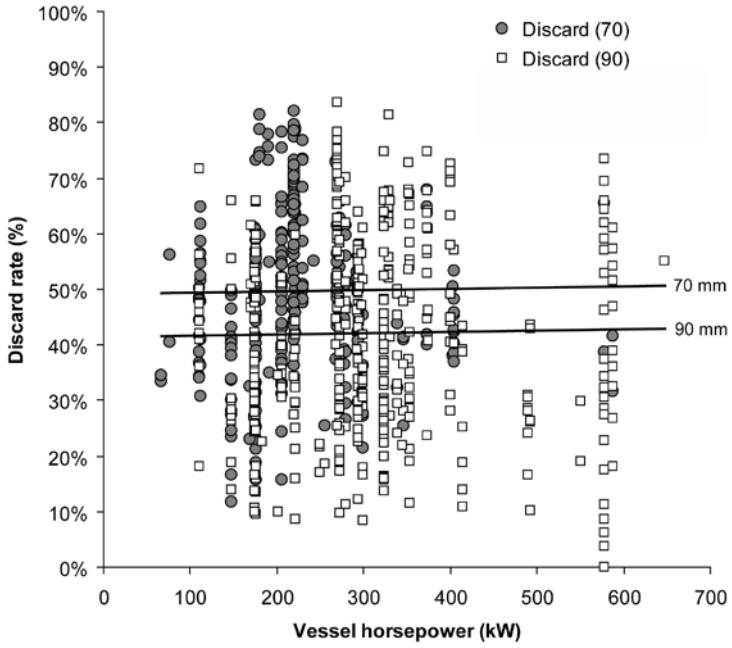

Figure **5. Vessel power plotted against discard rate (70 mm, n=267, 90 mm, n=448).**

English Discard Data

Differences in trawl selectivity between large and small vessels using data from the Cefas Discard Observer Programme

A recent analysis of the data from the Cefas Discard Observer Programme was used to look for any substantial differences in the catch length frequencies between small and large vessels (Catchpole, pers. comm.). Since 2002 the Cefas observer programme has taken length measurements of discarded and landed fish on board English fishing vessels during commercial fishing trips. Length data were raised to métier by effort (métiers were defined by fishing gear type, fishing ground and vessel length – 10 m and over and under 10 m). The median and mean lengths of fish were compared between under 10 m and over 10 m vessels that had used the same gear type and operated in the same fishing areas (ICES IV and VIId, ICES VIIe, ICES VIIa and ICES VIIfgh).

There was considered to be adequate data for a comparison for three species (plaice, whiting and haddock) in two areas (IV and VIId and VIIa) caught by vessels using two gear types (otter trawlers and *Nephrops* trawlers). The data indicated that the size of haddock, whiting and plaice did not differ between smaller and larger vessels. The analysis did not account for codend mesh size differences in the sampled trips. However, *Nephrops* trawlers almost exclusively use 80 mm mesh codends. The level of coverage for the Cefas Discard Observer Programme is less than 1% of the total effort exerted by English vessels. This approach would likely have only identified substantial differences in selectivity between small and large vessels.

16.8 Conclusions

- There is no evidence that there any differences in selectivity of larger/smaller and higher/lower powered vessels from the catch comparison, selectivity and discard data reviewed. However, it was concluded that to prove this lack of difference definitively would require further analysis

and ultimately a series of dedicated trials on vessels with a range of powers and in controlled conditions.

- A number of parameters were identified that may be influenced by the size or power of a fishing vessel, and lead to differences in the selectivity of larger/smaller and higher/lower powered vessels. These were: Size and Design of Fishing Gear; Sea State; Light Levels; Towing Speed; Catch Size; Codend design; and Fishing Operations.

16.9 References

Bova, D. J., Drewery, J., Fryer, R. J., Ferro, R. S. T. 2009. Effect of vessel horsepower on the selectivity of Nephrops trawls. Scottish Industry / Science Partnership (SISP) Report No 03/09, 20 pp.

Campos, A., Fonseca, P., Henriques, V. 2003. Size selectivity for four fish species of the deep groundfish assemblage off the Portuguese southwest coast: evidence of mesh size, mesh configuration and cod end catch effects, Fisheries Research, 63: 213–233.

Chosid, D., Pol, M.V., Szymanski, M., Ribas, L.R., Moth-Poulsen, T. 2008. Further Testing of Cod-Avoiding Trawl Net Designs. NOAA/NMFS Saltonstall-Kennedy Program Completion Report, 86 pp.

Cotter, J., Elson, J., Lovewell, S., Lawler, A., Boon, T. 2004. Report on catches of Nephrops, cod, and other species on the Farn Deeps ground by FV Luc and FV Still Waters in spring. Fisheries Management Group Cefas, Lowestoft 7 June 2004, 29 pp.

Dahm, E., Wienbeck, H., West, C. W., Valdemarsen, J. W., O'Neill, F. G. 2002. On the influence of towing speed and gear size on the selective properties of bottom trawls, Fisheries Research, 55: 103–119.

Engås, A., Soldal, V. 1992. Diurnal variations in bottom trawl catch rates of cod and haddock and their influence on abundance indices. ICES J. Mar. Sci., 49: 89–95.

Erickson, D. L., Perez-Comas, J. A., Pikitch, E. K., Wallace, J. R. 1996. Effects of catch size and codend type on the escapement of walleye Pollock (*Theragra chalcogramma*) from pelagic trawls, Fisheries Research, 28: 179–196.

Grimaldo, E., Larsen, R. B., Sistiaga, M., Madsen, N., Breen, M. 2009. Selectivity and escape percentages during three phases of the towing process for codends fitted with different selection systems. Fisheries Research, 95, 198–205.

Herrmann, B. 2005a. Effect of catch size and shape on the selectivity of diamond mesh codends I. Model development, Fisheries Research, 71: 1–13.

Herrmann, B. 2005b. Effect of catch size and shape on the selectivity of diamond mesh codends II. Theoretical study of haddock selection, Fisheries Research 71: 15–26.

Ifremer (coord.) 2007. Small-Scale Coastal Fisheries in Europe, Final report of the Contract No FISH/2005/10, 447 p.

Jones, E. G., Summerbell, K., O'Neill, F. 2008. The influence of towing speed and fish density on the behaviour of haddock in a trawl cod-end, Fisheries Research, 94: 166–174.

Kynoch, R. J. 2005. Engineering Performance Of Gears Used By The Scottish Fleet Targeting Nephrops in ICES Sub-Area IV. May 2005. Fisheries Research Services Internal Report No 06/05. 16pp.

Kynoch, R. J., Penny, I. 2006. Engineering Performance Of Gears Used By The Scottish Fleet Targeting Whitefish Species In ICES Sub-Area IV. August 2006. Fisheries Research Services Internal Report No 22/06. 21pp.

Kynoch, R. J., Ferro, R. S. T., Fryer, R. J. 2009. The effects of square mesh panel mesh size and position on the selectivity of high and low powered Nephrops trawlers. Scottish Industry / Science Partnership (SISP) Report No 04/09, 22 pp.

Madsen, N., Moth-Poulsen, T. M., Lowry, N. 1998. Selectivity experiments with window codends fished in the Baltic Sea cod (*Gadus morhua*) fishery, Fisheries Research, 36: 1–14.

Madsen, N., Skeide, R., Breen, M., Krag, L.,A., Huse, I., Soldal, A. V. 2008. Selectivity in trawl codend during haul-back operation – an overlooked phenomenon. Fisheries Research, 91, 168–174.

McDonald, D., Rihan, D.J., Browne, D., Tan, H., Mulligan, M. 2010. Effect of Vessel Horse-power on the Selectivity of Demersal Trawls, BIM internal report.

Michalsen, K., Godø, O., Fernö, A. 1996. Diel variation in the catchability of gadoids and its influence on the reliability of abundance indices. ICES J. Mar. Sci., 53: 389–395.

O'Neill, F. G., Kynoch, R. J. 1996. The effect of cover mesh size and cod-end catch size on cod-end selectivity, Fisheries Research 28: 291–303.

O'Neill, F. G., McKay, S., Ward, J. N., Strickland, A., Kynoch R. J., and Zuur, A. 2003. An investigation of the relationship between sea state induced vessel motion and cod-end selection. Fisheries Research, 60: 107–130.

Pol, M. V., Carr, H. A., Ribas, L. R. 2003. Groundfish Trawl Nets Designed to Reduce the Catch of Atlantic cod *Gadus morhua*. Report Northeast Consortium, 142.

Polet, H., Redant, F. 1994. Selectivity experiments in the Belgian Norway lobster fishery. ICES CM 1994/B:39.

Rihan, D. J., McDonald, D., Browne, D., Muligan, M., Tan, H. 2009. Summary report of Gear Trials in Demersal Fisheries VIA, BIM internal report, pp 31.

Rihan, D. J., McDonald, D., Browne, D. 2008. Enhanced Data Collection Programme for the Rockall Fishery, BIM internal report, pp 17.

Sala, A., Lucchetti, A., Buglioni, G. 2007. The influence of twine thickness on the size selectivity of polyamide codends in a Mediterranean bottom trawl. Fisheries Research, 83: 192–203.

Sala, A., Lucchetti, A. 2011. The effect of mesh configuration and codend circumference on selectivity in the Mediterranean trawl Nephrops fishery. Fisheries Research, doi:10.1016/j.fishres.2011.04.012.

Sala, A., Lucchetti, A. 2010. The effect of mesh configuration and codend circumference on selectivity in the Mediterranean trawl Nephrops fishery. Fisheries Research, 103: 63–72.

Sangster, G. I., Breen, M. 1998. Gear performance and catch comparison trials between a single trawl and a twin rigged gear. Fish. Res., 36: 15–26.

Suuronen, P., Millar, R. B., Järvik, A. 1991. Selectivity of diamond and hexagonal mesh codends in pelagic herring trawls: evidence of a catch size effect, Finnish Fisheries Research, 12: 143–156.

Tschernij, V., Holst, R. 1999. Evidence of factors at vessel-level affecting codend selectivity in Baltic cod demersal trawl fishery. ICES CM 1999/R:02, 24 pp.

Wileman, D. A., Ferro, R. S. T., Fonteyne, R., Millar, R. B. 1996. Manual of methods of measuring the selectivity of towed fishing gears, ICES Cooperative Research Report No. 215.

17 ToR d): Innovation in Fishing Gear Technology

17.1 General overview

The topic group met on 11 and 12 May 2011 in Reykjavik, Iceland. A total of 10 presentations were given on various innovative developments. Fishing gear types varied from trawls to light attraction devices to static traps. Examples were given of developments that led to application and the motives for take-up by the industry. Cost reduction and improvement of fishing efficiency were often prime motives. In the discussion it was emphasized that innovations take time, facilitating helps (e.g. the Dutch FIP-projects), communication is important, and a sense of ownership and identification with the problem are needed.

The group recognized that there is a role for WGFTFB to remain involved in innovation in fishing gears, to act as a contact forum, facilitate learning from each other, to enable setting up international (EU)-projects, to study fish behaviour inside gear, to continue work on seabed impact, selectivity, survival, energy consumption and greenhouse gas (GHG) emissions. It is recommended to further develop and improve methods for assessing ecosystem impact of new technology in close cooperation with other disciplines within ICES, to participate in guiding fisheries in reaching maximum sustainable yield (MSY), and to play a role in education in fisheries. It was expressed that this Topic Group should be continued next year.

17.2 Summary of major findings

Innovations are needed in the fishing industry to cope with rising energy costs, the emerging demand for lower greenhouse gas emissions, and requirements deriving from the move to the ecosystem approach to fisheries management (such as reducing bycatch and seabed impact). More responsibility is being placed on industry to ensure they remain ahead of technology to cope with the changing world, and there are many examples of many initiatives being taken by fishers and equipment manufacturers. The trend is more and more to directly finance the industry in such endeavours, e.g. from the European Fisheries Fund (EFF), with the risk of a limited input from the scientific community.

Tools are being developed to forecast ecosystem effects from introducing gear modifications and/or gear replacements in fishing fleets, e.g. the MAFCONS model on the effect on benthic communities in the North Sea (EU Project DEGREE). There is a role for a practical approach, but also a need for scientific input in the process to avoid these developments leading to increasing fishing effort (technology creep) and pressure on already overexploited stocks and other possible adverse ecosystem effects. This will be limited to modifications to otter and beam trawls, gear replacement (e.g. alternative gears) aimed at reducing energy consumption, bycatch and/or seabed impact.

17.3 Terms of Reference

A WGFTFB topic group of experts formed in 2010 met in Reykjavik in 2011 to continue to address the issue of innovation in fishing gear technology and the success of collaboration between fishers and scientists with the following terms of reference:

1) Review current technological developments and initiatives in gear technology and give examples of successful developments both in the EU and in other countries globally.

2) Discuss the contributions of fishers and scientists in the process of collaboration and identify conditions allowing rapid uptake of new technology, without the risk of introducing new adverse ecosystem effects.

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17.5 Opening of the meeting

Bob van Marlen opened the meeting. Participants briefly introduced themselves. Hans Polet volunteered to act as rapporteur.

17.6 Adoption of the agenda

The agenda was adopted without change.

17.7 Individual presentations

Innovative projects from a number of participants were described to illustrate the nature of research completed or ongoing.

17.7.1 Fishing Gear Innovation - Why and How? (Bob van Marlen, IMARES)

Innovation has always been part of the research agenda in Europe, in the late 1970s aimed at improving catch and mechanical efficiency of fishing, in later decades aimed at reducing unwanted bycatches and seabed impact. Examples of national and multidisciplinary EU-projects are given with major outcomes. A recent development is to

finance innovative projects initiated by the fishing industry directly through the European Fisheries Fund (EFF). This financing has led to higher motivation in the industry and some new remarkable fishing gears being used to a growing extent. Lessons learned are reviewed.

Conclusions are:

- Saving energy coincides well with reducing seabed impact and bycatches, as gear components are designed with less bottom contact and releasing unwanted bycatches avoids the need to drag these inside the net and bring these aboard. Substantial energy savings can be obtained with gear modifications.
- Success of introducing new selective, low impact and fuel efficient gears depends very much on strong (economic) incentives for fishers to use them (Table 4). Examples are sharp rises in fuel prices, threats of closing areas when selective gears are not used, enforcement by law, and fish products losing markets if not caught in a sustainable manner.
- The scientific community, having specific knowledge of fish behaviour, and not being restricted by the need to earn from catches, proved to be able to develop prototype fishing gears that can play a role in diminishing adverse ecosystem effects and produce better economy, but getting these applied was often difficult.
- It helps when fishers identify themselves with potential solutions, instead of being told what is good for them, and involving them more directly in identifying research needs leads to higher motivation and acceptability.
- Fishers' views and attitudes are changing as the world around them is changing, but they must be enabled to earn their living at sea.
- Best results may be obtained if scientists and fishers are working closely together to avoid the development of unsustainable ecosystem unfriendly technologies and practices. Cooperation between fishers and scientists needs to be stimulated, with emphasis on open-minded attitudes on both sides.

Table 4. Summary of motives and level of uptake.

Modification	*Gear*	*Motive(s)*	*Level of use*
LM	*OTM*	*Fuel costs ↓, catch ↑*	++++
Sieve net	*TBB*	*By-catch ↓, obliged*	++++
Sorting grid	*OTB*	*By-catch ↓, obliged*	++++
SMP, SMW	*OTB*	*By-catch ↓, obliged*	+++
SumWing	*TBB*	*Fuel costs ↓, impact ↓*	++
LM & SMW	*TBB*	*By-catch ↓*	++
Pulse Trawl	*TBB*	*By-catch ↓, fuel costs ↓*	++
Outrig	*TBB*	*Fuel costs ↓*	+
SP, ISP	*OTB*	*By-catch ↓*	+
HydroRig	*TBB*	*By-catch ↓, fuel costs ↓*	-
LMTP	*TBB*	*By-catch ↓*	-
Plate gear	*OTB*	*Impact ↓*	-

Discussion

Creating the right incentive is essential to the uptake of technological innovation. The main driver for fishers to accept e.g. the Nordmøre grid in Norway was that fishers

got access to certain fishing grounds that would be closed to vessels not using the grid. In France, the threat to have a discard ban helps innovation even if most fishers do not really believe a discard ban will be implemented. In the UK quota management is being used to stimulate innovation for reducing discards. WGFTFB can play a role in providing the technology and in evaluating the effects of technical alterations to gears on the marine ecosystem. It is important that innovation is evaluated in conjunction with developments so that the industry does not start investing in technology that thereafter may be found not to be acceptable because of undesired side effects.

Incentives can come from the legislator but the main driver often is economy. There is a lot of change going on e.g. in the Netherlands which is mainly driven by the market and by the drive to reduce exploitation cost. In innovation it is also important to foster leading innovators in the industry who demonstrate that innovations work. If successful, the rest will follow. The problem sometimes is that innovation goes more quickly than legislation. The industry can react much quicker compared to processes driven by government. Early success is important. Often one sees that when problems occur, the process stops. Science and management should play a stimulating role and keep the innovation process going. There is a new trend that, e.g. in the EFF, fishers themselves apply for projects and not the scientists. Science is there to guide, not to take the initiative. This approach also seems to stimulate ownership with stakeholders, and the uptake of new technologies.

Fishers also are invited to participate in stock assessment and this has advantages in the acceptance by the industry of management measures. Good communication between industry, management and science is important.

There is a general decline in gear technology research departments in many countries. The value of our work might not be sufficiently recognized. There is a network of gear technologists that can deliver valuable inputs to innovation, but there is a risk this is disappearing. The negative attitude by the industry towards some management measures sometimes hampers cooperation and trust between industry and science. Despite this, there seems to be a trend that the industry is becoming more and more interested in the work of gear technologists. A good and constant communication and building trust is important to improve cooperation. It has to be stressed that it is not only vessel owners or leaders of fishers' organizations that need to be addressed, but also skippers and fishers who are still actively fishing.

17.7.2 Energy saving effect of LED fishing lamps for angling and jigging boats (Heui Chun An, National Fisheries Research & Development Institute, Rep. of Korea)

This research aimed to develop a highly efficient LED fishing lamp for the squid jigging and hair tail angling fishery to reduce fuel consumption and greenhouse gas emissions. Korean commercial fishing boats use a conventional metal halide lamp, which consumes fuel accounting for 65% of the total fuel consumption by the fishing boats. In this study, two kinds of LED lamps were used to investigate catch efficiency and fuel consumption. Type A was 150W LED lamp unit with air-cooled system installed on a 9.77-tonne hair tail angling boat. Type B was a 150W LED lamp unit with an air-cooled system installed on a 9.77-tonne squid jigging boat. Catch efficiency and fuel consumption of vessels equipped with LED lamps were compared with those with metal halide lamps during fishing season of 2009 to 2010. Catch efficiency of vessels with the LED lamps was equal to or marginally higher than those with metal

halide lamps. As for fuel consumption, LED lamps were shown to save 60% of energy use of metal halide lamp in hair tail angling and 33% in squid jigging.

Discussion

The question was raised whether the LED lights had been tested underwater. Yes, in purse-seines, but the tests are ongoing and there are no results to report yet. The remark was made that data on CO2 and other greenhouse gas (GHG) emissions can be calculated from fuel consumption and can be given as CO2 emission. This calculation could provide interesting extra information.

17.7.3 Advances in the Nephrops Fishery in the Bay of Biscay: Innovations, difficulties and solutions for implementation (Pascal Larnaud, Ifremer, France)

After having summed-up the 'selectivity story' of the Nephrops fishery in the Bay of Biscay, this presentation describes the latest experimentations carried out in partnership with the industry, both on selective devices in trawls and on Nephrops traps. The difficulties encountered for their implementation are discussed and ongoing or proposed solutions are presented.

Discussion

The remark was made that in the ultimate design, four different selective devices are combined. Can you discriminate what the effect is of the separate devices? No, due to high cost of sea time, the devices were not tested separately. There have been previous experiments with designs similar to the separate devices but these tests were not set up with this purpose. In these tests, the position of the grid can improve the efficiency of the square mesh cylinder and top panel (for fish escapement) as well as the efficiency of the bottom square mesh panel (for Nephrops escapement).

The only missing device in this trawl design seems to be the T90. The opinion was expressed that this would be an interesting addition. The idea is that if one device fails, the other will take over, so T90 would be an interesting addition. The author mentions that the square mesh cylinder could be replaced by T90, because square meshes deform to rectangular meshes after a few months of use. T90 may not have this problem.

Is the escapement through the square mesh panel an active escape? The example is given that flatfish may escape through a top square mesh panel and in this case it is unlikely that this is active escape. The author, however, stresses that the escapement in this case is active and it was observed for hake, mackerel or horse mackerel

It was asked whether there is any information on cod, but this experiment was designed for Nephrops and no information is available for cod. There are data for hake but the results are very variable, mainly determined by the liveliness of the fish and depending on the season. The author mentions that the behaviour of cod does not give a good perspective because it stays close to the lower part of the trawl as is the case for the target species. The results have been controlled with underwater observation. Good results were obtained for small whiting in the North Sea using a combination of square mesh panel and grid. The survival of the Nephrops has been tested in survival experiments where containers with Nephrops were put on the seabed, i.e. in their natural habitat. In the Netherlands similar tests will be carried out on discarded flatfish.

A problem is mentioned in the English Nephrops fishery with discarding of flatfish. In the French experiment not much information is available for flatfish. There is some

information for sole but this species does not pose a problem, as they seem able to escape through square meshes.

17.7.4 Selection efficiency of rigid encircling grids in a herring pontoon trap and the mortality of size-selected herrings (Mikael Lundin, Swedish Board of Fisheries/Swedish University of Agricultural Science, Sweden)

High bycatches of undersized fish constitute a major problem in the Baltic Sea herring trap fishery. In an attempt to reduce the bycatch, this field study evaluates the efficiency of rigid encircling selection grids in a herring pontoon trap. The results from the present study demonstrate that 54–72% of the undersized herring were selected from the catch and swam out in the sea. Consequently, this study indicates that selection of small undersized herring in a pontoon trap may be a significant step towards a more efficient and sustainable herring fishery in the Baltic Sea.

However, it is unknown whether size-selected herring survive after swimming out from the pontoon trap and into the sea. Therefore, a study on the survival of grid-selected herring was performed. Grid selected herring were collected and stored in a closed space for seven days and the same procedure was done with control herring that had not passed any grid. A total of three replicates for each group were made. The results from this study clearly demonstrate that a passage through a selection grid did not affect the immediate mortality of herring. Ironically, the highest mortality of herring was in one of the control replicates. However, by using local temperatures at the grids (using a current and temperature meter) it was shown that the greater mortality in this particular control replicate was due to a temperature drop in the sea during these days.

Discussion

No questions.

17.7.5 T90 trawl gear for Baltic cod fishing - construction and results of pilot sea trials (Waldemar Moderhak, Sea Fisheries Institute in Gdynia, Poland)

In the early 1990s a new netting material (T90) with very good selective and protective properties was developed at the Sea Fisheries Institute (SFI/MIR) in Gdynia. First the T90 idea has been used to construct highly selective cod-ends and then trawl belly sections. Since about year 2005 the T90 technology has been used for design and construct of trawls made entirely of turned 90° meshes.

Two years ago at the SFI/MIR a complete T90 bottom trawl for fishing Baltic cod was designed based on computer calculation of a T90 meshes shape. In year 2010 a trawl gear was made and investigated from research and commercial vessels. The results obtained are very promising regarding cod protection and gear drag.

Discussion

Do you have a technique to determine the stiffness of the twine? There is a technique that was developed by the Italian fisheries institute of Ancona (Antonello Sala, CNR-ISMAR, Italy).

The question was raised if diamond mesh and T90 has been used simultaneously in one cod-end. No, separate trials have been done, but not in the same codend.

Has legislation been made to replace the Bacoma codend by T90? In the past there was resistance against Bacoma but nowadays, there is resistance against T90. However, the opinions are changing in favour of T90.

In the UK, T90 sections have been used in trawls. The netting seems, however, not to be stable over time when finer twines are used - the meshes do not stay open well. Was this effect seen in your experiments as well? The author states that in the beginning of use, the netting used will change its shape a little, but will then stay stable over time, at least in the Baltic. Twine thickness is however the most important factor.

The exact number of vessels using T90 is not known. In Germany, Poland and Sweden it is used to some extent.

The good results with T90 are largely attributable to the reduction in the number of meshes around in the codend, which is a typical feature of T90 codends.

It seems that every second bar is different in length. This may be because of the shape and turning of the knots. Have you measured this difference in length? In diamond mesh all bars are equal. The author states that different bar lengths are not desirable.

17.7.6 Improving Snow Crab Traps in Eastern Canada (Paul Winger, Scott Grant, Philip Walsh, and Georgina Bishop, Marine Institute, Canada)

Following the collapse of groundfish resources in the early 1990s, the fishery in Newfoundland and Labrador rapidly diversified and became a major producer of shellfish products. Snow crab (*Chionoecetes opilio*) in particular has grown steadily and in 2008 employed over 2100 active fishing enterprises harvesting 52,774 tonnes with a landed value worth $179.6 million CAD. This presentation provides an overview of several projects recently conducted to improve trap design toward the goal of improving trap life, increase catch rates, reduce bycatch, and disable the trap in the event it is accidently lost at-sea to minimize ghost-fishing. Specific topics will include behavioural observations under laboratory/at-sea conditions, material choice, mesh size, escape mechanisms, plastic barriers, biodegradable twine, and bait choice.

Discussion

Japanese research has been done on escapement of undersized crabs from traps. The idea was based on an escape outlet made of two horizontal parallel bars. The round shape was chosen for the Canadian study because this was the shape used in the king crab fishery and because it is easy to manufacture.

A comment was made on ghost-fishing of these traps, which might be persistent. By making parts of the trap of biodegradable twine or sewing the escape vents in with such material, one can avoid that they will remain fishing.

The snow crab traps seem to have this typical conical shape with top entrance. They are also stackable to save deck space. In the Bering Sea, rectangular shapes are used. The position of the bait is important because the plume of odour should not be too low, not too far away from the inlet. The shape seems to be the better choice, based on fishers' experience. Variation, however, exists. The bait is typically herring, capelin and squid. Squid is the best bait for snow crab. A lot of tests have been done but whole squid (not parts) or a combination of herring and squid seem to work well.

17.7.7 New Centre for Research (CRISP) - based Innovation in Sustainable fish Capture and Processing technology (John Willy Valdemarsen, IMR, Norway)

The Centre for Research-based Innovation in Sustainable fish capture and Preprocessing technology (CRISP) is an initiative to develop smarter technologies to meet future challenges for a sustainable and economically viable fishing industry. CRISP is a partnership between research institutions and the industry with a pending applica-

tion to the Research Council of Norway to become a Center for Research-based Innovation.

The Centre is set up in partnership with the research institute Nofima and the companies Scantrol AS, Kongsberg Maritime AS, Egersund Group AS, The Norwegian-Fishermen's Sales organization for pelagic fish, The Norwegian Fishermen's Sales Organization, Nofima Marin, and Nergård Havfiske AS. The budget is 1.3 M€/year.

Discussion

The comment is made that the industry finances 25% and science 50% of the budget. Where does the other 25% come from? The rest is provided by sales organizations and other research institutes.

CRISP focuses on new technology, e.g. gear related. Why are you not focusing on the fishing vessel? Issues such as energy efficiency become more important. The author states that, first of all, there is a limit in funding, not all issues can be covered. Secondly, the industry determines the research agenda and "the fishing vessel" was not included as a topic. Also in terms of gear type, the budget only allows research on a limited number of gear types.

The author mentions that international collaboration forms an integral part of the project. In the next phase this cooperation will be formalized.

Does the budget include the cost for wages of people? Yes, the scientists working for the project in the research institute are financed, based on actual time spent on the project.

The comment is made that this is an excellent initiative. It will help to spread a more realistic view on trawling. One problem that may be coming is a discard ban. Fishing vessels are not built to store the large catch volumes including what would be discarded.

Is there a link with the European Fisheries Technology Platform? No, no formal links with the EFTP exist. It is not clear in WGFTFB what this platform is planning and our WG should play a role. There is a website with a list of activities.

Can you expand on the species identification? The problem is mentioned with purse seining for tuna species discrimination. Often species are caught that cannot be kept on-board. CRISP indeed has the intention to develop sonars for this purpose, but more details cannot be given. It will be based on a level of precision to differentiate.

17.7.8 Hydrodynamics studies dedicated to fishing gears (Benoit Vincent, Ifremer, France)

HYDROPECHE (hydrodynamics dedicated to fishing gears) is an ongoing national project coordinated by Ifremer. It is a cluster of 4 PhDs, some experimental, some theoretical. It includes universities whose fields are fluid dynamics and mathematics. All aim at improving the knowledge of water flow around netting structures in order to optimize their design, or to better understand their behaviour. One of the PhDs aims at automatically optimizing any given trawl to improve its energy performance.

Discussion

Have there been full-scale trials? Yes, but the results were a little bit different from the simulation. There have been some discussions on this issue with fishers. There is a project called Effichalut in which field trials are part of the activities. The net optimization software produces sometimes odd cutting rates for net panels. A major ac-

tivity in optimization of trawls is the discussion with fishers. In the end, the fishers will have to use the trawl so it should be designed to their satisfaction. The software is usually taken on board to carry out the simulation. The first goal usually is to have the same catch. An increased catch rate can also cause problems.

Can this model be combined with behaviour models? No, not for the moment. It has been tried a few years ago, but it is very complicated. The Dutch HydroRig system is mentioned for which hydrodynamic modelling has also been used to aid the design of cups inducing flow vortices in their wake stimulating fish out of the seabed.

17.7.9 Strategic Spanish Project PSE-REDES (Jose Fernández García, IEO, Spain)

PSE-REDES is a multidisciplinary project, which began in 2009. This project aimed at the generation of technological innovations and devices on fishing gear used by the Spanish fishing fleet, in particular the trawling fleets. The project aims to reduce catches of unwanted marine species with the objective of reducing discard mortality. The project is based on collaboration between fishers, technicians and scientists. The first tests with the fishing gears of this project were performed in towing tank.

Discussion

Were fishers involved? Yes, open sessions were organized in the towing tank.

A square mesh panel was inserted just behind the footrope to reduce bycatch of invertebrates. However, care has to be taken not to lose commercial flatfish. The trials at sea will have to demonstrate whether this might be a problem. In the extension, it is the intention to test how to separate flatfish and roundfish with a separator panel. The idea is to divide the codend so that flatfish end up in the lower codend and roundfish in the upper. As such, codends can be designed differently for both species groups. The devices were designed in cooperation with fishers. This takes place in the first stage of the trials, before the towing tank experiments.

The question was raised whether the trawls used in the fleet are quite different or whether there is a standard design that is generally used. There is some standard, but there are specifics for each vessel.

Underwater observations will be part of the project. Investments have just been made in a new camera, and it is planned to do this early next year.

It was stressed that it is a very good idea to include the fish morphology in the design of new fishing gear.

17.7.10 Technological innovations in the most important fisheries in the Basque Country (Luis Arregi, AZTI-TECNALIA, Spain)

Tuna fish (long fin tuna and bluefin tuna) have long been two important species for Basque fishers. In the beginning, trolling was the fishing method used for these species, but in the middle of the 20th a new technique was developed, the pole and line method. This new fishing method in which live bait is used for tuna has been shown to be more effective than trolling. In this presentation we show the methodology we are using to obtain information on the innovations introduced in the most important fisheries for Basque fishers with a special emphasis in tuna fishery.

Discussion

The idea to record information on the history of fishing methods is very important because this information is disappearing. It was noted that the retired fishers were more open in giving information than active fishers who still are competitors.

The tuna which you are referring to are trans-boundary, a migrating species. Did you have any comments from the old fishers on international relationships relating to this fishing métier? No, no problems have been reported, because the fish are caught in international waters. The only occasion when problems were observed was when the 200 miles zone was introduced.

17.8 General discussion

Some discussion was allocated to the form to be chosen. One option raised is to have presentations in an open session and TOR-group meetings to facilitate more extensive discussion on elements as success factors, and the role of WGFTFB in the innovation process. The topic was deemed important enough to be continued in whatever format chosen.

- Do we continue with TOR D?
- What are the success factors in innovation?
- What is our role as WGFTFB related to innovation and the EAF?

Most presentations during this meeting were focused on concrete examples of innovation. An element that may be missing is the larger scale effects of innovation, the modelling side, etc. The main success factor for innovation to be taken up by the industry is profitability, and cost-effectiveness, as in any other business. A matrix was made with "drivers", "barriers" and "actors" involved.

Drivers	Barriers	Actors
Cost (fuel)	*Legislation*	*NGO's*
Salaries	*Social pressure*	*Manufacturers*
Market demands	*Low fish price*	*Scientists*
Legislation		*Fishermen*
Communication strategies		*Fishermen's organizations*
Ownership		*Banks*
Social pressure		*Consumers*
		Certification organizations

There seems to be a trend that fishers are leading innovation and even like to proceed without guidance by scientists. The projects under the Dutch Innovation Platform form a good example of this trend, although in order to be successful applications must involve scientific institutes to guide the research. But the initiative for a project remains with fishers or fishermen's organizations.

Due to years of pressure related to environmental issues, the attitude in many fisheries has changed and this, besides costs, has become an extra driver for innovation.

How can we facilitate innovation? In the Netherlands the innovation platform where fishers themselves send in project applications has helped. There is much more research input and motivation. The Dutch knowledge circles (fisheries expert groups) also helped, but financial support remains a need. It certainly helps to bring people together, but it takes time to build up trust among the members of a group. Not everyone is willing and open to share experience. In France experience was obtained with explaining the benefits of innovation to stakeholders, not only related to aspects

of incomes of fishers, but also regarding environmental aspects. Communication is a key element. However, there are examples where a lot of effort has been made on communication involving liaison groups, leaflets, videos, etc., but with no uptake at all of the new gear designs that were proved to meet the chosen objectives. There is also experience with involvement of NGOs in discussions with fishers among some participants. Often this seems to be an effective way forward with mutual understanding. An example was given where innovation was not taken up, because gear manufacturers were not involved, and it was noted that their involvement might be a key factor.

The time frame needed for completing gear innovation varies according to the participants. The Dutch pulse fishing system took some 20 years to be developed. The Nordmøre grid, however, was taken up in less than a year, due to legislation becoming in force stimulating its use. The development of TEDs started in the early 1970s and is still going on. The development and introduction of low drag pelagic trawls in the Dutch pelagic fleet took 5–10 years; transitions in light fishing technology took some 10 years.

What is the role of gear technologists? There are several examples where gear technology departments have more or less disappeared, e.g. in Germany and the Netherlands. A problem is the limited time frame of project work. Some form of continuity is desirable. Finding partners in funding, and not just relying on one financer, might facilitate this, and WGFTFB has proven to be an excellent forum for this purpose.

Gear technologists used to be on the forefront of expertise and development. This does not seem to be the case anymore in many fisheries. There are, however, topics where we are still on the forefront e.g. fish behaviour, and modelling ecosystem effects.

An important topic for the future is what the behaviour of the fish is between the net opening and the codend. Fishers and scientists are curious to know. In this field we need input of the expertise of WGFAST, because we need updated knowledge of equipment and data analysis.

Seabed impact will stay an important issue for the near future, but also older topics will need continued emphasis, such as selectivity and survival. It is estimated that fisheries use about 10% of the global fuel consumption. Thus any improvement in fuel use in fisheries has global consequences. The use of fuel should also be seen in relation to stock status. If stocks and consequently catches are at higher levels, fuel costs become less important.

Social aspects are often taken into account in the management of innovation. There is also a general trend that fewer young people step into fisheries. Some fishers are also waiting for decommissioning schemes to be able to step out.

Can WGFTFB help in reaching MSY? Selective fishing gears can contribute in reaching MSY. Survival of escapees is as mentioned earlier a topic that comes back. The general gear work related to mitigating ecosystem and seabed impact remains important. Alternative gears may become an important study topic, especially because switching from trawling to passive gear seems to be generally accepted as a good idea, but in practice does not seem to be simple. We need studies with good data.

Establishing or maintaining links with other fields in marine science and management is important. Examples are ecosystem modelling and appraisal of effects of

introducing innovative gears on a wider regional scale. More attention should also go to education in fisheries, in which WGFTFB can play a role.

17.9 Recommendations

WGFTFB recommend that this Topic Group: *i)* meet again next year and extend the table of innovation projects with more information from other countries as well as updating project outcomes; *ii)* have presentations in plenary session; *iii)* possibly involve other experts (modelling ecosystem effects).

18 Summary of other presentations

18.1 Oral presentations

18.1.1 Introduction to Risk based Assessment of the Effects of Fishing

Hans Polet, ILVO, Belgium

Abstract

A request was made by the chair of WGECO for input by WGFTFB in the risk based assessment work related to fisheries impact. A method is being adopted by Ireland to determine which fishing gears will be allowed in marine protected areas in Irish waters. The method has been developed in Australia and adopted for risk assessment for most Australian fisheries. The method has been developed to be flexible, comprehensive, scientifically defensible, and understandable for fisheries managers and involves stakeholders.

There is a need for data to be fed into the method on selectivity, effects of gear alterations and effects of introduction of alternative gears. WGFTFB holds the expertise to provide the necessary input. The cooperation of WGFTFB is thus requested.

The request firstly holds the question whether there is any interest in WGFTFB to allocate effort to this topic. If positive, the way forward should be determined. A possibility would be the organization of a workshop to collate the data. It will be investigated whether some finances can be found to organize the workshop.

18.1.2 Ecological Risk Assessment for the Effects of Fishing

Susie Brown[1], Emer Rogan[1], David Reid[2]

[1]School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland. [2]Marine Institute, Rinville, Oranmore, Co. Galway, Ireland.

Abstract

Ecological Risk Assessment for the Effects of Fishing (ERAEF) is a hierarchical, precautionary approach used to assess ecological risk in an Ecosystem-based Fishery Management (EBFM) context (Hobday *et al*., 2011). It has been applied to many fisheries including those in Australia, where the process was developed, and is also applied as part of the certification process of the Marine Stewardship Council. To be fit for purpose ERAEF must be comprehensive, flexible, transparent, repeatable and useful for management. Stakeholder engagement and expert opinion are crucial in the development of the framework and to the successful application of ERAEF. The process is continuously being refined and adapted and there is considerable scope for input from experts, across a variety of disciplines, in developing the methodology. In particular there is an urgent need for establishing the risks posed by different fishing gears. To this end a scoring system for gears, which defines selectivity and which can be applied in the ERAEF process, requires development. As a multi-disciplinary consortium comprising research groups from University College Cork, Queen's University Belfast, and the Marine Institute Galway, we are applying ERAEF in Irish waters and in collaboration with other national efforts seek to establish a new global best practice for the application of the technique in the EBFM context. We are keen to

forge links with the ICES Working Group on Fishing Technology and Fish Behaviour; a group which we feel is uniquely placed to contribute towards this goal.

Discussion

The WG was asked if it was interested in participating in a workshop either within or without ICES on applying ERAEF. The chair expressed the opinion that a workshop was the proper mechanism, and that the WG's participation was important at this stage. There was some discussion of the timing of the workshop to suit the needs of the proponents. Some interest was expressed by WG members, and the proponents were invited to draft ToRs for a workshop.

18.1.3 The mobilization of sediment by towed demersal gears

Barry O'Neill and Keith Summerbell, Marine Scotland - Science, Scotland, UK.

Abstract

The mobilization of sediment by towed demersal fishing gears has been related to the release of nutrients, benthic infaunal mortality and the resuspension of phytoplankton cysts and copepod eggs. Hence, to understand the broader environmental and ecological implications of demersal fishing, it is important to be able to estimate accurately the amount of sediment put into the water column by towed gears.

Experimental trials were carried out in the Moray Firth, Scotland, to measure the quantity of sediment remobilized by trawl gear components. It is demonstrated, for a given sediment type, that there is a relationship between the hydrodynamic drag of the gear component and the mass of sediment entrained behind it. A better understanding of this relationship and the hydrodynamic processes involved will lead to the development of accurate predictive models and aid the design of fishing gears of reduced impact.

Discussion

It was pointed out that in some areas, such as the US Gulf of Mexico, high natural resuspension makes the effects of trawling minor. The presenter was asked if an evaluation has been carried out for seines: no, but it might be interesting to compare with that of trawling. Another question regarding the time of the resuspension was asked – the estimation occurred in real time.

A question was asked about the position of the doors during the experiment. In the first part the doors were flat and perpendicular, in the second experiment they were in a more typical position.

18.1.4 Growth, selectivity, stock biomass and catch

Eckhard Bethke

Johann Heinrich von Thuenen-Institute (vTI), Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Palmaille 9, D 22767 Hamburg.

Abstract

Ecosystem changes also cause changes in growth-rates of fish. This effect means that at high growth-rates fish are caught long before its mean age at first capture. In star-

vation periods, however, fish grow slowly and reach the L50 determined by the trawl design accordingly late. The knowledge of the selection properties of the trawls used in the fishery is a prerequisite for the calculation of the partial recruitment in stock assessment and management. Changes in fishing practices – in good fishing situations fishers often voluntarily use bigger mesh sizes – can change the partial recruitment, and may cause lower catches per unit effort while increasing profit by catching fish of higher value. Not taking actual selection properties into account confuses, however, the fisheries based stock assessment and forecasts and the stock size estimation becomes unnecessarily vague. Here a system of equations is presented which allows the inclusion of the selection parameters of trawls used within the stock assessment which reduces measurement errors. Another important application of these equations is the prediction of the impact of regulation changes, e.g. technical measures, on the ecosystem and the fishery.

Discussion

It was asked whether the reactions of older fish and their effect on selectivity were considered. It was noted that the equations were meant to describe how information such as this could be incorporated.

18.2 References

Hobday, A. J., Smith, A. D. M., Stobutzki, I. C., Bulman, C., Daleya, R., Dambacher, J. M., Deng, R. A., Dowdney, J., Fuller, M., Furlani, D., Griffiths, S. P., Johnson, D., Kenyon, R., Knuckey, I. A., Ling, S. D., Pitcher, R., Sainsbury, K. J., Sporcic, M., Smith, T., Turnbull, C., Walker, T. I., Wayte, S. E., Webb, H., Williams, A., Wise, B. S., Zhou, S. 2011. Ecological risk assessment for the effects of fishing. Fisheries Research, 108: 372–384.

O'Neill, F.G., Summerbell, K. 2011. The mobilization of sediment by demersal otter trawls. Marine Pollution Bulletin, 62: 1088–1097.

19 National Reports

19.1 General Overview

Participants were asked prior to and during the meeting to prepare summaries of current and expected research related to the activities of the WG within their country. Nine national reports were produced: Canada, France, Iceland, Ireland, Italy, Norway, UK-Scotland, Spain, and the United States. The full text of these reports is reported below by country. Prior practice (over ten years ago) was to provide an overall summary of the National Reports during the meeting. In recent years, the lack of a summary and the value of the National Reports have been highlighted during discussions. In response to the perceived value of a summary, the chair attempted a quick summary of some of the major themes crossing nations during the meeting. Following the meeting, the National reports were re-read for the purposes of producing a more thorough general overview. A word cloud was produced from the full text of the National Reports as a means of concisely and simply summarizing the main areas of interest in the reporting countries (Figure 6). The word cloud displays words in font sizes proportional to their frequency within the text – the bigger the word, the more frequently it appeared in the reports. The word counts are also displayed in parentheses. Not surprisingly, words such as "fishing", "fisheries", and "project" were common. Several words appeared that offer insight into common themes for 2011 that may be a bit unexpected: "efficiency", "fuel", "system" and "whale". The primary species names that appeared were "shrimp" and "cod". Consistent with prior experience, "trawl" was the most common gear seen in the cloud.

Figure 6. Word cloud of the text of all national reports. Word size is proportional to its frequency; counts are reported in parentheses next to each word.

The contents of the individual National reports are NOT discussed fully by the group, and as such they, and this summary, **do not necessarily reflect the views of the WGFTFB**. Nine themes were identified and are used below to summarize the overall research. It is recognized that projects can belong to multiple themes, and that the themes are not independent. For example, "energy efficiency" and "environmental impact" are intimately related. Separation of themes is used for summary purposes only, and to allow WG members to uncover potential collaborations or additional data within the WG. The summary is not meant to be comprehensive – it is meant to encourage full reading of the National Reports.

Energy efficiency has stimulated a great deal of research in 2010–2011. Energy audits, fuel management systems, and vessel monitoring systems designed to optimize energy consumption were reported by Spain, Italy, Netherlands, Norway, and France, primarily in mobile gears. Spain has a multifaceted program to optimize hull and propulsion in addition to several unique energy-related programs: use of recycled lubricant oil as fuel, vessel routing by weather, recovery of waste heat from engines to generate electricity or for other purposes, testing of fuel additives, and hydrogen production from exhaust gases, among others. Use of Dynex trawl warps or bridles is being investigated in Ireland and in the USA. Modelling of water flow for optimization of trawl design is underway in France using flume tank and computer simulation technologies.

Energy efficiency can yield reduced environmental impact, another common theme. Nearly all nations reported efforts to completely examine some or all aspects of mobile gear to reduce drag and environmental impact, and specific efforts were made to make demersal gear more pelagic in Italy, Netherlands, and Norway, where a new centre addressing the entire value chain has opened. Biodegradable designs for fishing gear are being examined in Canada and Norway. Ireland recycled 35,000 kg of polyamide so far and plans to recycle more.

Research on trawls and dredges beyond impact and fuel efficiency is being widely conducted on a variety of topics. Primary is separation of species (particularly Nephrops – France, Iceland, Norway, and UK-Scotland) using, among other strategies, rigid and flexible grids/grates, square mesh panels, and exit windows. Modified groundgear and headlines are being testing in multiple nations. The USA has more

than 13 separate projects on species separation in trawl gear. France and Norway were investigating T-90 effects. Both Norway and the USA were investigating catch control mechanisms in the codend.

Many projects on non-trawl gear were reported. Research on pots for commercial and survey use is widespread: for invertebrates (whelks– Canada; Nephrops – France, crabs – Canada and Norway) and fish ((France, Netherlands), especially cod (Canada, France, Iceland, Norway, and USA)). Iceland reported an intriguing development: lights initially used on pots for filming attracted krill which attracted cod. Gillnet research was reported in Norway, Ireland, and the Netherlands, which also is investigating trammelnets. In the USA, the possibility of deterring turtles in gillnets with photo luminescent products is being investigated. Hooks and longline research projects were reported for the Netherlands, and the USA, where a great deal of work is being done using weak hooks to release larger, stronger non-target fish like bluefin tunas. Other hook research in the USA aims to reduce shark bycatch and mortality with electropositive metals, with hook offsets, or weak links. Seining projects were reported by Canada, the Netherlands, and France. Scuba diving in France for scallops and weirs for squid in the USA were some unusual gears mentioned.

Behaviour of target and non-target species is a partial focus or main focus of many projects. In the USA, feeding behaviour of lobsters under ultraviolet light is being studied; also, behaviour of flatfish and roundfish in response to Dynex bridles. Scotland is deploying an innovative trawl with the mouth divided into three vertical compartments to study herding behaviours of different species. Norway and France are modelling flow around trawlnetting. Several projects are taking the approach that Spanish researchers working with the Baka trawl are: using a camera to identify the type or location of a bycatch reduction device.

A wide range of projects related to handling, quality, welfare, holding and transport, and mortality, perhaps loosely defined as animal health, were reported. Discard mortality after capture was being investigated in the Norwegian mackerel and herring purse-seine fisheries, and in the USA for skates, rockfish, crabs, and marlins. Maintaining live fish was the focus of many projects in Norway; the quality of fish caught with T-90 is being studied in France. In the Netherlands, the possibility of stunning fish with electricity before processing as a welfare issue was the subject of some work.

As mentioned earlier, Nephrops is the target of many research projects. Two countries (Canada and the USA) have multiple projects on shrimp fisheries. The Canadian work involves improving energy efficiency in trawls and modelling to improve commercial and survey trawl performance. Turtle excluder devices (TEDs) are under continuing study in the USA, along with grates and modified groundgear to reduce bycatch. The Netherlands were investigating a shrimp electric pulse trawl.

TEDS are part of an effort to reduce catch of protected species. Ireland, Canada and the USA reported assessments of interactions between protected species, particularly marine mammals, and fishing gear or efforts to reduce interactions.

Technological upgrades or research were reported for many countries. Canada, France, and the USA reported updated or new camera systems. The USA camera system was developed specifically to loan to fishers to investigate impact and bycatch reduction on their own. Electric pulse fishing was under new or continuing development in Ireland and the Netherlands. Iceland was enhancing electronic logbooks. Quite a few countries reported large-scale cooperative or collaborative research ef-

forts into different aspects of fishing and the fishing industry. The Netherlands has formed a number of groups or knowledge circles providing information, coordination or direction toward surveys and gear research. Similarly, Norway announced the formation of a new centre for development of sustainable trawl and purse-seine technology involving multiple government and industry partners. Both Spain and the USA reported broad partnerships to work with industry on technology transfer or spatial-temporal examination of discards. Ireland was documenting responsible fishing practices for more than 100 vessels.

A number of efforts above involve survey gears (shrimp survey nets in Canada; scup pot survey in the USA). The Netherlands incorporated fishers into survey design and conduct, and conducted a parallel beam trawl survey on a commercial vessel. In addition, Norway is leading a three Nordic country development of a pelagic survey trawl. Norway also reported a comparison of video samples, pots, and trawls in estimation of king crab abundance. Investigations to improve safety at sea were reported by Canada, France and Italy, where a specific program to prevent injury from winch cables was described.

19.2 Canada

19.2.1 Fisheries and Marine Institute of Memorial University of Newfoundland

Whelk Trap Excluder

The objective of this study was to devise a means to reduce the capture of undersized waved whelk. To achieve this, an excluder device which consisted of a steel bar welded between every second diagonal trap frame support was incorporated above the bottom ring of a trap in such a way as to produce a bar spacing of sufficient size to allow undersize whelk to pass through. Controlled simulation experiments revealed that when a trap is fitted with a 30 mm excluder device and oriented at an angle of 40–45° from horizontal an average of 28.6–36.4% of the undersize whelk can be excluded from a trap during simulated 2 minute haul back duration and vertical surge distances of 0.3–1 m. Field trials under commercial fishing conditions are planned for 2011.
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Energy Efficient Shrimp Trawl

Collaborative research in 2009/10 investigated methods of reducing fuel consumption during inshore shrimp trawling activities in Newfoundland and Labrador, Canada. Working with local trawl manufacturers, various technical measures were examined during two separate studies in an effort to reduce hydrodynamic resistance of the common trawl designs in use by the fishing industry. We tested the feasibility of shortened bridles, reduced twine diameters, modified footgear, increased mesh size, and improved trawl door design, all as means for reducing hydrodynamic drag and saving fuel. The work was conducted under the controlled conditions of a flume tank in St John's, Newfoundland, Canada, using scaled engineering models (1:4, 1:8, 1:40). Full-scale prototypes of the trawls have been constructed with sea trials planned for this summer.
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Reducing Seabed Impacts of Bottom Trawls

A five year study has just been initiated with an industry partner to develop and commercialize bottom trawl technology capable of catching commercial quantities of

finfish and shellfish with reduced seabed contact compared to traditional systems, thereby reducing significant environmental affect the seabed. The objectives of the project are to conduct computer simulation of innovative fishing systems; evaluate physical models using the flume tank; and construct and evaluate full-scale prototypes.
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Underwater Camera Upgrades

The university's self-contained underwater camera was upgraded to high definition (full HD, 1080p) with solid-state recording on DVR. Under laboratory conditions, we compared the performance of the new system to four similar camera systems used during the last decade. Our laboratory study results revealed that HD video could offer significantly improved image quality by up to 20% and allow objects as thin as 0.4 cm to be observed underwater from 4.0 m away. We also tested its performance at-sea attached to an offshore groundfish trawl and found surprisingly good image quality. Although developed for otter trawl research, the camera system is highly flexible and can be applied to stationary gear, such as pots or traps, and other forms of mobile gear.
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Biodegradable Twine

An experiment was conducted to evaluate various natural fibres (cotton, hemp, jute, and sisal) for their breaking strength over time. A total of five twines were evaluated in field trials, covering a period of 124 days at liberty. The 96-thread cotton twine performed the best. Compared to the other twines evaluated, the rate of degradation for this twine was relatively quick, with a 33% reduction in the initial breaking strength recorded after 64 days, and a total reduction of 63% of the initial strength upon conclusion of the study at 124 days. No difference in performance was observed between different bays and crab fishers are readily adopting the new technology as a means of reducing ghost fishing of lost snow crab pots. Use of the twine will become mandatory in 2013.
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Cod Potting

The catching of Atlantic cod with baited pots is now legal in Canada. It continues to gain momentum in Newfoundland as an alternative to gillnets. In 2009/2010 there were ten (n=10) fishing enterprises catching their entire commercial quota using baited cod pots. A value chain has been assembled straight through to high-end niche restaurants where consumers pay more for sustainably caught fish. Several articles have been written in popular magazines, including Fishing News International, National Fishermen, and Commercial Fisheries News.
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Escape Mechanisms in Snow Crab Traps

Research on effectiveness of escape mechanisms is now completed. They were introduced into the commercial snow crab fishery in Newfoundland on an experimental basis during 2005–2009 and in 2010 became legalized for voluntary use. Depending on the region and season, escape mechanisms have been shown to reduce the catch rate of juvenile snow crab by up to 47%.
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19.2.2 Fisheries and Oceans Canada Central and Arctic Region

Modifications to the Campelen shrimp Trawl

The standard Campelen 1800 shrimp trawl excessively tears-up in northern assessment surveys in the Hudson Strait area. Modifications were made to the trawl which increased the foot gear from the standard 14 inch roller to 21 inch diameter. In addition floatation was added to the fishing line in order to further lift the bellies of the trawl away from the bottom. A model of the modifications was tested in the Flume Tank at the Marine Institute, St John's, NL to fine tune the amount of floatation added to the fishing line and to examine the effects these modifications might have on the performance of the trawl.
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Modelling the Cosmos Shrimp Trawl:

A Cosmos 2600 shrimp trawl is the standard trawl used by DFO (Central and Arctic Region) shrimp assessment surveys conducted in the north. In order to develop a mathematical model relating door spread to swept width by the trawl, a model of the Cosmos trawl was built and tested at the Marine Institute's Flume Tank in St John's, NL. Results showed that the determination of swept width required a multiple regression using both door spread and trawl speed.

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19.2.3 Fisheries and Oceans Canada Maritimes Region

Ecosystem Effects of Scallop Dredging:

Before-after regression experiments were conducted using a scallop dredge with 16 different fishing intensities on soft and hard substrate habitats in the southern Gulf of St Lawrence, Canada. The experimental design controlled for ecosystem level changes in the abundance of benthic invertebrate taxa that were unrelated to fishing. No significant short-term fishing effects were detected in either ecosystem in single taxon and multi-taxon analyses. A post hoc simulation of the statistical power of the experimental design and analysis was conducted. Despite generally low statistical power to detect fishing effects at low and medium fishing mortalities, significant fishing effects were even less frequent than those expected based on the power simulation for a low level of fishing mortality (5% mortality per fishing gear sweep). This result suggests that realized fishing mortalities in the experiment were generally small.

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19.2.4 Fisheries and Oceans Canada Newfoundland Region

Bottom Seining Review

Efforts are currently underway in collaboration with the Fisheries and Marine Institute to review the current and historical development of Canadian bottom seining technology with special emphasis on developments in the east coast fisheries. A comprehensive technical report (> 130 pages) will be released in 2011.
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Sinking Rope

This ongoing experiment aims to determine if the use of a sinking rope (Hydropro) reduces entanglements of marine mammals and leatherbacks turtles in the snow crab and whelk fisheries by eliminating the natural snare created between traps. The sinking rope was distributed to five (5) fishing enterprises in NAFO Division 3PS to assess the practicality of using Hydropro rope. Preliminary observations suggest that the rope preformed as well as traditional polypropylene rope in maintaining fishing effectiveness and handling characteristics, however it is too early to determine if long-term entanglement rates are lower as a result.

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19.2.5 Merinov Centre d'Innovation de l'Aquaculture et des Pêches du Québec

Reducing Trawl Drag and Fuel Consumption in the Gulf Shrimp Fishery

This study aimed to design a bottom trawl with reduced fuel consumption for use in the Gulf of Saint-Lawrence (Quebec, Canada) shrimp fishery. The new trawl system consists of a net with less surface area combined with Thyboron Type 11 trawl doors. The project was split into two phases. In the first one, software DynamiT has been used to numerically model the new trawl system with a standard one. Sea trials were then carried out on commercial fishing grounds during summer 2010 over a four week period. Total trawl drag was registered during 220 hours with a SCANMAR datalogging system. Both simulations and sea trials reveal a 5% reduction in trawl drag with the new trawl. Full-scale trials also showed that the new trawl maintained its ability to catch shrimps and consumed 4% less fuel at the same commercial trawling speed. Other investigations are planned for the future in order to improve the energy efficiency and to reduce the bottom impact of the trawl system. For that, new materials like spectra and new foot gear (with rubber plate) should be considered.

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Mitigating the Bottom Impact of Scallop Dredges

The objective of this study was to find new options to mitigate bottom impact of scallop dredging in Québec fisheries. A survey of fishing gears used in Québec by the scallop industry was completed in summer 2010. During the same time, a literature review allowed us to identify R&D solutions proposed elsewhere to reduce physical impacts of scallop dredging. Results of these studies were presented and debated during a workshop held in Gaspé city in November 2010. Fishermen, biologists, engineers and specialized technicians were gathered to identify proper solutions to mitigate dredge impacts in Quebec fisheries. Reports and proceeding are available in French at www.merinov.ca/projetpdg2010.

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ASCAB: Improving Whelk Trap Selectivity

The main purpose of this project is to modify whelk traps to reduce the catch of undersize individuals in order to sort them on the bottom rather than on the fish boat deck. First, in 2009, different bottom trap materials like snow fence, lobster trap panel wires, and fishing net were tested in the laboratory to compare their selectivity. Secondly, the lobster trap wires, as the best one, was selected and compared at sea with standards reference traps on northern gulf of Saint-Lawrence (Quebec, Canada) commercial fishing grounds. Results showed that modified traps reduce the catch of

undersized whelk whilst retaining the same quantity of commercial ones. Other modifications should be considered to ease handling namely in terms of traps stacking.

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Energy Efficiency of Different Fishing Boat Stabilization

The performance of two anti-rolling motion devices: paravanes and hinge fins, a new system adapted to Quebec mid and inshore fishing vessels, was sea tested on-board two snow crabber sister ships in the Bay of Chaleurs, Quebec, Canada in the summers of 2009 and 2010. In addition to safety hazards, one aspect that has been assessed was the energy efficiency when the boats were steaming at full or at fishing speed. Main results are under analysis and will be available in the 2011 autumn.

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19.3 France

19.3.1 Ifremer

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Energy savings and lower impact on the seabed

OPTIPÊCHE project

OPTIPECHE national project ("Pôle Mer Bretagne") aims at improving trawl gear design in order to reduce fuel costs and impacts on the seabed. The project's final report was written during 2010. It integrates recent results from IMP[1] concerning Jumper doors' ergonomic and security, tested on a professional vessel.

HYDROPECHE project

This national project aims at studying, modelling and optimizing the hydrodynamic behaviour of fishing nets. Four theses are dedicated to this project. The flow around a rigid codend and a bottom trawl at the scale of 1/10 was characterized. The results were obtained in 2009 during test cruises in Boulogne's testing basin. The acquisition of the new PIV camera augmented progress compared to preceding works. The whirlpool turbulences behind a trawl's rear have been highlighted. The digital processes aim at developing tools to get realistic simulation of the flow around flexible and porous structures. Two main axes were defined:

- the development of an unsteady method of finite volumes
- the use of an academic software based on finite elements.

Until now, these studies have led to bi-dimensional flow models around circular structures. The first 3D extensions have also been realized. The optimization work will help to develop automatic tools to reduce drag. Several developments have been realized and the first optimization results of both a bottom trawl and a pelagic trawl have been obtained. The comparison of the geometric trawls determined with the structure model against experimental data collected from a pelagic reference trawl has been made. These studies were the objects of presentations in several congresses:

[1] Institut Maritime de Prévention.

- Numerical optimization of trawls design to improve their energy efficiency, D. Priour, Fisheries Research 98 (2009), pp 40–50;
    - Note on the POD-based time interpolation from successive PIV images, E. Bouhoubeiny, P. Druault, CR Mécanique 337 (2009), pp 776–780;
    - Optimization of trawl energy efficiency under fishing effort constraint, D. Priour, R. Khaled, DEMAT Kinki, 2009;
    - Comparison between two methods of trawl optimization, D. Priour, R. Khaled, IMAM Istanbul, 2009;
    - Experimental analysis of the characteristics of the flow around bottom trawls, E. Bouhoubeiny, G. Germain, P. Druault, E-Fishing 2010, Vigo;
    - HydroPêche: a way to improve energy efficiency of fishing devices, G. Germain, P. Druault, R. Lewandowski, B. Vincent, D. Priour, JY. Billard, E-Fishing 2010, Vigo;
    - Numerical method for energy optimization of bottom trawl, R. Khaled, D. Priour, Congrès E-Fishing, Vigo, 2010;
    - Experimental investigation of the large-scale flow structures around a trawl, E. Bouhoubeiny, G. Germain, P. Druault, 15th Symp. On Appl. Of Laser Tech. To Fluid Mechanics;
    - Time-resolved PIV investigations of the flowfield around a rigid codend net structure, E. Bouhoubeiny, G. Germain, P. Druault, submitted to Fisheries Research.

EFFICHALUT project

The purpose of this national project is to test at sea the results of a software program to optimize trawls automatically. This software, which is under development in the Hydropêche project, is a digital tool, which may induce step by step adjustments of a trawl reference plan in order to gain energetic efficiency. Effichalut first consists in collecting the trawl's plans of the commercial trawlers involved in the project. It will perform numerical simulations to get the shape and strains of this trawl. Tests at sea will be necessary to validate that the software computed shape and strength are realistic. A new trawl shape will be computed automatically by the optimization software. This trawl will then be made with the new shape and tested at sea to check the automatic optimization software by comparing the results from sea tests with the simulation results. Here are some results: for a classical trawl, an improved trawl and an optimized trawl, the drag values are respectively 6.7t, 6t and 5.9t. As long as, at first sight, the fuel consumption is directly cross linked with drag multiplied by towing speed, this would lead to a proportional decrease in fuel consumption.

Alternative fishing gears

ITIS SQUAL project: Fish pots and Nephrops traps

The ITIS SQUAL action, approved in the Pole Mer Bretagne framework, has enabled the development and test of innovative fish pots and Nephrops traps, following specifications defined in partnership with manufacturers and interested fishers. The evolution of this project has shown evidence of the complexity to build up such fishing equipment, so that fishing remains sustainable, aware of the environment and resources, and economically viable. ITIS project initiated a joint research interest between fishery's technologists, manufacturers and fishers in Brittany. Fish pots proto-

types created during this project evolved towards commercial products sold by the Le Drezen Company. The first outcomes and products issued from this project contributed to help other projects such as ORCASAV, which aimed at developing pot fishing for toothfish in southern areas, or on the French littoral zone in the framework of several running or scheduled projects, such as :

- PRESPO (Interreg) in the Bay of Biscay.
- SPD (Selectivity Sustainable Fisheries) in partnership with AGLIA[2], in the Bay of Biscay.
- RP3E (Targeting an eco-aware and low energy consumption energy fishery), in Mediterranean Sea on bass, sea bream, hake.
- F2E Fish2Energy (Interreg), in English Channel, North Sea on cod and bass.

Other complementary works are necessary, in relation with users upon the following aspects:

- set up of pots lines
- bait tests (natural or "artificial")
- optimal immersion time
- ergonomic optimization
- regulation

Concerning the improvement of quality (linked to selectivity) in trawls, the "T-90" system, which appeared to be the best, showed its ability to naturally open the mesh of the trawl therefore reducing the constraints on catch and increasing the volume, increasing selectivity as well. It might be applied to specific fish fisheries, including deep sea fisheries. The mesh size should be adapted according to targeted species. Other selective devices, more adapted to Nephrops fishery, are tested at the moment in partnership with AGLIA. The ITIS SQUAL action has been completed in 2010 with the final report in May and feedback to funding agencies at the Pole Mer Bretagne on 17 September 2010 in Brest.

ORCASAV project

Experimental cruise ORCASAV around Crozet archipelago (Pêche aux CASiers pour lutter contre la déprédation par les ORques et la mortalité Aviaire, Pots fishing to fight against killer whale depredation and avian mortality). This action aims to set up and develop a new toothfish pots fishing method to replace bottom longlines. The industrial partnership is SARPC[3]. Institutional actors are Pôle Mer Bretagne, Pôle Qualitropic, Ifremer, MNHN[4], CNRS[5], and TAAF[6]. In addition to the industry contribution, the funding has been completed by FUI (Enterprises General Direction), the Brittany Region, the Reunion region, and the General Councils of Morbihan and Finistère. In 2009 tests were carried out at Lorient and Boulogne flume tanks to validate the pot prototypes specially adapted to toothfish fishing conditions. The experimen-

[2] Association du Grand Littoral Atlantique
[3] Syndicat des Armements Réunionnais de Palangriers Congélateurs, Syndicat of freezer longliners of the Réunion Island
[4] Muséum National d'Histoire Naturelle
[5] Centre National de la Recherche Scientifique
[6] Terres Australes Antarctiques Françaises

tal cruise was conducted on an Australian ship, named the Austral Leader 2, from the 14 January to the 24 February. Ifremer took part in the scientific framework of these tests, managing fish pot's technical aspects and collected physical data and underwater videos of the pots in deep sea conditions. Two LTH laboratory members were on board (a fishing gear technologist and an engineer specialized in measurement and underwater observation. Eleven prototypes were tested: cylindrical, rectangular, truncated, rigid, foldaway, with one or two chambers, with upward or aside access. 55 shootings for 3150 pots immersed were carried out to determine and select the best gear. After the cruise, the year 2010 was devoted to data and video analysis and coordination/redaction of the final report.

Bio-Technical-Economical expertises (seines, pots, diving, etc.)

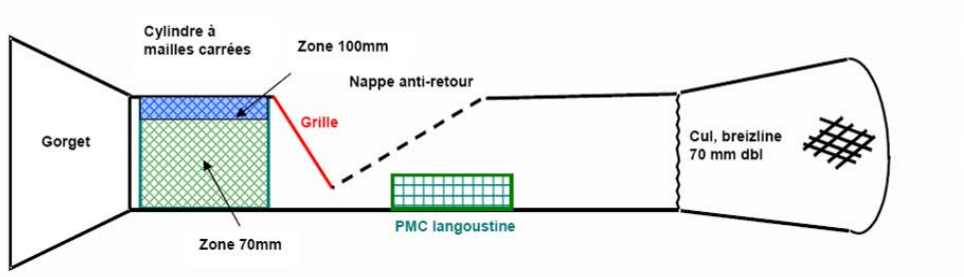
Alternative technologies to towed gears, set up to reduce environment impact, overfishing and exploitation costs remain badly known in France. The complete 2010 study shows a general description of several alternative fisheries and identifies a methodology in order to compare performances between several fishing techniques and to analyse the conditions of emergence and viability of these alternative techniques. This methodology was applied to three emerging cases in France: the Danish/Scottish seine for demersal fish, the Nephrops trap and scuba diving on scallops. The results rely on Ifremer's databases, bibliography and on field investigations conducted among professionals in France and abroad. They show that the alternative fisheries techniques generally grant a better catch value, a reduced dependency on fuel price and are globally more respectful of the environment. Their viability depends nevertheless on the conditions in which they are used and on interactions between space, resources and market.

Selectivity

Selectivity trials in the mixed fishery Nephrops/Hake in the Bay of Biscay

In partnership with the industry, several tests were conducted during 2010 upon ambitious selective systems aiming at reducing significantly the discards of small fish and Nephrops, which is still an important issue in the Bay of Biscay. The methodology consists in testing selective systems on the oceanographic vessel Gwen-Drez, in order to select the most performing tools, then test them on professional vessels in the framework of the project "Selectivity for sustainable fishery" conducted by AGLIA.

During 2010, Ifremer fishery technologists conducted a cruise to test a trawl equipped with 3 complementary devices already tested individually during spring 2009; this combination of devices takes into account the different behaviour of fish and Nephrops:



- cylinder with square meshes: the upper part is made of 100 mm square mesh, so that non-commercial size hake can escape. The inferior part is made of 70 mm square mesh, so that very small hake and non-commercial size Nephrops can escape.
- Semi-rigid selective grid: the 13mm gap between bars will spare small sized Nephrops and small fish. The small mesh backward panel avoids small fish that have escaped across the grid to come back into the trawl.
- Nephrops square mesh panel: this system completes the use of the grid. Small animals that have not been "filtered" earlier will have a second escapement opportunity.

Results show an escapement rate of 46% for Nephrops and 46% for hakes under commercial size (in extra compared to hakes' escapement through the square mesh panel already present on commercial trawls and control trawl). At the same time those tests were conducted on the Gwen-Drez, there were experiments conducted by AGLIA on commercial vessels, more precisely on the square mesh cylinder (tested on the Gwen-Drez in 2009) and on the new Nephrops grid setting. Data will be analysed by Ifremer by 2011.

SELECCAB project

The signature of the "Norway agreements" in December 2008 means to set up selective devices for cod in the North Sea and East Channel. According to DPMA, inshore and offshore Channel and North Sea fishers, CMPMEM, Nord-Pas de Calais-Picardie CRPMEM demand, Ifremer contributed, in 2009 and 2010, to several selective devices. Several types of semi-rigid grids or combinations of grids have been tested, as well as very big mesh trawls. Work on conception and tests in flume tank were conducted during 2009, and prototypes were finalized by mid-January 2010 including the preparation of a video campaign on a professional trawler at the end of January. The underwater video campaign took place from 25 to 29 of January on board a commercial trawler: Le Mercator from Boulogne/Etaples. During this observation cruise, not less than 20 hours of images have been collected, which show precisely the behaviour of the selective kits and of the animals. Globally, these devices aiming at reducing (if not eliminating) the cod catches without reducing other species did not give satisfaction due to escapement. For offshore vessels, for example, saithe has behaviour very similar to cod, and thereby escapes the same way; this confirms tests conducted by Cefas in 2009 with the "eliminator trawl". It shows the limits in some cases of technical measures. For whiting, the best results have been obtained with the 23 mm bar spacing grid. It had already been tested in 2009 with a square mesh panel, positioned upstream, with an escapement rate of at least 43%. However, a similar decrease has been observed on small commercial sizes between 27 and 35 cm. It is planned to pursue these studies on whiting selectivity with the industry, by testing

other known devices in the Bay of Biscay, in order to build a technical "toolbox" which Channel and North Sea fishers could draw from, according to their needs and the evolution of the technical measures. The final restitution of the SELECCAB project took place in the Ifremer centre of Boulogne on the 24 September 2010 in front of numerous professionals, the local Maritime Authority administrator, and representatives from National Fisheries Committee and Nord Pas de Calais-Picardie Regional Fisheries Committee.

PRESPO project (INTERREG)

The ICES Working Group for the survey of Nephrops stock still uses the survival rate of discards presented by Guéguen and Charruau in 1975. Fishing gears used in the Bay of Biscay and the minimum landing size have significantly evolved; it became obvious that this parameter should be updated. Discarded Nephrops survival rate estimation after trawling is the combination of the proportion of discarded living individuals and the proportion of re-immersed survivors. The re-immersed survivors' proportion was estimated along two cruises on board a commercial vessel in 2009 and during a complementary cruise in 2010. The proportion of living individuals discarded after sorting out by the crew has been assessed along 8 cruises in 2010. The data show that the ability of Nephrops to survive after catch relies on time exposure on the deck and air temperature. The shorter the duration of exposure and the lower the temperature, the more the young Nephrops will have chances to survive. Those results were presented to the fishers so that they were motivated into setting up discarding gutters on board, with the support of AGLIA. This simple system will hasten the immersion of the small Nephrops during sorting out operations, reducing their damage risks and thereafter increasing their surviving chances.

Security

SOS stabilité Project: Security at sea

The SOS Stabilité project was meant to last 3 years. It started in 2009 and will be prolonged for 1 year. It has been approved by Pôle Mer Bretagne and Pôle mer PACA. It aims at improving security on board small fishing vessels.

The main objectives, based on the dynamic stability of the fishing vessels from 12 to 24 meters long, are:

- development and set up of embedded systems which could increase security on board ships.
- New concepts for ships, for new fishing gears and links between them.
- An important contribution to training fishers via supports and tools generated by the project.

Ifremer Lorient tasks mainly concern new "fishing solutions" and numerical modelisation of the fishing gears dynamic together with ship's dynamic. An experimental part will improve our knowledge of the fishing gears dynamic. A first step resolved partly the problem of coupling "fishing gears" simulators with "vessel" using algorithms and the software architecture of DynamiT. A second step started in September 2010 and deals with the experimental part. The new Lorient flume tank facilities have been used. SIREHNA, project manager is in partnership with Ifremer, Mauric, Veritas, Institut Maritime de Prévention, Merre and Principia.

19.4 Iceland

19.4.1 Marine Research Institute

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Codend size selectivity

A research trip was conducted to investigate how codend dimensions affect size selectivity of cod and haddock. Four different codends, all with 135mm nominal mesh size, were assessed using the covered codend method. 1) Regular codend, 100 meshes in circumference, 2) Same codend but 10m shorter, 3) Narrow codend, 50 meshes in circumference and 4) double codend, 2 x 50 meshes in circumference. The narrow codend had significantly higher L50 and less variation in both L50 and SR than the other codends.

Bycatch reduction in Nephrops trawling

Research was conducted during summer 2010 on a commercial vessel, towing two *Nephrops* trawls. The objectives were to improve size selectivity of fish and *Nephrops* in the *Nephrops* trawl fisheries. The experimental trawl had larger meshes in the top panel (135mm vs. 80mm minimum mesh size), the panel was hung to force higher mesh openings. The trawl design and rigging of the panel (hanging ratio/slack) seems crucial and determines the efficiency in both size selection of *Nephrops* and fish.

Attraction and trapping of cod

The objective of this project is to investigate cost-effective ways to trap cod. This work is based on direct observation of how cod are caught in traditional traps/pots and is in three phases: 1) Finding a useable odour-solution to use for attraction. 2) Building an odour releaser and control unit. 3) Testing of equipment and effects of odour release. The first phase was finished in 2008: no mixtures of amino acids were found efficient unless in extreme quantities but a solution with mixed herring, and even boiled herring mix was found to be effective in attracting cod. Building of odour releaser, control unit and camera rigging with the ability of remote control and observation of the devices through wireless communication interface was completed in autumn 2009. The first commercial tests were carried out in October and November 2009 without any traps. Herring mixture was released in short pulses and reaction and behaviour of fish observed. In May 2010 the monitoring gear was deployed again with a circular trap, 1.4 m in height and 3.2 m in diameter. Observations in 2010 showed that multi entrance or circular entrance traps are needed when smell is used for attraction. In 2011 further experiments with controlled smell release are planned using different trap designs. During 2010 the project created two spinoffs. Spin-off 1: Accumulation of krill (Thysanoessa) in the beams from observation camera lights during night, led to fishing experiments with one trap using a single battery driven light bulb as "bait" attracting krill at night. Results where promising and a larger fishing trial project is designed and planned in 2011/2012. Spin-off 2: Grazing cod in the wild using light and krill attraction. A pilot project was designed and run from January – April 2011 for testing if cod could grow feeding on krill accumulation during night. Preliminary results indicate so, and a larger project is being planned to test this further.

Electronic logbook

It has been mandatory to hold a fishing logbook in Iceland for many years, with positions, types of fishing gears, estimated catches etc. The fleet is now using the electronic logbooks with increasing information on types of fishing gears and devices, improved accuracy in position and continuous registration via mobile phones and satellite systems. This program has been ongoing for some years, and considerable effort has been allocated to the project to define registration variables and programming.

19.5 Ireland

19.5.1 Bord Iascaigh Mhara, Ireland

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Conservation and Selectivity Trials

Early in 2010 BIM/Marine Institute carried out trials/enhanced observer coverage using rigid grids in the Irish Sea. The trials showed that using the grid had maintained low cod catches (< 1%) while still maintaining minimal losses in Nephrops (< 10%). Flexible designs of the grid were also tested but showed that losses of Nephrops were too large to continue using the grids commercially. In July/August 2010 BIM carried out twin trawl selectivity trials on two under 15m vessels with different horsepower in the mixed demersal fishery in the Celtic Sea in Ices Area VIIf/g. A set of selectivity observations were carried out on the 11m vessel "MFV Providence II" with 150hp while another set of selectivity observations were carried out on-board the 14m vessel MFV "Ludovic Geoffray" with 413 hp. Weather conditions during these trials were good. The objective of the trials was to compare selectivity observations from both vessels to see if any significant differences could be identified and also to see what the effects of introducing these gears would be in the Celtic Sea. BIM carried out trials using a gear combination of 110mm codend with a 120mm square mesh panel (smp) placed 9–12m from the codline. Vessels > 15m currently must use 120mm codend with a 120mm smp positioned 9–12m from the codline. Irish vessels > 15m primarily work on the Stanton Bank and Barra Head grounds in Area VIa in a mixed fishery targeting megrim, monkfish and hake. On the basis of an analysis of selectivity data and catch comparison trials carried out, Ireland would argue that the 110mm/120mm smp gear combination will not significantly alter the selection pattern for haddock and whiting compared to the current 120/120mm smp gear. In addition observer data shows that Irish vessels operating in Area VIa have very low cod catches in the areas they operate. Catch data from vessels indicate combined catches of haddock, whiting and cod show the percentage of these three species to be well below the 30% threshold specified in the regulation. Ireland would also point out that the use of the 120mm codend mesh size has resulted in significant reductions in megrim catches when compared to 100mm or 110mm codends and also has led to an increase in the percentage of damaged megrim in the catch. This combined with the reduction in catches of other species with the bigger mesh size represent a reduction in earnings of between 7–15% in total. The use of 110mm codend will reduce these losses and rate of damage of megrim ensuring economic viability for these vessels, while not having an adverse impact on cod, haddock and whiting stocks that Ireland recognizes are in poor condition. In April of 2011 BIM are carrying out a series of hake gillnet selectivity trials. Selectivity trials are being carried out currently to establish a range of selectivity parameters using 80mm, 100mm, 120mm and 140mm twine size. Sea trials are expected to be completed in June.

Environmental Management Systems (EMS)

During 2009 and 2010, BIM continued to work closely with industry to further utilize the Seafood Environmental Management Systems (SEMS) developed in the last two years. By the end of 2010 close to 100 vessels had entered the programme. In addition to the successful outcome for the two pelagic mackerel fisheries achieving MSC and the vessels in the southwest achieving the West Cork regional code of practice, Fuchsia, the Erris Inshore Fishermen's Association has also undertaken a significant campaign to create a regional identity for the fish through the SEMS approach. The Industry also formed their own SEMS Fishermen's Association for those vessels that employ the SEMS approach, under the banner of "Responsible Irish Fish". A number of vessels involved in this scheme have voluntarily adopted more selective gears to demonstrate responsibility including the use of square mesh panels and increased codend mesh sizes.

Fuel Efficiency

Dynex Warp Trials

In 2010 the 30 m "MFV Catherine R" single rig demersal trawler has started using 1000m of 25m Dynex warp as opposed to 25 mm Steel Wire. The initial cost of the warp is very expensive at approximately three times the cost of steel wire. A number of parameters including towing speed, rpm and ground to mention a few were recorded when using the conventional steel warp and similar parameters were observed using the new Dynex warp. The owner of the vessel is reporting significant fuel reductions and has few negative comments to make. One issue that he has highlighted is that the guide on gear on the winches must be very precise. This is not a direct issue with the Dynex warp but is something that must be taken into account. The Dynex warp has shown that it is standing up to the test and is robust from the trials to date. Only time will tell if the additional initial costs of purchasing the warp will be recouped by outlasting the conventional warp by up to three to four times.

Waste Management

Over the past few years BIM, working closely with the industry, has been encouraging fishers to recycle old fishing gear rather than sending it to landfill sites for disposal. This year alone, a total of 35,000kg of monofilament netting (PA6) has been exported to Lithuania and Germany for recycling into a pellet form for subsequent moulding into suitable end products. Since the project started in 2005, an approximate total of 170,000kg of this waste nylon has been recycled successfully in Lithuania, Germany, Taiwan and Mainland China. Based on the initial success achieved by BIM the project is now focusing its attention on the potentials of recycling other waste materials from the Irish fishing industry, principally polyethylene or PE. At present there is a potential for reusing this material, albeit in a recycled form, in the marine environment for making products such as gear-marker poles, rubbing strips (fenders) for harbours, decking for marinas, etc.

Cetacean Bycatch

A study for the European Parliament providing a description of the status of the populations and the incidental catches of a number of cetacean species in EU waters and assessing the regulatory framework adopted in the EU for the mitigation of incidental catches of cetaceans in EU waters was completed in conjunction with St Andrews University in the UK. It focused primarily on provisions under Council

Regulation (EC) No. 812/2004 and also Council Directive 92/43/EEC (Habitats Directive).

Development of a fishery for razor clams

Work to develop an experimental fishery for razorfish (Ensis) using electric pulses dredges in the southern part of the Irish Sea off Rosslare was begun in 2010. Two 10–12m vessels have been involved in these trials initially. Vessels in this fishery traditionally use hydraulic dredges. Based on the trials the main benefits observed while using the pulse gear when compared to the standard hydraulic dredge currently used include the following:

- Less impact on substrate with a maximum of 5cm disturbed as opposed to 30 cm;
- Resuspension of substrate and possible ecosystem modification is greatly reduced, as water is not pumped at pressure through the substrate as is the case with the hydraulic dredge;
- Significant reduction in damage to target species ;
- Reduced number of non target species retained in pulse dredge compared with hydraulic dredge;
- Non target species may be returned alive;
- Improved catch rates of the target species, enabling the catch to be caught with less effort, benefiting the ecosystem and the improving the fishery economics;
- Improved quality, particularly the shelf life of the target species;
- Greater fuel efficiency resulting due to lower towing resistance and no necessity for high capacity pump;
- Improved vessel stability and thus safety due to lower gear weight and sediment retention by the pulse dredge compared with the hydraulic dredge.

This work is continuing.

19.6 Italy

19.6.1 CNR-ISMAR

Energy use in commercial fishing vessels

Recent oil price increases have brought renewed attention to energy-saving methods in the fishing industry. Due to the European commission restrictions on new constructions, the major opportunities for reducing fuel consumption are chiefly related to improving vessel operation rather than commissioning new energy saving vessels. Large numbers of fishing vessels are not efficient usually because of outdated technology. Fuel efficiency directly affects emissions causing pollution by affecting the amount of fuel used. In the current work some fishing vessels, representing the various fleet sectors of the Italian fisheries, were selected for a fuel efficiency audit. The vessels were divided on the basis of type of fisheries and vessel size. An energy audit template was developed to assess the main vessel and equipment features: engine usage, trip scheduling, propeller, etc. Onsite visual inspections were performed during the audit. During the fishing cruises a data acquisition system allowed recording and diagnosis of the vessel's work parameters, offering real-time dynamics. Subsequently detailed analysis of energy usage was carried out. Some energy performance

indicators were developed to display the effective energy efficiency of each vessel. Potential areas where savings can be obtained were identified and changes to make the fisheries more energy efficient in its practice were recommended. The data collecting system tested was conceived at CNR-ISMAR Ancona (Italy) and consists of a data analyser for hydraulic and electric power, shaft power meter, load cells for drag resistance, flowmeters for fuel consumption and GPS data logger. The performance of monitored vessels was evaluated during typical daily fishing trips. In particular fishing and sailing phases were considered. This allowed for a full characterization of the average trip for each vessel.

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Assessment of the protected species bycatch in pelagic trawl

The project aims at evaluating the bycatch of protected species in pelagic trawls. The second goal of the project was to find solutions to avoid the bycatch of protected species. Pelagic trawlers in the Adriatic Sea only target small pelagic species (anchovy and sardine). CNR-ISMAR carried out several observations on-board to monitor catch and bycatch. In order to reduce the bycatch in pelagic trawl a modified TED (Turtle Excluder Device) was developed and adapted to a single boat pelagic trawl. The preliminary results are encouraging. Next step will be to test the TED in a pair trawl which is the most common type in the Adriatic Sea.

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Impact and performances of otter trawls

Following the results obtained and the methodology applied during the DEGREE project, the Fishing Technology Unit of the CNR-ISMAR has conducted several additional sea cruises in order to test the impact and the performances of new doors (E-max, Midnight, Thyboron). The performances of the doors were measured using two electronic TEKKAL (Germany) load cells to measure the warp loads. By means of the instrumentation mounted on this vessel, it was possible to measure some additional parameters. In particular a Doppler Log was used to measure the instant vessel speed in relation to the seabed; a power meter measured the engine revolutions, the shaft torque, the shaft power and the fuel consumption of the main vessel engine. Very good results were obtained both with E-max and Thyboron otter boards. Moreover, different types of angle sensors were used in order to evaluate the door angle during the tow. In addition to this methodology an innovative approach using sidescan sonar was tested in order to evaluate the physical impact on the bottom and real-time performance of a towed gear. This technology requires some improvement.

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Safety on board fishing vessels: automatic braking release of the winch

The safety concept involves organising, designing, managing aspects which support the working mechanism of fishers, considering the whole "fishing vessel" system from the early design stage. Accidents when manoeuvring fishing equipment represent an important part of the total accidents registered in maritime fishing. During fishing, the most common cause of accident is connected to the condition in which the fishing gear gets entangled to a certain obstruction on seabed. When performing the various fishing manoeuvres, an important role is occupied by steel ropes that have been valuated as an essential element of the on-board fishing equipment for several years. Metallic ropes can be the origin of great accidents, for trawling the fish-

ers to the pulleys and traction motors, for seizing and dragging to the sea, for violent repercussions due to the eventual their breakage and, moreover, because they can become a centre of sudden strains with accumulation of great elastic energy. These accidents could be prevented by using automatic braking release of the winch.

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Permanent fuel consumption survey on-board commercial fishing vessel

A fuel consumption monitoring system was set up for research purpose in order to evaluate the energy performance of fishing vessels under different operating conditions. The fuel monitoring system conceived at CNR-ISMAR Ancona (Italy) consists of two mass flow sensors, one multichannel recorder and one GPS data logger. Fuel consumption rate and vessel speed data were used to identify energy performance under different vessel-operating conditions. The system is an effective means to monitor engine and vessel performance, but can be also used to give a real-time indication of engine fuel economy on a commercial fishing vessel. Fitting fuel flowmeters can have a positive impact on fuel consumption, particularly with respect to savings made while steaming. A valuable outcome of this experiment was that, after having installed the fuel monitoring systems the skippers reduced the navigation speed from 11.0 to 10.5 knots, and even small adjustments to revolutions (rpm) settings resulted in significant fuel savings of around 10–15%.

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Ecosystem-based Responsive Fisheries Management in Europe

EcoFishMan is an EC-funded RTD project that seeks to develop a responsive fisheries management system (RFMS) based on results-based management (RBM) principles. The intended context of application of the RFMS is complex, mixed-fisheries and multistakeholder fishery sectors like those found in the EU/Common Fisheries Policy (CFP) area. European fisheries are in a miserable state. In the Green Paper on the reform of the fisheries policy, the EU Commission characterizes the situation in the sector in terms of overfishing, fleet overcapacity, heavy subsidies, low economic resilience and decline in the volume of fish caught. Other problems, such as discards and social problems connected to regional development are also well known. The EcoFishMan concept is based on the notion that major problems in fisheries, particularly within complex fisheries like those in Europe, are linked to the shortcomings of the particular form of management developed within the sector. These shortcomings are typically characterized by administrative micro-management procedures. An important avenue towards more healthy fisheries can be found in a transition towards a RBM system. RBM systems are generic and flexible, but they must be specifically tailored to fit the technical, economic and political structures of the relevant sector. The general objective of EcoFishMan is to develop and pre-evaluate a responsive fisheries management system (RFMS) based on RBM principles. In this new RFMS, active stakeholder involvement is essential. The development and evaluation of the RFMS takes place in an iterative process to ensure that the RFMS is adapted to different types of fisheries and changes in the environment. Each iteration of the developmental work is based on a three-step-process:

1) Design the basic components of the RFMS (conceptualisation)

2) Develop general guidelines for making a management plan (MP)

3) Develop a management plan (MP) for the specific ecosystem

Through four case studies (three fully fledged case studies used for developing the RFMS and one approval test case study used to verify that the RFMS can be adapted to other types of fisheries), the RFMS will be adapted to the respective fisheries, and the effect of the RFMS will be evaluated. A final recommendation for an overall RFMS to be applied in all EU waters will be the main outcome of the project.

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19.7 Netherlands

19.7.1 IMARES/ILVO

ICES research on pulse trawling

Further work was carried out on cod (*Gadus morhua* L.) under electric stimulation in cooperation with IMR Austevoll of Norway. Two different pulse trawl systems produced in the Netherlands were simulated. Both small cod (0.12–0.16 m) and large cod (0.44–0.55 m) were tested. It appeared that spinal damage and direct mortality did not occur in small cod, and by lowering pulse amplitude and increasing pulse frequency this problem may be mitigated. For the Dutch Ministry a short desk study was undertaken to identify the main pulse characteristics and the state of knowledge in this field. This serves to recommend further studies. IMARES and ILVO are participating in a new group with representatives from the fishing industry, pulse trawl producers, and the Dutch Ministry to address problems concerning control and enforcement in shrimp and flatfish pulse trawling developments. In May 2011 comparative fishing trials will be undertaken of two pulse trawl boats (system PulseWing by HFK Engineering and system pulse trawl by Verburg-DELMECO) and a conventional beam trawler fishing nearby.

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Shrimp Pulse Trawl

A new project was started to test the Belgian "HOVERCRAN" (low impact shrimp pulse trawl) on three Dutch vessels. One was recently fitted with the system and trial fishery has begun. ILVO and Marelec from Belgium are involved.

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VIP Pulse cable

The DELMECO group started this project with Draka cable, TU Delft and beam trawl skippers to address current problems in feeding cables in pulse trawling. In case of damage a cable often fills up with seawater. The intention is to build in slots at certain length intervals to avoid a full fill-up. Also optimal cable diameter and construction will be addressed. IMARES/ILVO will undertake underwater observations on three commercial fishing boats working with the new cable on their pulse trawls.

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VIP Skipper Network SumWing South

The SumWing is a technology applied at an increasing rate to replace conventional beams and trawls shoes in flatfish beam trawling. On uneven grounds in the southern North Sea this new gear gets damaged to a larger degree. Underwater observations carried out by ILVO revealed that the wing tips often hit the seabed in case of middle sized ripples. In larger sea dunes the gear lifts off the seabed and flies over

some distance, and then lands back on the bottom. Constructional improvements are designed and tested to reduce structural damage. Some skippers opt for the integrated PulseWing system, in which SumWing and pulse trawling are combined.

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VIP Skipper Network Discards South

This is a new project with beam trawl skippers of the southern Dutch ports. Its purpose is to address the problem of discarding by exchanging information on fishing gear and practices and addressing handling of catches on board. Shipyard Maaskant is involved in designed a so-called catch separator system, in which debris will be filtered out before it will affect catch, thus improving the chances for survival of discards. A number of beam trawler skippers were interviewed to retrieve their knowledge and experience in reducing discards. IMARES/ILVO will participate in trials on the catch separator system, and measure discard survival.

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VIP HydroRig

This project started in 2008. The idea is to replace the effect of tickler chains by water flow stimulation. First attempts involved a wing-shaped beam deflecting the flow to the seabed. Later spherical cups were used to generate vortices in the wake. Laboratory tests at Deltares, Delft, The Netherlands in 2009 showed their potential. Sea trials were positive at first with reasonably good plaice catches and considerably fewer benthos. Direct observations were made by ILVO Ostend Belgium. Comparative fishing trials with direct observation were done in May 2010 in collaboration with ILVO. Unfortunately the skipper decided to go back to tickler chain beam trawling on sole under pressure of his crew, because catches were still lower than on vessels in their vicinity. New net designs with the footrope closer to the beam were made and tested in the flume tank of Ifremer Boulogne in December 2010. Additional flow calculations were made by Deltares of the assembly of a beam with cups of varying shape. The angle of incidence is very important to generate an effect on the bottom: at 20° no effect and just two vortices above the seabed, at 45°a clear effect hitting the seabed. A flattened shape did not give much improvement in terms of induced vortices. The current rise in fuel price may bring this gear back into attention, although fish prices for plaice remain too low for economic viability. A follow-up project proposal was made in the VIP-call of March 2011.

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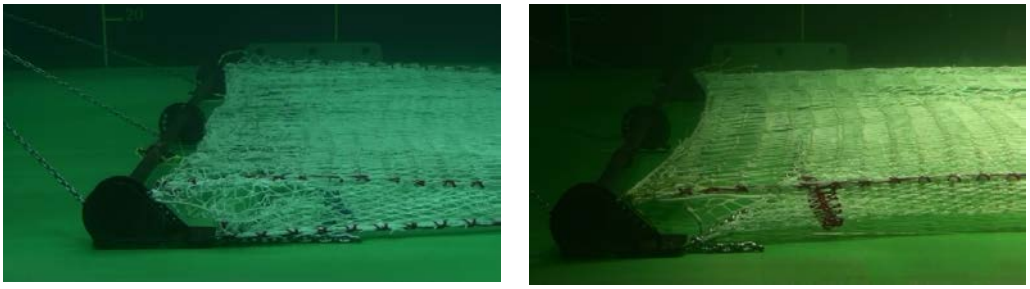

Figure 7. New designs HydroRig net tested in Boulogne in 2010.

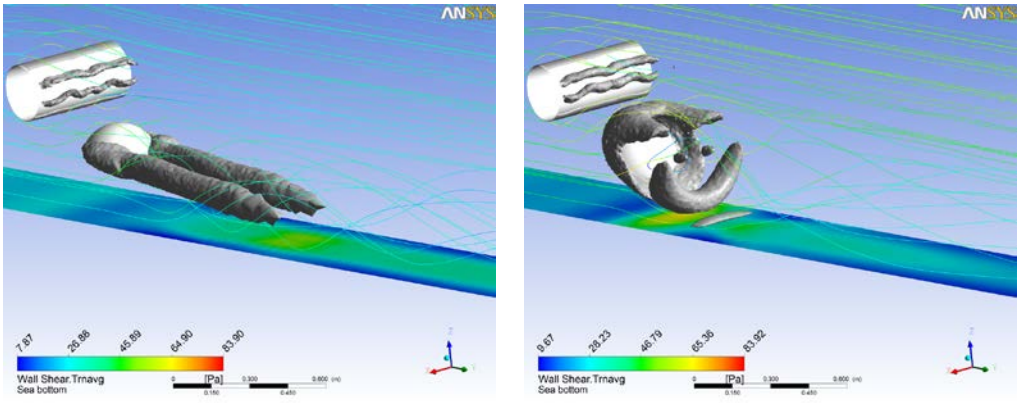

Figure 8. HydroRig flow simulations (Source: Deltares Delft).

VIP Passive Gear Development

A new project was started in 2010 with three vessels operating passive gears. Their wish is to create a year-round fishery. A research programme was set up for each boat involving the use of gillnets, trammelnets, pots and jigging machines. Data were collected on trammelnet shots using a predefined format and will be analysed by IMARES. A jigging experiment was carried out on Atlantic mackerel.

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VIP VDTN Bycatch Reduction by Technical Means

As follow-up of earlier projects with Benthic Release Panels and Benthic Release Holes a new project was set-up with three commercial beam trawlers. The idea is to bring together a number of skippers, exchange ideas, test new adapted versions first on FRV "Tridens", and then conduct practical trials on the commercial boats to fine-tune these devices. This work is also done in cooperation with ILVO. Financing problems cause a delay of this project.

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Institute: IMARES

VIP ViBOS

This project aims at developing a data collection and decision support system for fishers. Three beam trawler skippers are involved. The project is coordinated by Chartworx Ltd. of Den Helder, the Netherlands. We aim to bring together data from various sources, e.g. DGPS, electronic sea charts with hydrographical data, vessel plotter, catches and bycatches (E-logbook), warp loads, fuel consumption, etc. The system will be made to optimize the skippers' performance in terms of catches, fuel use and effects on the marine ecosystem. The project is delayed by financing problems.

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VIP PALSED

Fish welfare is a topic of growing concern. A fishing company (Ekofish Group of Urk) is investigating with IMARES/WUR specialists in fish welfare and the consultant Scienta Nova the possibility of stunning fish by electricity caught on-board before gutting, and by doing this to decrease suffering. A prototype stunner in which fish

can be fed by hand was tested in the laboratory of IMARES on dab. The system is able to render the fish unconscious before further processing takes place. Further test will be done on plaice. A Norwegian company is involved in making a prototype that will be tested on-board a commercial fly shooter later in the project.

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Cooperative Research Platform

This project is all about cooperation between the Dutch Ministry for Agriculture, Nature and Food Quality, the Dutch Fisheries Product Board and IMARES. For several years, fisheries managers, fisheries representatives and fisheries scientists have been working on improving cooperation for a better management of the Dutch demersal fisheries. First there was the 'F-project', which aimed at improved stock assessments; better use of fisheries' dependent data; and communication between all parties (2002–2007). Then, in 2008, a platform for Cooperative Research was set up. In the platform representatives of the fisheries, managers and scientists take place. Their common objective is to coordinate all ongoing projects that are relevant to management and to share information. Several issues are being dealt with in the Cooperative Research Platform, e.g. validity of research surveys, collaboration in discards monitoring, setting up an industry survey etc. A structural way of communication improves cooperation between parties and has a positive effect on innovative trajectories in fisheries management. The platform is funded by both the Ministry and the Product Board.

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Industry involvement in research surveys

In the framework of the Cooperative Research Platform a new role was established for the industry in research surveys that are used for plaice and sole stock assessments (Beam Trawl Survey and Sole Net Survey). Fishers cooperated with scientists to check the survey nets before the surveys started and fishers joined the survey onboard of the research vessel. This resulted in more insight in the surveys from a fishers' point of view and a higher quality of the discussion between scientists, fisheries managers and fishers about the survey.

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VIP Industry Survey: Phase 1

In 2009 the first phase of the Trajectory Industry Survey was carried out. In this trajectory, fisheries managers, fishers and fisheries scientists investigate whether an industry survey – in addition to research surveys – for plaice and sole is useful. It is being investigated how such an industry survey should be set up and how it may influence fisheries management. The first phase showed that comparative fishing between research vessels and a commercial vessel is feasible and that there is sufficient support for an industry survey from (international) scientists, fishery managers and fishers. A request for funding of phase 2 was submitted in March 2010. In that phase the comparison of length frequencies of plaice and sole will be finalized.

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VIP Industry Survey: Phase 2

In 2010 the second phase of the Trajectory Industry Survey was carried out (see previous project). The objective of the second phase was to compare catch composition

of research vessels and a commercial vessel, while fishing alongside during the Beam Trawl Survey (BTS). Length frequencies of plaice and sole were compared. It appeared that all length classes are caught by both research and commercial vessels. This resulted in the conclusion that the BTS is good enough for getting a signal on developments in the plaice and sole stocks. A commercial vessel however, does of course catch a lot more plaice and sole per unit of fishing effort. Therefore it is expected that a survey with commercial vessels, fishing at commercial speed using commercial gear, would result in more information on plaice and sole. More information would help to get less uncertainty in estimates of recent stock developments. Eventually this may reduce inter annual variation in estimated stock size and TAC advice.

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Fishery Study Groups ('Knowledge Circles')

Fishery Study Groups are (study) groups of fishers and fish-farmers who formulated challenges, questions or problems in their fishing or fish-farming activity. Together they look for solutions to make their fishery more sustainable: both from an economic and ecological point of view. There are currently 12 Fishery Study Groups, working on various fisheries in the Dutch sea, lakes and rivers and on farming of oysters or fish. Issues that are being dealt with are e.g.: gear development (pulse trawl, SumWing, outrig, fly shooting, static gear, Nephrops trawl and shrimp (*Crangon crangon* L.) trawl), reduction of bycatch or discards, increasing knowledge of target species, reduction of fuel costs and improving cooperation between fishers and retailers.

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Fishery Study Groups Flyshoot fisheries

Since 2008 Dutch fly shoot skippers from the North and the South (about 16) are working together in a Fishery Study Group exchanging practical experiences and discussing problems. Besides communication and marketing aspects they are interested in improving their fishing techniques. A group of fly shoot fishers visited Icelandic colleagues, the Marine Research Institute and flume tank, as well as netmakers. The technical questions are related to creating more sustainable fisheries and improving fishing techniques, with specific interest in the behaviour of seine ropes on different grounds. Flume tanks are too small for scaling these ropes (2 x 1500 m) correctly for model testing. It was investigated whether other facilities could be used, such as model basins used in naval studies (e.g. of MARIN the Netherlands), but this appeared to be too costly. Discussions are still ongoing about whether to make use of ROV's and/or underwater cameras or even mini-submarines for direct observations. It appeared that the insurance fee was too high for the use a mini submarine or an ROV. Instead the Dutch /Danish company MacArtney is willing to modify an existing net camera recording unit for the fly shoot fisheries against cost-price. Fishery study group members will test the unit in May/June 2011 off the coast of Scheveningen. The Dutch netmakers and skippers are also interested in user-friendly net design software. Contacts with SINTEF and Ifremer were made.

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19.8 Norway

19.8.1 Institute Of Marine Research, Bergen

Reduced bycatch of bottom fish in the small mesh trawl fishery for blue whiting and Norway pout

The experiment with grid sorting systems in bottom trawls for Norway pout in the Norwegian Trench continued in 2010, with some minor problem with fish loss through the fish outlet. Due to a smaller mesh size used in the Norway pout fishery compared to that normally used in the blue whiting fishery, an increased water flow through this outlet swept a substantial portion of the target fish out of the trawl. The problem was solved by introducing an extra extension piece with slightly bigger mesh size aft of the grid section. Experiments with flexible grid with rectangular bars (10x45 mm) instead of round steel bars (12 mm diameter) as used in earlier experiments, gave only half the water flow through the grid, with a subsequent loss of target fish. These experiments will be continued in 2011 with drop-shaped bars, and end late 2011.

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Resource and environmental friendly purse-seine technology

Earlier, well-established catch procedures with large quantities of low-priced fish from pelagic fisheries have often resulted in slipping of part or all of the catch. This has been due to wrong size or quality, or simply because the vessel was unable to take the whole catch on board. There has seldom been a focus on or any thinking about this practice, or about whether it could have a negative impact in terms of unaccounted mortality of the fish slipped. Catch slipping has been a part of everyday reality in the purse-seine fisheries, and has been regarded as a necessary tool for regulating catch size. Full-scale survival experiments have in the recent years revealed a substantial mortality both of mackerel as well as on herring that has been exposed to crowding and slipping. This knowledge initiated in 2010 research on methods to get a sample of purse-seine caught fish on deck in an early stage in the purse seining process, and well before crowding. Net pockets sewn the net wall of the purse-seine, gave samples from time to time, but no evidence of which factors determined a successful sample or not. The methods as such gave reliable results regarding fish size as there were no significant difference in size of fish from the sample pockets and those in the main catch. The experiments with sampling technique and methods of gentle release of fish from a purse-seine will continue in the coming years, along with development of rough observation equipment designed for use in purse-seine hauled through triplex and power block.

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Technology development for capture, transport and storage of cod (*Gadus morhua*) in Capture-based aquaculture (Institute of Marine Research in collaboration with SINTEF Fisheries and Aquaculture and NOFIMA Marine)

Introduction of pair seining as means to increase CBA landings for the smaller coastal fleet

In order to increase the landings of live cod for buffer storage and on-growing, as well as to include small vessels (< 15m) in this fishery, a pilot study was performed in May 2010 using the Canadian pair seining technique as described from the early 1970s. Due to bad weather in the experiment period, only four hauls were success-

fully performed by the 14 and 15 meter vessels, catching from 2500 to 4500 kg cod per haul of 15–20 minutes. The seine rigged for one-boat seining turned out to be too light for pair seining, and took off bottom at several occasions. Pair seining is regarded as a very interesting option for small boats, both for live fish activities, but also to improve general fishing efficiency during autumn when both cod and haddock moves deeper and partly out of range for these vessel with limited rope length (< 6 coils). The experiments will continue in 2011.

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Bagging and vacuum pumping as loading systems in CBA, effects on survival and fish welfare

Cod captured by Danish seine for CBA purposes on the Finnmark coast in April 2010 were loaded from the codend on-board to the fishing vessel using either bagging or vacuum pumping. Fish welfare was evaluated using a combination of physiology, visual physical injuries and reflex testing for survival potential. One hundred fish from each loading system were evaluated after sorting at deck, and then 1500 fish from each group were followed up in a six week net pen holding period before an end evaluation of another 200 specimens was conducted. Only small differences between the two loading systems were apparent for the small and medium sized hauls investigated (<8 metric tons). Neither physiology nor survival was markedly different for the two loading systems compared. A higher percentage of eye injuries and a higher degree of finsplitting for the bagging method than for vacuum was observed as expected since fish are susceptible to more net contact during bagging than vacuum pumping. These damages are not easily seen at sorting and may develop in the holding experiment. Given the strict sorting regimes governed by CBA legislations, there is so far little to suggest that any of the two methods is markedly more advantageous in terms of fish welfare than the other. Experiments will continue in 2012.

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Development of a coastal fishing vessel concept (Danish Seiner, Loa = 14.99 m) for catch and freight of living fish

In June 2010 fishers in Båtsfjord and Sortland were visited to discuss a possible interest in building a new 14,99m coastal fishing vessel for catch and freight of living fish. In Båtsfjord we met John Roger Eriksen, owner of Rubin (L=14,04m, B= 5,0m) and Knut Haldorsen, owner of Pontos (L=12,97m, B=5,0m); both vessels were built by Skogsøy Shipyard - Rubin in 2005 and Pontos in 2008. Rubin is arranged as a Danish seiner and has a hold capacity of 45m^3 for living fish freight. The seawater pump capacity is 100m^3/hour and the living fish capacity is 4.5 tons. Seawater is pumped through a double bottom that is perforated, thus allowing good circulation of fresh seawater in the hold. Pontos is also prepared for living fish transportation. We also met Mikal Steffensen, owner of Klotind (L=14,99m, B= 5,0m). Klotind is built at Mjosundet Shipyard in 1986. Klotind is arranged for long lining. Mikal Steffensen and John Roger Eriksen were both interested to participate in the development of a new vessel concept with a view to renewal. The following activities have been carried out in 2010:

1) Meetings with ship owners with renewal plans.

2) Hull design, including tanks for living fish transportation.

3) Preliminary general arrangement of 14,99m Danish seiner.

4) Outline specification of a 14,99m Danish seiner.

The outline specification is prepared in cooperation with Mikal Steffensen. The specifications describe the user requirements regarding main dimensions, capacities, deck equipment and on board facilities. In 2011 we will incorporate a shipyard in the project group.

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Flow pattern inside a towed cylindrical netting section

To verify the flow pattern in the cross section of a netcone similar to the aft belly/codend entrance of a small mesh trawl, flow measurements were taken in various positions relative to the netting of a net cylinder made from 24 mm mesh size PA netting. The cylinder was kept open with a front ring of 2 m diameter and four supporting rings of 1.5 m diameter along the netting section to obtain its cylindrical shape. The flow in various positions inside and outside the netting wall were measured with towing speeds of 1 and 1,8 knot in the Hirtshals flume tank and with towing speeds between 2 and 5 knot in sea trials. The tests did not indicate reduced inflow in the entrance of the netting cylinder, whereas the flow along the netting of the cylinder was slightly reduced in the vicinity of the netting, and that the width of the reduced flow area increased backwards. Among others these results might explain some of the fish behaviour patterns while passing through the aft trawl belly section into sometimes narrow codend entrances. www.imr.no/filarkiv/2011/03/hi-rapp_2-2011_til_web.pdf/nb-no.

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Development of a new Multi Purpose Pelagic Ecosystem Trawl (MULTPELT)

IMR is coordinating a process to develop a standard survey trawl for pelagic resource surveys in the Northeast Atlantic. Participants in this work are scientists (gear technologists as stock survey specialists) and trawl manufacturers from Iceland, the Faroe Islands and Norway. A multipurpose trawl with 832 m circumference and 16 m front part meshes to be towed at 5 knots has been designed, and it is now in the process of being accepted by the three Nordic countries participating in the process. Other countries are encouraged to adopt a similar pelagic survey trawl.

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Establishment a Center for Research-based Innovation in Sustainable fish capture and Processing technology (CRISP)

IMR has been granted 8 years of partial funding from the Norwegian Research Council to host CRISP (www.imr.no/filarkiv/2010/08/hi_nytt_11_web.pdf/en), a Center for Research-based Innovation. Other participants in the centre are Norwegian instrument and fishing gear manufacturers, a fishing company, the two Norwegian sales organizations for demersal and pelagic fish, the universities in Tromsø and Bergen and Nofima as a major research partner dealing with fish quality and marketing of fish products. The primary objective of the centre is to enhance the position of Norwegian fisheries-related companies as leading suppliers of equipment and seafood to a global market through the development of sustainable trawl and purse-seine technology. Secondary objectives are to:

- Develop and implement instrumentation to identify species and sizes prior to the catching process;
- Develop and implement instrumentation for commercial fishing to monitor fish behaviour and gear performance during fishing operation;

- Develop methods and instrumentation that actively release unwanted by-catch unharmed during trawl and purse-seine fishing;
- Develop new trawl designs that minimize the environmental impact on bottom habitats and reduce air pollution;
- Develop capture and handling practices to optimize quality and thus value of captured fish;
- Analyse and document the economical benefits for the fishing industry resulting from implementation of the new technology developed by the project.

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Midwater trawling for gadoids in the Barents Sea

Experiments to explore if midwater trawling techniques can be an economical and sustainable method for the trawler fleet to catch gadoids in the Barents Sea have continued in 2010. The motivation for performing the trials is to reduce the bottom impact from the trawler fleet by shifting effort from demersal to pelagic trawling. The 4-panel design of grid section and codend has been further elaborated by the construction of a trouser aft section. This effectively doubles the sorting capacity of the system. Each leg consisted of a grid section made of square meshes and a codend with square meshes in the upper section and diamond-meshed netting in the side and bottom panels. All panels were made of braided, knotless netting. The grid installed was a flexible grid of the commercial "Flexirist" design. The system was tested on board a research vessel in October and during full-scale selectivity trials on board a commercial stern trawler in late November. Selectivity was similar to that measured for bottom trawls using identical mesh size and grid bar spacing. The fishing experiments also showed large spatial and temporal variability of the availability of cod and haddock to pelagic trawling. Pelagic trawl is therefore a supplement and not a replacement for bottom trawl. However, when favourably distributed, large catches can be taken during very short towing times. To avoid this, a catch limiting device will be designed to release surplus fish at the fishing depth.

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Unaccounted mortality of Norwegian spring-spawning herring crowded and slipped in purse-seine fisheries

Full-scale survival experiments were carried out at the coast of southern Norway in March/April this year. They showed that the unaccounted mortality of herring *(Clupea harengus)* that were exposed to hard crowding and subsequent slipping from a purse-seine was substantial. The mortality rate five days after slipping depended on crowding density, with about 37% mortality in the hardest crowded group. The mortality in the control group was close to zero. Blood samples taken during the experiments indicate that herring struggle to maintain their water/salt balance after slipping probably as a result of scale loss and skin damage. These results suggest a need to revise the legislation on slipping in these fisheries.

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Capture of wild fish at fish farms

Fish farms may act as a fish aggregating device (FAD) and attract wild fish. In Norway there is a 100-m safety zone around fish farms that ban fishing in close vicinity of the farms. Fishing trials with pot were carried out in order to develop a fishing tech-

nique that can be used within the safety zone without causing damage to fish farm installations. Catch rates (cod and saithe) obtained at the cages were much higher than those at a distance of 100 m from the cages, and larger pots gave higher catch rates than small pots.

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Density estimation of King Crab in the Neidenfjord based on underwater video and compared to pot and trawl

In August/September 2009 two sampling gears, pots and trawl, used in stock assessment for king crab were evaluated. First, a video transact was performed with an underwater drifting camera rig and afterwards trawl and pot samples were taken in the same area. Based on this investigation the average area "fished" by pots was estimated to be 4631 m2 and the trawl efficiency was estimated to 0.37. The work continued in 2010 with comparative experiments including use of video and trawl and pot experiments.

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Reduced bycatch of King Crab in the gillnet fisheries for cod in Northern Norway

This is an ongoing project where a fine meshed net of a height of one meter is mounted on the lower part of the gillnets. These nets will be compared with standard gillnets to evaluate the bycatch reduction of king crab.

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19.8.2 SINTEF Fisheries and aquaculture

Development of s selection system for midwater trawling for cod

Full-scale experiments to assess the selectivity of two codends were performed on board the commercial trawler "Atlantic Star" in November 2010. The results showed that the selectivity of a 138 mm T-90 codend and that of a codend with 130 mm Exit Windows gives encouraging good selection in midwater trawling for cod. Both codends proved to be effective to sort out small fish under relatively high catch rates of fish (up to 12 tonne fish per hour). Both codends gave stable selection regardless of catch size (which ranged from 1.6 to 18 tons), and both caught on average less than 2% of undersized fish in areas which had up to 32% of undersized fish. These selection systems can thus become a clear alternative to grid selection in midwater trawling in the Barents Sea cod fishery. Further work in this project is planned for 2011 and will focus on size selection, development of catch control systems and registering of energy consumption by midwater trawling.

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Development of a catch control device for midwater (and/or bottom) trawling

One of the problems of fishing cod with pelagic trawls is that one can easily take too big catches. Large densities of pelagic cod mean that large quantities of fish enter the trawl in only few minutes. Therefore the sizes of the catches are difficult to control even with a lot of electronic surveillance on the trawl. Too big catches (over 30 tons of fish) mean that the fish must be on the intake bins for several hours before being processed, a situation that reduces quality of the catch. This project will develop a catch control system where the skipper can easily control the size of the catch. Small scale experiments with catch control devices were performed the flume tank in Hirt-

shals, Denmark (April 2011) and full-scale experiments will be carried out on board the RV "Jan Mayen" in May 2011.

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Mapping of potential solutions about the use of biodegradable materials in fishing nets to reduce ghost fishing

Lost fishing gear is a major environmental problem both internationally and in national waters. Norway is the only country in the world to systematically clean up nets on the most intensive gillnets fishing grounds. Norwegian authorities estimate that there are lost between 500 and 1000 nets per year only in Norwegian waters (Misund, *et al.*, 2006). Experience with clean-up work shows that the lost gillnets that is left on the seabed may be actively fishing in at least seven years after they are lost. This represents a significant hidden, unwanted and totally unnecessary form of resource use. Lost nets contribute to hidden mortality of a large quantity of fish of different species throughout the year. In addition to the environmental problems creates lost fishing gear conflicts between different groups. This project is aimed at generating solutions to reduce/avoid the impact of ghost fishing by proposing the use of organic materials in the construction of certain components of gillnets.

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Selectivity studies in the Barents Seabed trawl gadoid fishery: gear and methods

Despite international criticism and efforts to implement more environmentally friendly gear, bottom trawling remains one of the main fishing techniques used in the Norwegian and Barents Seas to catch cod and haddock. This study deals with some of the challenges that selectivity studies in trawl fisheries face. The main goal of the project was to positively contribute to the development of demersal trawl fisheries research and management in general and to issues relevant to the Barents Sea in particular. Since 1997, all trawlers fishing in the Norwegian waters of the Barents Sea have been required to use a sorting grid with a minimum bar spacing of 55 mm followed by a codend with a minimum diamond mesh size of 135 mm. In the first part of the project, we studied alternatives to the obligatory grid + codend setup and the effect on the selectivity of cod and haddock of increasing grid bar spacing from 55 mm. The alternative gears tested were a diamond mesh codend of 155 mm nominal mesh size and a diamond mesh codend of 135 mm (nominal mesh size) with two lateral 142 mm nominal mesh size exit windows. The sampling method used in the experiments conducted during the first part of the project is known as the paired-gear method. This method and the covered codend method are the two most commonly used techniques for selectivity studies in demersal trawl fisheries. Therefore, both sampling methods were compared at sea with four different selection gears. When using a grid + codend selection gear, fish actually can escape from the trawl through a process of dual selection and therefore we investigated in detail the dual selection process that occurs when using such setups. In the last part of the project we carried out a multidisciplinary approach to size selectivity studies that combines recent methodological developments and technology, sea trial results, and underwater observations for the Barents Sea cod and haddock bottom trawl fishery. The combination of the different disciplines provides a more global view of the selection processes that take place in the different gear used in this fishery. The project was funded by the University of Tromsø and carried out in close cooperation with DTU Aqua (Denmark). The first four chapters of the study are published in Fisheries Research while the last one is published at Canadian Journal of Fisheries and Aquatic Sciences.

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New fuel- and catch efficient active fishing gear concepts based on trawl and seine

A project was started in 2009 and running to 2012, with the aim to reduce NOx- and other environmental emissions and impacts from demersal fisheries by proposing new fuel- and catch efficient active fishing gear concepts based on trawl- and seine technology. The project shall propose new rational fishing strategies and develop new, feasible gear concepts in close cooperation with fishers and the fishing industry, through workshops, lab tests and numerical simulations, including aspects such as net design, towing resistance and catch efficiency, including among other things a PhD in Operational Analysis. A matrix of potentially interesting combinations of nets, spreading devices and groundgear for bottom trawls, (semi-)pelagic trawls and (Scottish) seines has been established and tested in the Hirtshals flume tank, and some of these will be followed up with full-scale trials. In addition a dynamic trawl simulation tool is being extended to handle seine-like operation.

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19.9 Scotland

19.9.1 Marine Scotland – Science, Marine Laboratory, Aberdeen, Scotland

A 45 mm flexible grid in a Scottish Nephrops trawl fishery

A set of catch comparison trials was conducted in the North Sea to examine the effect of fitting a Nephrops trawl with (i) a flexible grid with 45 mm bar spacing plus large open bottom gaps and (ii) a similar flexible grid with bars of 45 mm spacing all the way down. The results can be summarized as follows

i) There are no significant losses found of Nephrops < approx 44mm (carapace length) from the gear using the grid with the bottom gaps, but there were found to be losses in the larger sizes e.g. approx 20% at 50 mm and 57% at 60 mm.

ii) Retention of cod, haddock, whiting and witch was found to be greatly reduced as compared to the commercial gear. In trials with the 45mm grid which incorporated open gaps at the bottom, no cod > 46 cm, haddock > 50 cm, whiting > 42 cm and witch > 44 cm were retained by the grid gear.

iii) The grid with no large open bottom gaps was found to clog up badly with buckies and starfish, and sometimes seemingly caused the grid to fall over onto its side during fishing.

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Low headline Nephrops trawl

Trials were held to assess whether whitefish bycatch could be reduced in the Nephrops trawl fishery by using low headline Nephrops trawls. There was no significant reduction in the quantities of cod caught when using the Nephrops trawl with a headline height no greater than 1m. For whiting there was no significant difference between the two trawls for fish below 27 cm and for haddock below 30 cm. However, for larger whiting and haddock there were significant differences in relative catch rates in lengths >28 cm and >31 cm respectively. For Nephrops the control gear appeared to fish better than the test with significant differences in the catch rates found

for Nephrops above 36mm carapace length. However, overall catch rates for this species was very low with none of the hauls being representative of commercial catches.

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The mobilization of sediment by towed demersal trawls

Experimental trials were carried out in the Moray Firth, Scotland during 2007 and 2008 to measure the quantity of sediment remobilized by trawl gear components towed using a benthic sledge. A LIIST 100X particle size analyser was mounted on the sledge and measured the particle size distribution and concentration in the sediment plume behind a range of gear components. During 2011 these data have been analysed and demonstrate, for a given sediment type, that there is a relationship between the hydrodynamic drag of the gear component and the mass of sediment entrained behind it. A better understanding of this relationship and the hydrodynamic processes involved will lead to the development of accurate predictive models and aid the design of fishing gears of reduced impact.

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Fish behaviour at the mouth of a trawl gear – the 3T trawl

As part of a project to investigate fish behaviour in trawl fishing gears a trawl (the "3T trawl") was designed, in conjunction with Cefas and SEAFISH, to quantify the horizontal distribution of different fish species entering the trawl relative to three sections (port side, centre and starboard side). The trawl is partitioned into three sections using two vertical panels running from the mouth of the net to three separate codends. The leading edges of the panels run from the quarters on the fishing line up to the shoulders on the headline, on the port and starboard side of the net respectively. To observe fish behaviour video cameras were placed in fixed and coordinated positions on the net. A total of 38 fishing tows were used to collect data for determining the distribution of fish entering the trawl mouth (in particular cod, megrim and monk) and tow duration was limited to 1–1½ hours due to limited facilities on deck to accommodate larger catches. The camera observation and fish data are currently undergoing analysis.

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19.10 Spain

19.10.1 AZTI Tecnalia

Fishing Technology related projects that are being carried out at AZTI Fundazioa (Technological Institute for Fisheries and Food; www.azti.es) by the Marine and Fishing Gear Technology Research Area.

Development of a fuel management system for improvement of the fuel consumption pattern in fishing vessels

The main aim of the project is to improve fuel efficiency of fishing vessels. In order to accurately characterize the pattern of fuel usage on-board, a complex consumption measuring system was initially designed, capable of recording not only the fuel consumption but also many other interesting variables, such as the wind force and direction, the exhaust gas temperature, the rolling and pitch movements and the vessel speed among others. The information given by each sensor was recorded every sec-

ond in a computer. This system allowed calculating how much the fishing vessel consumed in each part of the fishing operation. The installation of the measuring system was carried out in 4 vessels from 3 fleet segments where the fuel consumption is higher (trawling, purse seining and trolling). The system was running for practically a year. The results were very satisfactory and brought fuel consumption reductions up to 20% depending on the fishing segment. After this period we reached several different conclusions. The main conclusion was that such a complex system was not necessary to bring notable benefits to the user. The following step was to develop our own low cost system to assist the fleet in the fuel consumption management on board. The system was modular, including the options of electric measuring, register and physical parameters like temperature, pressures, etc. The system does not need a PC, although it can communicate with one. It is an autonomous system that comprises in minimum configuration: fuel measuring, vessel speed measuring, engine speed, software for efficient sailing recommendations and register of all the parameters. The modular configuration lets the system to be incremented with more cards and include engine physical parameters and electric consumption and generation parameters.

MarineRC, recover of the energetic losses from waste heat from thermal engines

The main goal of this project is to develop a system that allows the recovering of part of the waste heat in diesel engines to generate electric energy or to move any other mechanic gear. In this way a reduction of the fuel consumption will be achieved and in the same time the emissions to the atmosphere will be reduced, what means an improvement of the environment. Basically the project involves the development of a system that with the best use of the heat lost in the exhaust gases and in the cooling water to move an expander which generates mechanical energy that produces electric energy or moves another mechanic device.

MarineFUEL, experimental tests on alternative fuels for the fishing fleet coming from recycled lubricant oils

The main goal of this project is to characterize the combustion characteristics of a new alternative fuel oil coming from recycled oils in a test bed and in real operating conditions and to compare with the traditional distilled diesel oil in controlled conditions to define its possible use in the fishing boats.

EFIOIL

This project focused on fuel efficiency consists of five subprojects:

- ORC: Organic Rankine Cycle. Development of an experimental Organic Rankine Cycle with a scroll expander for recovering waste heat from cooling water and exhaust gases;
- AUDITOIL: Development of energy audits for fishing fleet;
- HELIZAK: Measurement of propeller thrust for efficiency evaluation;
- HOBEBIDE: Development of a tool for weather routing in Basque fishing fleet;
- BULBOS: Evaluation of bulb installation in Basque fishing fleet via CFD simulation and water tank tests.

Technical and economical study on the potential fuel efficiency improvements of hull and propeller modifications

When a boat is sailing at a constant speed, the pushing force of the propeller is balanced by the force resisting motion. The main objective of this study is to evaluate the suitability of changing the propeller and hull appendage designs in order to reduce fuel consumption, either optimizing the propulsion or improving the hydrodynamic characteristics of the hull. A classification in different groups has been carried out among all the fishing vessels of the fleet based on hull design and fishing operation. A sample of several fishing vessels, representatives of each group, and all the possible modifications on the hull are being studied and designs of new propellers are being carried out. Although many of the modifications studied will not be executed during the length of this project, improvement in fuel efficiency will be estimated based on naval engineering methods. Preliminary results show that bow bulbs improve fuel efficiency in larger vessels, in the same way a propeller adequate to hull design helps in fuel efficiency improvement. Also, a correct trimming of the vessel is another important factor for that objective.

AURREZLE: Tests of fuel saving devices and fuel additives in test bench and in real operation conditions

The purpose of the project is to check several fuel saving devices in order to know their efficiency in fuel saving. Devices to be checked are two fuel polarizers and a hydrogen producing device with exhaust gas. Two types of fuel additives also will be checked. The tests will be carried out in test bench and if results are positive later will be carried out on board in real operating conditions. Monitoring on board will be carried out with our designed fuel management system and torque meter.

MANTOIL: Condition Based Maintenance for efficient operation of main engine

The purpose of the project is to monitor the different parameters of the engine that have a direct relationship with engine fuel efficiency. The engine efficiency will be constantly checked and the performance will be analysed in order to keep the engine in efficient operating conditions from a fuel consumption point of view. The monitoring of the fuel consumption and the engine parameters will be carried out with our designed fuel management system. The data analysis will be carried out with artificial neural networks.

Reduction of the discards by mean of selective devices in the "Baka" single bottom trawl

In this 3 year project started in 2009 we will try to reduce the discard in bottom trawlers operating in ICES VIIIabd by mean of selective devices. In the first steps of this project an underwater video camera will be set in different parts of the trawl to study the behaviour of different species of fish. The footage obtained with the camera will contribute to a decision on the most suitable part of the trawl to set selective devices in relation to fish behaviour. During 2009 one cruise was carried out and no cruise could be done in 2010 due to a reduction in funds. During 2011 we expect to carry out one or two cruises in which our main goal will be to determine the selective parameters of a system composed of 70 mm codend and 100 mm square mesh panel. This panel is mandatory to use 70 mm codend otherwise 100 mm should be used.

Quantification of the discards and improvement of the selectivity in the artisanal fisheries

In this 3-year project, started in 2009, a characterization and quantification of the discards in different gillnetting artisanal métiers will be carried out in order to identify the ones with the higher discard rates. The discard will be characterized (species involved, reason for discard and discard rate by fishing métier). An analysis of the possible methods to reduce the bycatch of the more frequent discarded species will be done, paying special attention to the operational factors in the fishery. Finally, in fishing trials the selected method for reduction of the bycatch of discarded species will be tested.

Identification of the technological creep since 1950 in some of the most traditional fisheries for the Basque fishers

In this project, retired skippers will be interviewed in order to identify the technological creep in the fisheries they have been involved. With that purpose, 4 fisheries have been selected: anchovy with purse seining, tuna with pole and lines, tuna with trolling lines and tuna freezers with purse seining in tropical waters. For each one of the mentioned fisheries all the technological improvements introduced in the fishery will be identified and characterized. Thereafter, a description or quantification of the importance of each of the technological changes, in terms of increase of the catches, will be done. In addition information about the evolution of these fisheries will be collected in terms of when change was introduced and where it comes from, also.

19.10.2 Instituto Español de Oceanografía (IEO)

Discard reduction and fishing technology related projects are being carried out by the Instituto Español de Oceanografía (IEO; www.ieo.es) in collaboration with other institutions and fishing sector

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Strategic Spanish Project relating responsible fishing on discard reduction (REDES)

REDES is a multidisciplinary project funded by Spanish Science and Innovation Ministry and the EU, which began in 2009 to try to address the gaps identified in Spanish gear selectivity. REDES included fishers' associations, ship-owners, technology industries, research institutes and university departments in a collaborative way. The project dealt with two Spanish métiers during 2010. A description of the partnership is shown below:

- The fishing industry is represented by two of the main Spanish associations (ARVI and CEPESCA), linking the relevant fleets that will have to face discard reductions with the project.
- Other key industrial partners in REDES are those companies having to deal with fishing gear and fishing technology. TECNOPESCA PYM and MAREXI are two Spanish SME´s in charge of the implementation of new ideas into specific products feasible for target fishing units.
- Five different public research institutions such as the Spanish Institute for Oceanography (IEO), the University of Vigo, the University of A Coruña, CETMAR Foundation and the CEHIPAR Flume Tank collaborated in the R&D.

REDES was designed as an integrated project comprising the following sub-projects:

- SP1 – Analysis of the distribution, performance and factors influencing discarding in the selected fishing métiers
- SP2 – Design and construction of the selective fishing gears and devices.SP2 includes the so-called "Design Centre", a meeting point between fishers, technicians and scientists.
- SP3 – Simulation, testing and re-design of new fishing gears and devices.
- SP4 – Analysis of selectivity and the major effects expected from the introduction and use of selective fishing gears.
- SP5 – Project Office: Coordination, dissemination, contribution to standardization and technology transfer support.

Only SP1, SP2 and part of SP3 (simulations and towing tank testing) were active for the time being owing to unexpected budget restrictions from the Spanish ministry of science. Alternative financing is being sought to continue the work begun with REDES.

Integral Networking of Fishing Sector Actors to Organize a Responsible, Optimal and Sustainable Exploitation of Marine Resources: FAROS

The main objective of FAROS is the development and implementation of an efficient and integral discard and bycatch management network, including all actors present in the fishing sector (fleets, ports, auctions, industries, etc.), which both aims for the minimization of discards/bycatch as well as their optimal valorisation to recover and to produce valuable chemicals of interest in the food and pharmaceutical industry. In keeping with this objective, several goals are being pursued:

- To predict spatio-temporal distribution of common catches of a given fleet, aiming to avoid fishing mortality on the non-valorised species and to improve the chance of fishing valuable species and sizes demanded by industry (with subsequent reduction of fuel consumption).
- To select the target fisheries based on historical analysis of the total catch composition. To analyse the obtained "total catch-métiers" in order to understand their spatial-temporal behaviour. Results from this analysis could be used as a base to forecast their catch supply along the year.
- To develop a complete characterization of discards on the selected fisheries (based on proposed automated classification, analysis and data collection tools) as potential raw material for different valorisation processes in land.
- Based in the new scenario, with the new defined unwanted bycatch, to determine different action protocols to minimize that unwanted bycatch
- To create a supervisory network for an efficient and integral discards management based on information flows exchanged between fleets and on land agents (offer and demand, respectively).
- To demonstrate the benefits of the proposed discards management environment.

Expected results:

1) The main expected result is an integral management network for the extractive fishing sector and related process industries (transforming, valorising, etc.) which will induce a modification of capture methods, areas, depth, etc, to reduce unwanted bycatch and eliminate discards in each

fishery or to get the specific target species. This network environment will both allow:

- To the fishing fleets: to know the market demand for all the species captured during a campaign, allowing them to optimally program their activity in order to get a responsible and sustainable exploitation of marine resources.
- To the industries: to know in real time if all the required amount of raw material (discards) for a given valorising industry from a port near them will be available based on the data obtained from the fleets. This integral network will supply the needed information to obtain the desired raw material from other geographic areas, allowing also planning for transport in advance (before the vessels arrive to land).

2) A spatial and temporal map based on a developed GIS model for the activity of the selected fleets (considering species distribution) will be developed, giving the opportunity to fishers to both avoid areas or times with an abundance of unwanted bycatch as well as to contribute to obtaining the most profitable, ecological and lowest fuel consumption catch, fulfilling the EU Commission policies regarding environmental protection.

3) In connection with Result 1, a project on development and implementation of new on-board technologies to allow both real time data capturing based on vision (BEOS System) and data transmitting equipment from at-sea fleets to land and vice versa (red boxes) has begun.

Bycatch and Discards: Management INdicators, Trends and locatiON (BADMINTON)

In the EU there is intensive data collection of bycatch and discard on-board commercial vessels but until now there have been few attempts to describe the general patterns in these data, and still less to understand the factors that determine what and how much is discarded. However, the latter step is key factor if we are to develop operational indicators and propose mitigation tools for fisheries management. There is especially a need to investigate the effectiveness of mitigation methods that have been implemented in the past; that is, primarily technical regulations, including gear modification. This has to be done at the scale of the fishery. Many gear modifications shown to make a difference in field trials, however there have been few studies about the way fishers used these modified gears, and the real impact it had on catch and discards on the fleet scale. The proposal is developed along five main steps:

1) A descriptive analysis of total catch in terms of species and size composition, based on the data collected on-board EU vessels under the Data Collection Regulation. This includes a quantification of spatial and temporal distribution and abundance of discards.

2) The development of indicators of discard issues: indicators of discard state (amounts and characteristics of discards), of the pressures that determine discards (selectivity of fishing), and of the management responses to this issue.

3) An analysis of the factors that determine discard amounts, including environmental settings, year-class strength, community composition, and fishing practices. This includes an examination of the efficiency of technical regulations currently in force and retrospective analyses of the efficiency of such measures in the past.

4) An analysis of socio-economic and institutional drivers and incentives that influence fishers' behaviour in regard to selectivity and discard.

5) Based on all previous steps, the elaboration of potential mitigation measures. Beyond technical measures, integrated approaches that will remove or at least reduce incentives to discard should be aimed at.

19.11 USA

19.11.1 Massachusetts Division of Marine Fisheries - Conservation Engineering Program

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REDNET: A Network to Redevelop a Sustainable Redfish (*Sebastes fasciatus*) Trawl Fishery in the Gulf of Maine

REDNET is a new multi-institution, vertically integrated network whose goal is to access redfish in the Gulf of Maine, USA using selective trawls. Redfish historically supported a high-volume fishery that has only recently recovered. The project unites fishers, gear scientists, assessment biologists, fisheries managers, economists, processors and others to develop field efforts that will support regulatory implementation of a sustainable trawl fishery in an efficient and practical manner. Fieldwork scheduled for 2011 includes exploratory fishing with sublegal codend meshes (110 mm). Selectivity studies and bycatch reduction studies, based on exploratory results, will follow in 2012.

CEMFIN/GEARNET: Conservation Engineering Marine Fisheries Initiative

This initiative is another new collaborative network with the goal of assisting industry transition to output controls by identifying short-term technology transfer and pilot gear projects, based on existing knowledge and experience that could quickly reduce bycatch and avoid weaker stocks. Identified projects include demonstration of the large-mesh fronted haddock net, drop chain/raised footrope trawls, topless/cutaway trawls, norsel gillnets, acoustic pingers, cod pots, and others. Field efforts are scheduled to begin immediately and continue into 2012. Collaboration with Shelly Tallack and Steve Eayrs of GMRI, Pingguo He of SMAST, and others.

BreakBag

We are developing and testing a simple, low-cost codend closing mechanism based on a fisher's idea to control and limit the amount of fish caught. Inspired by output control rules that raise the risk of overcatch, the mechanism is designed to prevent additional catch once a pre-set limit is reached, and allow additional fish to escape. Design meetings with a broad collaborative network were held and prototype ideas are currently in development and testing.

Design and Test of a Squid Trawl with Raised Footrope Rigging and a Grid Device to Reduce Winter Flounder, Scup, and Butterfish Bycatch (SQUIDGRID)

Bycatch in a Loligo squid trawl fishery may be reduced through use of a raised footrope rigging and a grid. In collaboration with industry and Pingguo He, tests for May 2011 are planned to compare codend catches with and without the grid, following flume tank testing.

BRIDLE BEHAVIOR: Investigation of haddock and flounder behaviour near standard and floating bridles

Flatfish are herded primarily through contact with ground cables and with suspended sediment. Replacement of wire cables with synthetic ropes may allow targeting of haddock with reduced flatfish bycatch. Field observations of flatfish behaviour near bridles and alternate tows to test synthetic ground cables are planned for June 2011 in collaboration with Pingguo He and industry.

Development of a Spiny Dogfish Excluder in a Raised Footrope Whiting Trawl

A spiny dogfish *Squalus acanthias* excluder grate (grid) within the extension of a silver hake (whiting) *Merluccius bilinearis* trawlnet was designed and tested in Massachusetts Bay, USA between October 2008 and August 2009 using a live-fed underwater video camera. Grates with 50 mm spacing were investigated for effects from colour (white or black), angle, and direction (leading to a top or bottom escape vent). Spiny dogfish numbers were greatly reduced for all gear configurations based on video observations and data collected from the codend, while target species were caught in commercial quantities. Four tows (of various gear configurations) resulted in spiny dogfish blockages in front of the grate. The reduction of spiny dogfish led to increases in the quality of marketable catches, likely reductions in non-target species mortality, and decreases in the codend catch handling times. Results were published in Fisheries Research: http://dx.doi.org/10.1016/ j.fishres.2011.03.007. Industry is voluntarily testing this grate for adoption.

Determining the Seasonality of Cod Pots

Newfoundland-style, large, large-mesh static pots were compared to Norwegian-style smaller, small-mesh, off-bottom, dynamic pots in a controlled study from a commercial fishing vessel from November 2008-November 2009. Results from analysis indicate that cod were most vulnerable to pots during a limited season, and that the smaller mesh pot caught more small cod. Otherwise, the pots performed similarly. We conclude that either pot style may be effective for further development, that seasonality plays an important role and should be exploited for further testing, and observation of nearfield behaviour in cod near pots is still vital and problematic.

The Five Point Trawl

This trawlnet was designed to harvest Georges Bank haddock *Melanogrammus aeglefinus* while avoiding a weaker stock of Atlantic cod *Gadus morhua*. This semi-pelagic, sweepless, raised footrope trawlnet touches bottom with five drop-chains and exploits the rising behaviour of haddock while passing over cod during the herding process. Continued catch comparisons of the Five-Point Haddock Trawlnet and a separator panel trawl were conducted in May, 2009. Conducted analyses included paired non-parametric randomizations and generalized linear mixed models. Haddock, cod, and most flatfish catch results indicate that the experimental net does not perform significantly different from a separator trawlnet; yellowtail flounder catch was significantly lower in the experimental net. Based on the strong reductions in Atlantic cod and proven overall stability, this net may be ready for inclusion into regulations for use along with other selective haddock nets. A final report was submitted in 2010.

19.11.2 NOAA Fisheries, Northeast Fisheries Science Center (NEFSC), Protected Species Branch, Woods Hole, Massachusetts

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More info: www.nmfs.noaa.gov/by_catch/docs/brep_final_2011.pdf

Gear Modification Research to Reduce the Bycatch of Butterfish in the Offshore *Loligo pealei* Fishery

Analyses have shown that the primary source of butterfish (*Peprilus triacanthus*) discards is the *Loligo pealei* fishery because it uses small-mesh codends and because butterfish and Loligo co-occur year-round. Separation by mechanical means (e.g. grid or grate) is unlikely because butterfish and squid are both small-bodied and often occur together. We intend to use behavioural differences to attain species separation. Three prototype BRDs were evaluated at a flume tank in St John's, Newfoundland. Our goal is to obtain underwater video footage of the full-scale gear to evaluate performance and understand behaviour of fish species around the gear to further assess the potential of the different BRD designs. We anticipate results from the testing to be analysed early in 2011. We will use the results to complete a report by spring 2011 on the different BRDs and their effectiveness at reducing butterfish and other bycatch in the directed longfin squid fishery.

Assessment of the Impacts of Gear Modifications in the Monkfish Fishery on Bycatch of Atlantic Sturgeon and Harbour Porpoise

The majority of sturgeon *Acipenser oxyrinchus* bycatch mortality is attributed to the monkfish sink gillnet fishery. Tie-downs, which reduce the height of gillnets in the water column, appears to increase the overall size range of retained Atlantic sturgeon by increasing the susceptibility of smaller individuals to be retained, and increase the likelihood of mortality. Captive sturgeon under controlled conditions (eight fish placed in a 14-by-21-foot oval tank) suggested that removing tie-downs allowed more sturgeon to escape the gear. This study, which began in late 2010, compared bycatch rates for Atlantic sturgeon and harbour porpoises in a comparative experiment using gillnet gear with and without tie-downs in mid-Atlantic waters. The project was conducted in an area that had high catches of Atlantic sturgeon historically, and was conducted during November to December 2010; no results have yet been obtained.

Other NEFSC-identified future projects:

- Seabird bycatch reduction through completing gillnet seabird bycatch estimation analysis (2011–2012)
- Seabird bycatch reduction through completing seabird bycatch estimation analysis for gear type(s) other than gillnets (2011–2013)
- Turtle bycatch reduction in non-scallop trawl fisheries (2011–2015)
- Continuation of the estimation of bycatch of turtles and marine mammals in Northwest Atlantic trawl, gillnet, pot, dredge and longline fisheries (2011–2015)
- Finfish bycatch reduction in squid, herring, and Northeast multispecies trawl fisheries (2011–2015) Atlantic large whale take reduction in fisheries that entangle whales, through the development of gear modifications and other technologies to reduce takes (2011–2015)

19.11.3 University of Rhode Island Fisheries Center, Kingston, Rhode Island

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Reducing the Capture of Flatfish in Small Mesh Bottom Trawls Using the 30.5 cm (12 in.) Drop Chain Trawlnet Design

A modified fishing net (MFN) was designed using a standard bottom trawl squid net (SFN) with the addition of a 30.5 cm (12 inch) drop chain to create space between the sweep and the footrope. This net was laboratory and field tested for its ability to reduce the capture of flatfish. A total of 42 successful comparative paired tows (84 total tows) were completed over 7 sampling days using the SFN and MFN in Block Island and Rhode Island Sound. After testing for vessel effects, a paired t-test was used to test for differences between the combined mean weight in kilograms per tow for flatfish (summer, yellowtail and windowpane flounders) and target species (squid, scup and butterfish) in the SFN and MFN. Results show a significant difference between mean weights per tow for all flatfish species. There was no significant difference between mean weights per tow of target species. The findings of this research indicate the 30.5 cm (12 in.) drop chain trawlnet design has the ability to reduce the capture of flatfish while retaining target species in the small mesh fishery of southern New England.

Reduction of Butterfish and Scup Bycatch in the Inshore Loligo Squid Fishery

An experimental trawl with an escape panel and funnel was compared to the standard fishing net using side-by-side vessels on its ability to reduce the catches of butterfish and scup in the Loligo squid fishery in southern New England. Testing of the model net was conducted in the flume tank at the Marine Institute of Memorial University in Newfoundland in August 2009; field testing was conducted in and around Block Island Sound and Rhode Island Sound in autumn 2009 and spring 2010. Results show no significant difference in catch of the target species, Loligo squid, between the catch weights of the nets. In addition, there was no significant difference of total catch weights of scup and butterfish between the standard net and the modified net. However, there was a significant difference between nets for landed scup. Fieldwork for this study is complete; though underwater video collection is still planned with the hope of improving the design of the gear.

Fishery-independent Scup Survey of Eight Hard Bottom Areas in Southern New England Waters

This project, entering its eighth year, is designed to collect scup from hard bottom sites using unvented fish traps in Southern New England. Commercial vessels perform the fieldwork which is conducted in areas which are un-sampled by current trawl surveys. This project is a collaboration between commercial fishers, URI Fisheries Center, RI Department of Environmental Management Division of Fish and Wildlife, and the Massachusetts Division of Marine Fisheries. In 2010, data on black sea bass were also collected and is continuing in 2011. Analysts from the School for Marine Science & Technology (SMAST) have conducted a comprehensive analysis and a peer review workshop is being held at the end of April 2011 to go over the analysis and discuss terms of reference. Bycatch reduction in shrimp trawls.

19.11.4 New England Aquarium, Edgerton Research Laboratory, Boston, Massachusetts and University of New England, Marine Science Center, Biddeford, Maine

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Investigating the immediate and delayed mortality of skates subsequent to otter trawl and sink-gillnet capture

Fishing capture and handling can have outright or delayed lethal consequences in fish. Due to regulatory and market factors, species from the family Rajidae are routinely discarded as bycatch during commercial fishing operations in the Northwest Atlantic Ocean. This ongoing study is investigating the post-capture/handling viability and delayed (post-release) mortality of four rajids indigenous to the Gulf of Maine (USA) – *Amblyraja radiata*; *Leucoraja ocellata*; *Malacoraja senta*; and *Leucoraja erinacea* - subsequent to otter trawl and sink gillnet capture during normal commercial fishing activities. Thus far, ~800 skates have been monitored for delayed mortality in the study, with extensive work slated for the remainder of 2010. Analysis is ongoing and the work will be presented at multiple meetings this summer/fall. There is a paucity of data addressing the condition and mortality of skates caught by commercial fishing activities, and results from this study will aid in the management and stock assessments for these species.

Investigating the acute physiological effects of air exposure and the implications on discard survival in skates from the western Gulf of Maine

Skates are routinely discarded as bycatch during commercial fishing operations in the Northwest Atlantic. These capture events involve a variety of physiological stressors that may impact survivability. As part of the larger bycatch mortality study on skates, we are examining (in the laboratory) the physiological changes and delayed mortality associated with graded periods of air exposure - an obligate repercussion of "deck-time" during sorting of the catch – by species. Data will help reveal comparative resiliencies to deck-time among these species, which will further aid management.

19.11.5 Consortium for Wildlife Bycatch Reduction

Tim Werner (New England Aquarium; twerner@neaq.org), Ken Baldwin (Center for Ocean Engineering, University of New Hampshire), Scott Kraus (New England Aquarium), Patrice McCarron (Maine Lobstermen's Association), Andy Read (Duke University Marine Lab), Rich Ruais (Blue Water Fishermen's Association). The Consortium for Wildlife Bycatch Reduction is a partnership of fishers, wildlife biologists, and engineers. The Consortium supports collaborative research between scientists and the fishing industry to develop practical fishing techniques that reduce the bycatch of threatened non-target species. Projects supported by the Consortium come under three main categories: (1) Global exchange of bycatch reduction technology; (2) Understanding wildlife interactions in commercial fishing operations; and (3) Research and development of bycatch reduction methods. Some of the Consortium's current projects are described below.

Dynamics of Large Whale Entanglements in Fishing Gear

Bellequant Engineering, Duke University, New England Aquarium, Maine Lobstermen's Association, Provincetown Center for Coastal Studies, University of New Hampshire, Woods Hole Oceanographic Institution. Scott Landry of PCCS produced 61 illustrations of right whale (43) and humpback (18) whale entanglements to provide a visual reference of entanglement events. For all entanglements cases where the

whale was carrying gear, the degree of scarring and gear wrapping severity were defined and categorized. Work is underway to categorize all entanglement interactions for right whales observed with rope scars that were never observed carrying gear. A rope engineer analysed the breaking strength and other characteristics of ropes retrieved from whale entanglements to determine how they may relate to entanglement severity. From February 9 – 11, 2011, fishers, whale scientists, fishing gear engineers, rope manufacturers, and marine wildlife disentanglement experts participated in a workshop to review these data and carry out a forensic-type analysis of particular whale entanglement cases. Participants were asked to reflect on whale-gear conflict scenarios that could have led to the entanglement observed ("reverse engineering") and to consider what gear modifications may have prevented the entanglement or reduced its severity. The Preliminary Report from this workshop can be read and downloaded at: www.bycatch.org/publications.

Outreach on Best Lobster Fishing Practices

Maine Lobstermen's Association, New England Aquarium

The aim of this project is to document the range of lobster fishing methods used in Maine and identify those that may pose the least threat to whale entanglement while also identifying ideas for new bycatch mitigation techniques. Maine Lobstermen's Association (MLA) has identified, through meetings with lobstermen in 68 coastal districts, the full range of fishing gear used in the Gulf of Maine lobster fishery, including detailed characterization of ropes, traps, gear deployment methods, methods of rigging gear, gear configuration, and vessel configuration. MLA will organize and convene five regional workshops to discuss the findings with lobstermen, biologists, and bycatch experts to consider what techniques may pose relatively more or less risk.

Field Studies to Assess the Potential for Using Vision to Reduce Right Whale Entanglements in Fishing Gear

Jeffry Fasick, Kean University

Little is known about the visual capabilities of mysticetes. In order to determine if a visual deterrent might be effective in avoiding whale entanglements in fishing ropes, Dr Fasick assessed the spectral sensitivities of the retinal visual pigments from the North Atlantic right whale. He estimated that the right whale has a rod visual pigment with a λmax of 499 nm and a middle-wavelength sensitive (MWS) cone visual pigment with a λmax of 524 nm. The MWS cone pigment is blue-shifted in its spectral sensitivity like those from odontocetes, but the spectral sensitivity of the right whale rod visual pigment is similar to those from terrestrial mammals.

Field Studies to Assess the Potential for Using Vision to Reduce Right Whale Entanglements in Fishing Gear

New England Aquarium

Using the findings from Dr Fasick's study of right whale vision (above), Dr Scott Kraus of the New England Aquarium is working to determine right whale behavioural responses to visual deterrents. The study uses rope mimics created out of rigid PVC pipe approximately the same diameter as rope, which have been scored to break upon impact with a whale so as not to hurt the animal. Different combinations of colours, black, green, red and white/glow, have been applied to sections of 20 foot PVC "rope" and attached to a buoy. Whales that are skim feeding at the surface are

targeted with the rope mimics so that antecedent and response behaviours are visible. The first round of trials in Cape Cod Bay began in April of 2011 and over three evenings in the field, 27 interaction events were recorded. The tests will resume in spring 2012.

Testing "Whale-Safe" Hooks in the North Carolina and Hawaii-based Pelagic Longline Fisheries

Blue Water Fishermen's Association, NOVA Southeastern University, Duke University

The goal of this project is to determine whether three experimental "weak circle hooks" could be used as a gear modification to reduce pilot and false killer whale bycatch while retaining target catch. The logic is that hooks of thinner diameter may be of sufficient strength to retain target catch but are weak enough to become straightened when pulled on by the mouths of much larger, non-target mammals. In 2010, six vessel trips had been completed in North Carolina, and the remaining sets will be completed this year to involve a total of 15,000 hooks. In Hawaii, 129 sets were observed that deployed >2000 hooks per set. There were 76 bent or straightened hooks, with more bent "weak" hooks (n=70) than control hooks (n=6). Only one false killer whale was caught during the 129 sets; it was caught on a control hook that bent and straightened to release the whale. There were no significant decreases in target species catch. To provide some biological underpinning for the "whale-safe" or "weak hook" field trials, Duke Researchers will test the "hook pulling" jaw strength of pilot whales. First, they will test the variation in hook strength within standard commercially available hooks from several manufacturers. They will also assess the effect of hook type and strength on the probability of straightening and pulling out of the mouth of a pilot whale. To do this, they will embed hooks in the jaws of heads from stranded pilot whale carcasses and measure the tensile strength required to straighten the hooks and pull them out of the jaws.

Stable Isotope Analysis of Pilot Whale Diet

Duke University

The goal of this project is to quantify the relative contribution of local pilot whale depredation on tuna off North Carolina, and to quantify the proportion of the population that engages in depredation. Potential prey samples (bigeye tuna, yellowfin tuna, and Loligo squid) and pilot whale skin samples were processed and analysed by isotope ratio mass spectrometry. Ten pilot whales were sampled from different pods. The preliminary results indicate that the pilot whales are not consuming bigeye tuna on a regular basis and that Loligo squid are not an important prey species for any of the predators tested. Additional pilot whale samples continue to be tested.

Efficacy of Electropositive Metals to Reduce Shark Bycatch in Longline Fisheries

Florida Atlantic University

This project has tested the efficacy of various lanthanide elements and their alloys as potential shark repellents. Neodymium (Nd) was selected to test as a repellent based on output voltage, dissolution rate, machinability, and cost. Behavioural trials were conducted on lemon, bonnethead, piked dogfish, and smooth dogfish sharks. Trials consisted of a choice test in which sharks were presented with baits affixed to one of four treatments: acrylic, stainless steel, lead, or Nd. The preliminary results indicate that Nd was successful at repelling individual bonnethead and smooth dogfish and groups of piked dogfish, but not groups of lemon, bonnethead or smooth dogfish.

Tests were also conducted on the response of the sharks to prey-simulating electric fields. Both the piked and smooth dogfish demonstrated similar behavioural responses to weak electric fields and their responses are similar to those of other species previously reported in the literature.

19.11.6 University of Massachusetts Dartmouth, School for Marine Science and Technology (SMAST), New Bedford, MA

Monitoring seal depredation in the Nantucket Sound weir fishery

Contact: Owen C. Nichols (SMAST/ Provincetown Center for Coastal Studies, onichols@umassd.edu), Ernie Eldredge (Chatham Fisheries/Monomoy Trap Co.), Steve Cadrin.

Gray seals (*Halichoerus grypus*) have been observed feeding on fish weir catches in Nantucket Sound (Massachusetts, northeast USA). Partially consumed longfin inshore squid (*Loligo pealeii*) and finfish in the nets recorded in logbooks are attributable to seal depredation. A Dual-frequency Identification Sonar (DIDSON) was deployed in a weir for six ~24-hour periods in May and June 2009 to monitor diel patterns of squid and fish catches, as well as seal presence and behaviour. Seal occurrence in the weir was observed throughout 24-hour periods, most frequently at night. Observations of seal and target species behaviour indicated that seal presence likely affected the efficiency of the weir, disrupting the passage of schooling squid and finfish into the catch chamber. The species composition of catch and prey remnants in the weirs will be analysed to examine seal prey preference, and photo-identification studies are planned to determine if random individual seals raid the weirs or if there is individual specialization by a select few. The above data will be used to inform the design of gear modifications to reduce depredation by excluding seals while maintaining catches of squid and fish.

Trawl gear modifications to reduce flounder bycatch and discards

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Testing of a modified otter trawl groundgear to reduce the catch of juvenile American plaice

Sea trials were completed over two seven day trips in March of 2011 to test a groundgear modified with "escape" windows to assess if the catch of undersized American plaice could be reduced while retaining commercial catches of legal sized fish. The experimental groundgear, designed by Reidar's Manufacturing Inc., is constructed of rock-hopper discs, cookie discs and has rubber risers along the entire length of the trawl that create space between the net and the groundgear to promote escapement early in the capture process. On the first trip, the dimensions of the windows were 40 cm by 18 cm, which resulted in a reduction in the catch of legal sized American plaice. The width of the window was decreased to 20 cm for the second trip. Data analysis is currently underway to determine the effectiveness of the groundgear in reducing bycatch.

Preliminary test of a modified groundfish trawl to reduce the catch of southern New England winter flounder in the large mesh groundfish fishery

The proof-of-concept project was recently completed over three days of comparative sea trials in April, 2011. A large mesh panel of 1.9 m diamond mesh replaced traditional 165 mm diamond mesh in the center of the belly 76 cm behind the fishing line. A modified groundgear was also tested, which consisted of 25 cm rock-hopper discs

and 15 cm rubber discs with rubber risers along the length of the trawl. The risers create "escape" windows between the fishing line and the groundgear. The "escape" window dimensions were 46 cm by 30 cm. The project's goal was to test if the modifications would allow winter flounder to escape while retaining catches of Atlantic cod.

Fish Behavior and Conservation Engineering

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Bycatch reduction in shrimp trawls

Analysis on the shrimp trawl size/species sorting grid experiment carried out in 2009 in Gulf of Maine has been completed. Both 9 mm and 11 mm size sorting grids reduced small shrimps compared with a regular Nordmøre grid without a size- sorting grid. A modified Nordmøre grid with netting around the grid removed reduced catch of finfish by 42–48%. A combination grid of size sorting and finfish reduction showed good results in reducing small shrimps and finfish. A new experiment replacing regular wire bridles with synthetic bridle is underway. The project is to further reduce flounders as "floating" polypropylene bridles will likely float off the seabed thus reducing herding of bottom-dwelling flatfish.

Species separation in groundfish trawls

A project testing the rope separator haddock on offshore grounds (Georges Bank) with a larger vessel (>25 m) has been funded with sea trials planned in spring 2011. This trawl is a larger version of the rope separator trawl tested in inshore Gulf of Maine in 2006 when very positive results in reducing cod and flounders were realized in the new haddock trawl. Another project to further understand behaviour of flounders and haddock and to reduce flounder catch when targeting haddock is being planned. The project intends to implement floating bridles in haddock trawls to reduce bottom-dwelling flatfish.

Silver hake trawl research

Small mesh silver hake trawls may catch other groundfish and spiny dogfish, as well as other controlled species. One silver hake trawl design incorporating large meshes in the front end of the trawl to reduce spiny dogfish is being tested in Southern New England waters. Another silver hake trawl incorporating belly windows to reduce flounders will be tested in Gulf of Maine.

Squid Trawl

Squid trawls in southern New England also catch other species such as butterfish, black sea bass, scup, and winter flounder. To reduce these species, a grid was designed and tested in flume tank in collaboration with Massachusetts Division of Marine Fisheries. Sea trials with the new grid are currently being carried out. The preliminary design includes the raised footrope design and a sorting grid.

Feeding behaviour of American lobster under ultra violet light conditions

We examined behavioural differences of lobsters toward bait under UV or normal light conditions under laboratory conditions. Video recording is currently being analysed.

19.11.7 Gulf of Maine Research Institute (GMRI), Portland, Maine

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Large-mesh trawl to reduce fuel consumption

With rising fuel prices fishers are increasingly taking steps to reduce fuel costs to remain profitable. Last summer GMRI partnered with fishers to replace the netting of a locally used trawl design with large-mesh, fine-diameter Sapphire netting. Initially, both trawls were tested at the flume tank at Memorial Institute in St John's, NFLD over a 4-day period. After standardizing the geometry of both trawls, the drag of the new trawl was reduced by almost 20%. Following this encouraging result a full-scale trawl constructed from 7-inch, 2.1 mm dia. Sapphire netting was compared against the locally designed trawl constructed from 6-inch, 3.0 mm dia. netting. After standardizing the geometry of both trawls, the drag of the new trawl was reduced by almost 30% with little difference in catch. Immediately following the trials the fisher fished commercially with the new trawl and reported similar fuel savings and no obvious reduction in catch compared to boats fishing nearby. A second fisher constructed the same net and reported a fuel savings of $700 per trip. This work will continue this summer.

Scallop twine top

In the NW Atlantic sea scallop fishery, large mesh panels, known as twine tops, are inserted into the top of a steel-mesh scallop dredge to allow fish escapement, including flounder. Three different hanging ratios (no. of 10-inch meshes to a single 4-inch steel mesh) were tested to evaluate the efficacy of the twine top. The hanging ratios were, 3:1, 2:1, and 3:1 turned sideways (90 deg.), and a covernet was used to collect any scallops and bycatch that escaped through the twine top. After completion of 287 tows the scallop catch represented 96% of the entire catch and skate, monkfish, and flounders represented the remainder. The scallop catch in the dredge with a 3:1 turned twine top was consistently lower (42–83% catching efficiency) than that for the other twine tops. In contrast, the efficiency of the 3:1 and 2:1 twine tops was little different. The dredge with the 3:1 hanging ratio allowed the escape of the smallest proportion of flounders, skates, and monkfish, and there was evidence that a larger proportion of flounders were able to escape capture using the 3:1 turned twine top. Simple relative speed models predicted that flounder should easily reach the twine top (although the results suggest escape was hampered by mesh orientation). The 3:1 hanging ratio only permitted the escape of flounders less than 0.1 m (~4″) unless they pivoted their body 90 degrees prior to reaching the mesh; in which case a flounder up to 0.3 m (~12″) would be permitted to escape. The 2:1 twine top would permit the escape of flounders 50% larger than that for the 3:1 twine top. In the absence of regulation pertaining to twine top hanging ratio it seems that twine top selectivity and bycatch reduction is currently not fully optimized in the fishery.

19.11.8 NOAA Fisheries, Southeast Fisheries Science Center

More info: http://www.nmfs.noaa.gov/by_catch/docs/brep_final_2011.pdf

Characterization of Target Catch cpue as a Function of Bait Soak Time in the Gulf of Mexico Bottom Longline Reef Fish Fishery: A Pilot Study to Examine Sea Turtle Mitigation Measures

We are conducting a pilot study to investigate the potential of reduced gear soak times as method of reducing sea turtle interactions and mortality. As a first step, research is being conducted to characterize the catch rate of target species as a function

of bait soak time. Three commercial vessels are participating in the experiment for an expected 120 fishing days. Hook timers (Lindgren Pitman HT 600) are attached on every fifth gangion in a given set to record the relative time of an interaction by a fish. To date, more than 70 of the 20 proposed fishing days have been completed by the three commercial vessels involved in the research. Of the 73 reef fish caught during the first trip, more than 80% were hooked less than 15 minutes after the hooks reached the bottom, with 100% of the bites occurring less than one hour after deployment. We anticipate the completion of the 120 fishing days by mid-December, with the data analysis completed in spring 2011.

Turtle Excluder Device Technology: Evaluations and Fisher Outreach

NMFS is considering an expansion of the TED requirement to skimmer gear and the mid-Atlantic croaker fishery, therefore a usability assessment of the flexible flatbar flynet TED (FFF-TED) was conducted during 17 days aboard flynet vessels participating in the North Carolina croaker fishery. The FFF-TED was tested over 14 days on six separate trips, while a new Cable TED prototype was tested over eight days on three separate trips. Fourteen additional days of testing are scheduled for the 2010–2011 fishing season. Underwater video collected during this work revealed sharks, skates, rays, and sturgeon readily escaping from the trawl through the TED opening without a significant amount of target catch loss observed. Catches of up to 40,000 lbs (18,144 kg) were documented. The FFF-TED also performed well functionally, easily wrapping around the net reel with no significant signs of structural damage.

Shrimp Trawl Bycatch Reduction Technology

The Composite Panel BRD has shown an overall finfish bycatch reduction rate of 25.3% in the Gulf of Mexico shrimp fishery. Testing in 2009 in combination with a Square Mesh Panel BRD demonstrated a finfish reduction rate of 36% by weight, with a shrimp reduction rate of 4%. The Composite Panel BRD in combination with a Finfish Stimulator Cone was tested. In 50 tows, the observed finfish reduction rate with this BRD combination is 51% by weight, with a shrimp reduction rate of 8.3%. Statistical analysis of Composite Panel BRD with the Square Mesh Panel BRD and the Composite Panel BRD with the Finfish Stimulator Cone will be completed by spring of 2011.

The Double Shot TED: Incorporating a TED and a BRD into a Single Device to Improve Debris Exclusion and Shrimp Retention

A prototype TED called the Double Shot TED was designed to address the industry's chief complaint with TEDs - debris (i.e. buckets, tires, and sponges) – as well as to maintain the proper fishing angle of the TED. The new grid design provides escape openings in both the top and bottom of the trawl extension, allowing for the discharge of dense benthic debris while the providing a clear top opening escape route for turtles. The Double Shot TED was configured with a fisheye-type BRD in each side for fishery-independent proof-of-concept testing and subsequent fishery-dependent BRD certification testing. Preliminary small turtle evaluation in 2009 resulted in 5 out of 5 turtles escaping from the TED. Full TED certification test was completed in June 2010; all 25 turtles escaped through the top escape opening. The mean escape time was 74.84 seconds and ranged from 15 to 231 seconds. This effort will result in the approval of this TED design for use in the Southeastern US shrimp fishery. Proof-of-concept testing was conducted aboard the RV "Caretta" in August and September 2010. In a paired test, nine tows were conducted comparing the Double Shot TED to a standard top shooting grid (test 1), and six tows were conducted

comparing two Double Shot TEDs, one with BRDs and one without (test 2). The results from test 1 showed an 11.6% reduction in finfish with a 5.5% reduction in shrimp. The finfish reduction rate for test 2 was 5.5% with an increase in the catch of shrimp by 2.3%. A BRD certification test for the Double Shot TED was scheduled to be conducted aboard a commercial shrimp trawler during winter 2010.

A Pilot Study to Assess Catch Rates of Shrimp and Finfish Bycatch using TEDs with Reduced Bar Spacing

As of October 2010, 40 tows have been conducted comparing shrimp and finfish catch rates between TEDs with 2-inch (experimental) and 4-inch (control) deflector bar spacing. These results show that the experimental TED reduced shark bycatch (all sharks combined) 72.3% by number (55 vs. 15) and 78.0% by weight. Additionally, the experimental trawl showed a 59.5% reduction in the capture of rays by number and 80.6% reduction by weight. The most prevalent bycatch species in the inshore tests were Atlantic croaker (*Micropogonias undulates*), which accounted for 52.8% of the total catch by weight in the control trawl. The experimental TED reduced Atlantic croaker catch 37.5% by weight. Trout species (Cynoscion sp.) were reduced 35.7% by weight in the experimental TED. Other recreational and commercially important species included Spanish mackerel (*Scomberomorus maculates*), which had reduction rates of 34.0% by number (109 vs. 73). Shrimp loss for the experimental TED was 6.3% by weight. Based on the results of a paired t-test, this loss was statistically significant with a p value of <0.042, and a power 51.5%. In order to achieve a statistical power of 80%, an additional 37 tows are needed. A portion of these tows will be conducted in November and December 2010.

Determination of Alternate Fishing Practices to Reduce Mortality of Prohibited Dusky Shark in Commercial Longline Fisheries

We conducted a series of fishing experiments using commercial vessels participating in the Sandbar Shark Research Fishery. Vessels set an average of 317 gangions with 18/0 circle hooks with a 10 degree 49 offset. Soak times averaged 15.0 hours. Fishers provided the bait and selected the fishing locations. Hook timers (HT 600, Lindgren-Pitman Inc.) were attached to every fourth hook. Data are still being collected as part of this program, which will continue through 2011. A total of 25 sets were completed in 2010 in areas off the east coast of the United States and the Gulf of Mexico. In addition to dusky shark, data also are being collected on 13 other species. For all species, preliminary results indicate the mean time for hook timers to be activated (i.e. time to bite the hook) was 6.6 hrs. Sharks remained on the hook for an average of 10.3 hours. For dusky shark captured with hook timers (n=3), all were reported dead at the vessel after a mean time on the hook of 13 hours. A full analysis of the data will be performed after data collection is complete in 2011.

Gulf of Mexico Pelagic Longline Bluefin Tuna Bycatch Mitigation

Anecdotal information from fishers indicates spawning bluefin tuna, which are much larger than yellowfin tuna, are capable of straightening some types of hooks used in the yellowfin tuna pelagic longline fishery. During the year one of the research (2007), 140-lb. and 200-lb. monofilament leader were determined to be capable of releasing bluefin tuna of the sizes of fish captured in the fishery. In year two of the project (2008), we evaluated the efficacy of a weaker 16/0 circle hook (experimental) in reducing bycatch of bluefin tuna by comparing experimental hook catch to catch by a standard 16/0 circle hook (control) used in the pelagic longline fishery. The experimental hook retains the dimensions of a 16/0 hook but has less tensile strength,

causing it to bend or straighten at loads that would not bend a conventional 16/0 hook. From 2008 to 2010, five commercial vessels completed 260 pelagic longline sets. Experimental hooks and standard 16/0 circle hooks were alternated on the longline with a total of 172,573 hooks set. A total of 33 bluefin were caught during the experiment, of which 10 were caught on the experimental hook (56.5% reduction). The difference in bluefin catch was statistically significant. Vessels landed a total of 1,785 yellowfin tuna. The difference in yellowfin catch rate for standard and experimental hooks was not significant.

Future work

- Bluefin tuna bycatch reduction in Gulf of Mexico yellowfin tuna fishery (2011–2012)
- Snapper and grouper mortality reduction through the use of modified circle hooks in recreational fisheries (2011–2013)
- Seabird bycatch reduction through enhanced observer coverage to assess potential protected species interactions with fisheries in the Atlantic (2011–2015)
- Turtle bycatch reduction in non-shrimp trawl fisheries (Atlantic flynet fishery, Atlantic whelk trawl fishery, Gulf butterfish fishery (2011–2015)
- Turtle excluder device and bycatch reduction device refinement in shrimp trawl fishery (2011–2015)
- Turtle bycatch reduction in various Atlantic and Gulf of Mexico gillnet fisheries (2011–2015)
- Turtle entanglement/bycatch reduction through development of weak links for the vertical lines used for buoys in a variety of pot fisheries (2011–2015)

19.11.9 NOAA Fisheries, Southwest Region and Southwest Fisheries Science Center, La Jolla, California

More info: http://www.nmfs.noaa.gov/by_catch/docs/brep_final_2011.pdf

Evaluating the Effects of Trailing Gear in the California Recreational Thresher Shark Fishery

This project was designed to quantify mortality rates associated with tail hooking and trailing gear in the Southern California recreational thresher shark fishery. Survivorship was determined using pop-off satellite archival tags (PSATs) deployed on subadult and adult common thresher sharks released with trailing gear. Concurrent investigations on the effectiveness of degradable links and alternative fishing techniques also were performed to reduce overall post-release mortality in the recreational fishery. PSATs were deployed on five common thresher sharks (132 to 175 cm FL) captured using fishery standard techniques and released with trailing tackle. As of late 2010, three tags have reported, revealing a 100% mortality rate with all mortalities occurring within 31 hours of release. All three tags were recovered after the deployment period using a radio direction finder.

One of the PSATs still at liberty never reported data, while the final tag is still within the scheduled 30 day recording window. Additional deployments to complete the study during autumn 2010 were designed to complement 2009 supported research and provide an overall mortality estimate for tail-hooked thresher sharks in the recreational fishery. Experimental gear trials were conducted in 2010 to test the effec-

tiveness of degradable links that may be used to reduce the long-term impacts of trailing gear in this fishery. However, results to date suggest that all thresher sharks with trailing gear from which we received data incurred mortality within 31 hours of release, therefore making a degradable link improbable as a sole solution to post-release mortality in the caudal fin-based fishery. Although additional testing and results may provide improved innovations, initial interviews with fishers also suggest that angler acceptance is questionable when it comes to incorporating a weak link into their terminal tackle.

Evaluating Gear Modifications to Prevent Marine Mammal Depredation in the California Halibut Trawl Fishery in Southern California

The objective of this project was to evaluate the effectiveness of modifying a trawlnet using a small mesh extension or "protection panel" to reduce or prevent pinnipeds depredation on California halibut trawl gear, while also minimizing, or at least not increasing, bycatch of other species. The idea put forward by the fishers was that use of a smaller mesh extension might prevent pinnipeds from reaching through with their claws and mouths in an attempt to remove or damage fish from this area of the net. Because the target of this fishery is live California halibut, fishers take care to avoid injuring fish in the net and codend using slow tow speeds and short tow times. In summer 2010, an experimental fishery protocol was established to compare the effectiveness of a halibut trawlnet using a 3.0-inch mesh size modification to the performance of the 5.5-inch mesh size trawlnet extension normally used in the fishery. This comparison focused on catch performance and depredation rate, including documentation of the behavioural response of pinnipeds during fishing activities with the aid of an underwater video camera system. Comparative research tows were conducted aboard the *F/V Cecelia* in the coastal waters near Santa Barbara and Oxnard, California, during the months of August, September, and October 2010. To date, about one-half of the expected 50 paired-tow comparisons have been successfully completed. Video monitoring of the trawlnet and pinnipeds behaviour during normal fishing was completed as part of two separate days of research. Fishing conditions were poor during most of this time period, and halibut catch was unusually low. In addition, pinniped activity was significantly less than what is anecdotally typical for the area, and observation of depredation events did not occur at anticipated levels. As a result, research efforts have been hampered to this point but will continue into FY11 as more normal fishing and depredation activity likely develops. Engineering of a new underwater video system has been completed and is expected to become an important part of the second half of this project.

Future work

- Shark bycatch and bycatch mortality reduction in drift gillnet and pelagic longline fisheries (2011–2012)
- Rockfish mortality reduction through the use of recompression cages and devices (2011–2012)
- Evaluation of gear modifications to prevent marine mammal depredation in the California halibut trawl fishery in Southern California (2011–2013)
- Shark bycatch mortality reduction in recreational catch-and-release fishery (2011–2014)
- Seabird bycatch reduction through enhanced collection of seabird distribution and abundance data on cetacean and ecosystem assessment cruises,

action at international regional fishery management organizations, and information and outreach to fishery participants (2011–2015)

19.11.10 Oregon Department of Fish and Wildlife, Marine Resources Program, Newport, Oregon

Evaluating the effect on eulachon bycatch (*Thaleichthys pacificus*) of reduced bar spacing in a rigid-grate BRD in the ocean shrimp (*Pandalus jordani*) trawl fishery

Contact: bob.w.hannah@state.or.us, Steve Jones.

We compared shrimp catch and bycatch between two rigid-grate BRDs with 19.1 mm and 25.4 mm vertical bar spacing, with an emphasis on reduction of eulachon bycatch. The rigid-grate BRD with 19.1 mm spacing reduced eulachon bycatch by 16.6%, with no reduction in ocean shrimp catch. It also reduced bycatch of slender sole, other small flatfish and juvenile darkblotched rockfish by 36.8%, 71.8% and 76.3%, respectively with no effect on bycatch of whitebait smelt or young-of-the-year (YOY) Pacific hake. Based on these results, Oregon modified fishery regulations to require the use of rigid-grate BRDs with 19.1 mm bar spacing as of April 1, 2012.

Evaluating the effect on demersal fish bycatch from removing the central one-third of the groundline in an ocean shrimp trawl

Contact: bob.w.hannah@state.or.us, Steve Jones, Mark Lomeli (PSMFC), W. Waldo Wakefield (NMFS, NWFSC).

An experimental footrope, modified by removing the central one third of the trawl groundline, reduced eulachon bycatch by 33.9% compared with a control footrope with an intact groundline. It also reduced bycatch of slender sole (*Lyopsetta exilis*), other small flatfish and juvenile darkblotched rockfish (*Sebastes crameri*) by 80% or more, but had no effect on bycatch of whitebait smelt (*Allosmerus elongatus*) or Pacific herring (*Clupea pallasii*). The experimental groundline also reduced the catch of ocean shrimp (weight) by 22.2% in hauls yielding commercial quantities of shrimp (>194 kg/haul) and by 23.2% in all hauls. The footrope modification tested, if it can be developed further to reduce shrimp loss, has the potential to also avoid trawl entrainment for some demersal fish, as well as reduce bottom impacts from trawling.

Video evaluation of footrope/seabed interactions in an ocean shrimp trawl

Contact: bob.w.hannah@state.or.us, Steve Jones, Mark Lomeli (PSMFC), W. Waldo Wakefield (NMFS, NWFSC).

We used an underwater video system with a specially designed cantilevered mount to film interactions between 4 styles of shrimp trawl footrope and benthic macroinvertebrates. Preliminary analysis of the video data showed that elimination or elevation of portions of the groundline, as well as elimination of high-friction surfaces in groundline materials have some potential to reduce impacts on macroinvertebrates from trawling.

Estimating discard mortality of Pacific rockfish (Sebastes) in the recreational hook and line fishery

Contact: bob.w.hannah@state.or.us, Polly Rankin.

We used a caging system designed to minimize the adverse effects of caging fish in marine waters to evaluate discard mortality of 7 rockfish (*Sebastes*) species with barotrauma. In total, 288 rockfish were captured, scored for barotrauma, evaluated behaviourally and caged individually on the seabed for 48 h to determine survival. With

the exception of 3 blue rockfish (*Sebastes mystinus*), condition of surviving fish after cage confinements from 41–71 h was excellent. At capture depths up to 54 m, survival was 100% for yelloweye (*S. ruberrimus*, n=25) and copper rockfish (*S. caurinus*, n=10) and 77.8% for blue rockfish (n=36). At capture depths up to 64 m, survival was 100% for canary (*S. pinniger*, n=41) and quillback rockfish (*S. maliger*, n=28) and 90.3% for black rockfish (*S. melanops*, n=144). Black rockfish survival was negatively associated with capture depth (m, $P<0.01$) and with surface-bottom temperature differential (°C, $P<0.01$). Blue rockfish survival was negatively associated with capture depth ($P<0.01$). Barotrauma signs and surface behaviour scores were not good indicators of survival potential across species, but were useful within species.

19.11.11 NOAA Fisheries, Northwest Fisheries Science Center, Seattle, Washington

Contact: waldo.wakefield@noaa.gov, mlomeli@psmfc.org.

Reducing bycatch of Chinook salmon (*Oncorhynchus tshawytscha*) and rockfish (Sebastes spp.) in the US Pacific hake (*Merluccius productus*) fishery using an open escape window bycatch reduction device

The basic design of this BRD consists of two mesh panels that direct actively swimming fish towards open escape windows on each side of the net. To date this project has examined two versions of the open escape window BRD. Tests were conducted off central Oregon during 2009 and 2010 aboard a midwater trawler. Data on fish behaviour and gear performance were observed using autonomous high-resolution colour video camera systems. During this study, bycatch of Chinook salmon, widow rockfish (*S. entomelas*), and canary rockfish (*S. pinniger*) was reduced by as much as 81.8%, 26.7%, and 14.7%, respectively. The number and location of escape windows affected both Chinook salmon and widow rockfish escapement rates. The presence of light was also noted to influence which escape window Chinook salmon utilized when escaping. Between the two designs examined, the mean escape time of Chinook salmon differed significantly. Escapement of Pacific hake, the target species, was rarely observed. Results indicate that Chinook salmon and rockfish bycatch can be reduced in the Pacific hake fishery using an open escape window BRD. Variations of this BRD design are being evaluated in the Bering Sea walleye pollock trawl fishery. In 2011, the NWFSC has planned to build and test a recapture net to accurately measure the escapement rates of salmon and rockfish under tows conducted with and without artificial light.

Providing direct observation loaner video camera systems to fishers for use in evaluating industry-designed approaches to reducing bycatch and impacts to benthic habitats in US Pacific coast fisheries.

The NOAA Fisheries Northwest Fisheries Science Center (NWFSC) developed two loaner video camera imaging systems and is currently making those systems available to commercial fishers and other sectors of the industry for their use in evaluating industry-designed bycatch reduction devices. As part of this development program, the NWFSC has conducted meetings with the fishing industry and collaborating agencies to obtain feedback on best practices for deploying the loaner video systems to the industry, and to create a forum for discussion of the role of conservation engineering in a catch share management environment. During 2011 and 2012 the NWFSC plans to further develop this program and expand the availability of video systems. Information on the loaner video camera systems can be found at: www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm.

Figure 9. Example of loaner video camera systems currently available to the US Pacific coast fishing industry through NOAA Fisheries NWFSC.

Future work

- Pacific coast roundfish bycatch reduction by improving performance of already proven bycatch reduction gear types, e.g. selective flatfish trawl to reduce rockfish bycatch in flatfish fishery (2011–2012)
- Endangered Species Act-listed salmon and rockfish (*Sebastes*) bycatch reduction through refinement and implementation of open escape window bycatch reduction devices in the Pacific hake fishery, as well as development of applications of flexible sorting grids in bottom trawl fisheries (2011–2015)
- Seabird bycatch reduction through continuation of Seabird Bycatch Research Project to reduce potential fisheries interactions with short-tailed albatross and other seabird species (2011–2015)
- Seabird bycatch reduction in Alaska and Northwest longline fisheries by providing free streamer lines and cost-sharing on integrated weight lines (2011–2015)

19.11.12 NOAA Fisheries, Alaska Fisheries Science Center, Seattle, Washington

Salmon Excluders

AFSC Conservation Engineering (CE) scientists participated in a workshop that included tests and refinement of salmon excluder designs at the flume tank facility at Memorial University in St John's, Newfoundland. Full-scale salmon excluders were tested in February and March 2010 on both catcher vessel and catcher–processor trawlers. CE scientists provided and operated underwater video and sonar equip-

ment to directly observe gear, assuring effective tuning of devices. Because of advances made during flume tank development and field monitoring, the escape portals of tested excluders were shown for the first time to be fully available throughout the tows, without interrupting fish flow or damaging the net. Chinook salmon escape rates were between 25–35%. A technician was placed aboard vessels through summer to demonstrate correct tuning and operation of the new excluder design to promote effective use of these excluders by the fleet.

More info www.nmfs.noaa.gov/by_catch/docs/brep_final_2011.pdf

Development and evaluation of trawl groundgears that produce less damage to crabs in soft bottom areas

Development of trawl footropes that reduce overall crab mortality must trade-off the potential loss of flatfish catch with reductions in either bycatch mortality or mortality of escaping crabs. In addition to measuring crab bycatch rates and mortality rates for conventional gear, catch and escape rates for target flatfish were also evaluated. This information, for two conventional footropes and one experimental design using plates, provides a basis for direct comparisons of these footropes, evaluating their performance on each aspect that affects overall crab mortality. These results were to be presented and discussed with trawl fishers in late 2010 to develop alternative designs for testing in 2011.

Crab mortality rates after trawl encounters

From 11–27 August 2010, CE scientists collected data to estimate the proportions of snow and Tanner crabs captured by trawls with conventional bottom trawl footropes aboard the chartered vessel F/V Pacific Explorer. These data provided one way to estimate how many crabs are subject to the unobserved mortality rates that we estimated for these species in prior years, and allowed us to collect additional observations to improve 2010 estimates. We also observed mortality rates for crabs that encountered footropes of pelagic trawls that are fished on the seabed, as occurs frequently in the pollock fishery. Additionally, CE scientists evaluated crabs caught by commercial trawl vessels in both the Bering Sea and the Gulf of Alaska to estimate snow and Tanner crab bycatch mortality rates. The improved estimates of crab bycatch mortality rates in the respective commercial fisheries will be used in conjunction with the footrope selectivity and escape mortality data collected during the F/V Pacific Explorer trip to evaluate trade-offs between target catch retention and bycatch mortality reduction in developing alternative footropes to reduce overall crab mortality due to trawling.

Future work

- Salmon bycatch reduction in Alaska pollock fisheries through development of trawl modifications (2011–2014)
- Pacific halibut bycatch reduction in Gulf of Alaska and Eastern Bering Sea groundfish (cod, flatfish, pollock) trawl and longline fisheries through development of fisheries-specific bycatch reduction devices (2011–2015)
- Crab bycatch reduction in groundfish fisheries through development of gear modifications (although trawl bycatch is a higher volume issue, bycatch of blue king crab in cod pots (baited traps) has a higher priority due to concern over potential overfishing of that species; 2011–2015)
- Seabed habitat and Essential Fish Habitat impact reduction by modifying trawls and trawling methods (2011–2015)

- Seabird bycatch reduction in Alaska trawl fisheries by further developing effective seabird mitigation gear, enhancing bycatch monitoring, exploring the role of vessel attraction and providing free seabird bycatch reduction gear (2011–2015).
- Seabird bycatch reduction in Alaska and Northwest longline fisheries by providing free streamer lines and cost-sharing on integrated weight lines (2011–2015)
- Reduction of unobserved crab mortality due to trawl encounters through development and implementation of modified trawl groundgear (2011–2015)
- Development of a more efficient method for identifying incidentally caught Pacific halibut that are live-release candidates (i.e. high survival rate), and development of methods consistent with observer program protocols for sorting, accounting, and discarding halibut rapidly to reduce bycatch mortality (2011–2015)
- Development of trawl modifications to reduce cod bycatch in trawls targeting flatfish (2011–2015).

19.11.13 NOAA Fisheries, Pacific Islands Region and Pacific Islands Fisheries Science Center, Honolulu, Hawaii

Evaluating the Post-Release Survival of Large Pacific Blue Marlin Captured in the Pacific Longline Fisheries: I. PSAT Studies

The objectives of this project were to determine through pop-up satellite archival tags (PSATs) the post-release survival of large Pacific blue marlin (*Makaira nigricans*) released from pelagic longline gear and to develop biochemical techniques that are portable and applicable to rapid analyses of post-release survivorship in many pelagic species. For the analysis of post-release survival, project personnel produced a sampling manual to describe the proper acquisition and storage of biochemical samples from the field. Laboratory equipment to collect and store biochemical samples in the field was procured and assembled into field kits. To carry out the bulk of the field sampling on the project, two fisheries observers were trained and equipped to acquire marlin samples from the Hawaii-based commercial longline fishery and deploy PSATs. As of October 2010, the observers had already provided samples to the project. To supplement observer sampling and PSAT deployments, a commercial longline vessel was contracted to complete a total of approximately 30 longline sets. It is expected that sampling and deployment of PSATs on blue marlin will continue in 2011. Pending additional funding, the project may expand to include striped marlin, *Kajikia audax*.

More info: www.nmfs.noaa.gov/by_catch/docs/brep_final_2011.pdf

Evaluating the Physiological Status of Large Pacific Blue Marlin Captured in the Pacific Longline Fisheries: II. Biochemical Correlates of Morbidity and Mortality

Post-release survival of large Pacific blue marlin (*Makaira nigricans*) released from pelagic longline gear will be estimated using biochemical correlates of morbidity and mortality from tissue plugs and blood. Analysis of the first biochemical samples commenced at Queens University (Ontario, Canada) in 2010. As this project concludes in early 2011, the tissue samples will be assayed for biochemical correlates of stress and morbidity. Plasma samples will be analysed for ion concentrations (Mg2+, Ca2+, K+); metabolite levels (such as lactate); and hormone levels (cortisol). For the

molecular analysis of muscle samples, consensus primers for genes that are a measure of stress response (members of the heat shock protein family) were designed and will be used to generate species-specific primers. These primers in turn will be used to measure relative mRNA levels in target animals.

Use of Photoluminescent Technology to Reduce Incidental Capture of Sea Turtles in Gillnet Fisheries

Fishers in Bahía de los Angeles, a small fishing town on the Gulf of California, report that during the late fall, winter, and early spring fishing seasons, extremely large numbers of sea lions (*Zalophus californianus*) are unintentionally caught at times exceeding 10–15 animals per day. Entangled sea lions are often dead, or if still alive, they are killed so fishers can safely remove them from the nets. Trials to examine the effects of illuminated gillnets (using LED lightsticks) on sea lion and finfish catch rates were scheduled to commence in January 2011, lasting through March 2011.

Future work

- False killer whale take reduction in the Hawaii-based pelagic longline fishery (2011–2015)
- Turtle bycatch reduction through continued operation and analysis of "TurtleWatch," which provides fishing area advisory charts indicating turtle avoidance areas to Hawaii longliners (2011–2015)
- International sea turtle, shark, and gamefish bycatch reduction through testing and promoting longline bycatch mitigation methodologies including: (1) continued testing of circle hooks to reduce sea turtle bycatch and maintain target catch; (2) continued testing of stiffer lines to reduce turtle entanglements in longlines; (3) testing chemical methods of reducing shark bycatch (now under domestic development); and (4) testing of operational alterations to reduce marlin catches (2011–2015)
- Seabird bycatch reduction in longline fisheries by providing free safe-lead gear and cost-sharing for side-setting vessel conversions (2011–2015)

20 Other Business

20.1 Date and Venue for 2012 WGFTFB Meeting

The **ICES/FAO Working Group on Fishing Technology and Fish Behaviour** (WGFTFB), chaired by Mike Pol, USA, will meet in Lorient, France, from 23–27 April 2012, at the invitation of Ifremer-Lorient Station.

20.2 Proposals for 2012 ASC Theme Sessions

Proposals for the 2012 ICES ASC were discussed but due to time constraints no decision was made. It was agreed WGFTFB would work by correspondence to formulate proposals before the 2012 ASC submittal deadline of Monday, 5 September 2011.

20.3 SELDAT database

SELDAT is a database consisting of selectivity data from 26 experiments consisting of 98 gear tests. Thirteen organizations worked on its creation from 1999 until 2003, at a cost exceeding €800,000. The database was built by Cefas in Lowestoft UK in close cooperation with experts within the group and a project steering committee. Cefas have recently requested payment for costs associated with maintenance of the database of over £10,000 per year. WG members do not have access to this level of funding. Inquiries were made to the ICES Data Centre about transfer of the database to their servers, where no costs would be incurred by WG members. Reaction was generally positive, and a plan of action was developed. However, recent inquiries to Cefas indicate that costs would be associated with decommissioning, estimated by Cefas to be £7851 excluding VAT.

The WG desires to maintain the database and endorsed continued efforts to transfer it to the ICES Data Centre. Inquiries will be made to find ways to reduce the costs of decommissioning.

20.4 JFTAB

WGFTFB recommends a joint WGFAST/WGFTFB session be scheduled for the 2014. Formal terms of reference will be developed intersessionally prior to the 2013 meeting.

20.5 International Standard Statistical Classification of Fishing Gear (ISSCFG)

20.5.1 Update

In March 2009 the ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) advised the Twenty-third session of Coordinating Working Party on Fishery Statistics (CWP) Secretariat of their effort since 2005 to update the technical contents of the revised edition FAO Technical Report 222/Rev.1. Since the original of this publication provided the basis of the CWP International Standard Statistical Classification of Fishing Gear (ISSCFG) adopted in 1980, the WGFTFB also developed the proposal of revision of ISSCFG and sought the advice of CWP Secretariat on the process to revise it. In May 2009, the CWP Secretariat was invited to join the WGFTFB discussion and informed WGFTFB that the ISSCFG was managed by the CWP and that its modification requires the adoption by the CWP itself. It was agreed that when the WGFTFB completed its revision of technical gear classifications, it would submit a proposal to the CWP for its consideration. CWP agreed to follow this issue intersessionally with the ad-hoc working group in close communication with the WGFTFB.

Terms of Reference of the ad-hoc group were developed as attached in Appendix 6 of the report of CWP23.

In October 2010, FAO FIRO (Chopin) was invited to join the "Ad-hoc Group for developing the draft revision of CWP Gear Classification". Following the outcome of the Ad-hoc meeting, Chopin thanked the members of CWP for the invitation to participate in the matters of ISSCFG and to bring to their attention the intention to revise the FAO paper FTP 222 Rev.1 that was published in 1982 (French and English) and 1984 (Spanish). As noted in the foreword of FTP 21 Rev.1, the scope of the document was enlarged in order to make it not only useful to staff involved in the preparation of fishery statistics, but also to all concerned with fishing gear identification and classification, in particular, fisheries administrations, research and development institutions, training centres, fishing technology services and extension service units.

20.5.2 Report of the CWP October 2010 Ad-hoc Meeting

The meeting discussions were very fruitful and the guidance provided by CWP on the alpha and numeric codes was well received. The CWP Ad-hoc Group responsible for developing the draft revision of CWP Gear Classification agreed to bring the ISSCFG issue to the attention of the intersessional meeting in mid 2011. The CWP Secretariat has informed FAO FIRO that since the last workshop in Rome, the communication on these matters in CWP has been low. However, based on lack of strong objections and comments on serious problems, the CWP Secretariat more or less expect the draft codes developed at the Ad-hoc meeting to be adopted. The draft will be presented to Fishery Special Group in December 2011 but the final adoption has to wait until the next session, probably in February 2013.

20.5.3 Outstanding Matters

FAO will continue to work to conclude on the text, alpha and numeric codes and the illustrations but recognizes the following:

1) The final FAO product to replace FTP222 Rev.1 cannot be completed till CWP have concluded their work with respect to the alpha and numeric code revisions

2) While a revised set of codes will be put before the intersessional meeting in mid 2011, there is no guarantee that the work will be concluded at this session

3) The next meeting of CWP will not occur till 2012

In order to build cooperation and collaboration between FAO and the CWP, the following steps were proposed:

1) FAO will re-draft the text descriptions of each fishing gear category in English only (R. S. T. Ferro – completed)

2) FAO will update the illustrations of each fishing gear in English only (Bundit –SEAFDEC / R. S. T. Ferro – 95% completed)

3) FAO will use as a place holder the series of alpha and numeric codes in English only, noting that these may change following the intersessional meeting of CWP in 2011 (R. S. T. Ferro – completed)

4) FAO will prepare an "advance draft – restricted circulation" manuscript of the revised FTP222 rev.1 [Not yet available]

An "advance draft - restricted circulation" will be made available to CWP in advance of their intersessional meeting to facilitate any further discussions on the text. The ownership of the text and illustrations will be retained by FAO as standard procedures.

An "advance draft – restricted circulation" will also be made available to the members of the ICES FAO FTFB Working Group reviewers who are: Steve Walsh, John Willy Valdemarsen, Wilfried Thiele, Steve Eayrs, Erdmann Dahm and Dominic Rihan. This group was formally involved in the development of the text and illustrations and need to appraise of the progress to date.

The CWP Secretariat will inform FAO – FIRO the outcome of the intersessional meeting in 2011 (probably December) so that FIRO can review the outcome of the meeting related to proposed changes and take appropriate actions in this matter.

20.6 Questionnaire on vessel survey standardization and calibration methodologies

As part of a review for the Ministry of Fisheries in New Zealand about the use of commercial vessels in trawl surveys, inter-calibration approaches, and trawl standardization, Emma Jones (jonese.tangaroa@niwa.amosconnect.com) was tasked with researching the European perspective. In addition to the work of the study group on survey trawl standardization (SGSTS), more recent (including anecdotal information) was requested from some key scientists that may be at WGFTFB.

The project will review international best practice with regards to standardized trawl survey methodologies and the challenges of inter-calibration under changing vessel or gear scenarios. Although focused on demersal fisheries caught in the middle depth range (200–900 m), information from international surveys outside this depth range is of relevance, as many of the issues around standardization, inter-calibration and cost-effectiveness will be relevant.

Internationally, and in New Zealand, resource surveys often use a single research trawler, which has the major advantage of using a single vessel and gear combination to minimize catchability differences that occur in multi-vessel surveys. However, ship availability and costs have resulted in some surveys using single or multiple vessels, often chartered from the fishing industry. This can create challenges for standardization and continuing availability.

A literature review will be taken as part of this project. However the experiences of fellow researchers following changes in gear, standard procedures and the use of commercial vessels are not always documented. As part of this work we are seeking information and advice on these two issues:

1) Experience with non-standard survey designs (e.g. multi-vessel) and non-research vessel surveys;
2) Experience with inter-calibration of vessels, gear or procedures, including:
   - lessons learned - both positive and negative;
   - comments on the cost in terms of vessel days and resources required.

A questionnaire is attached in Annex 5 which was circulated during the WGFTFB meeting.

Annex 1: List of participants

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Annex 2: Agenda

9 May, Monday

8:00	9:00	Registration

JFATB

9:00	10:30	Joint Session
10:30	11:00	Body and Mind Break (Coffee)
11:00	12:00	Joint Session continues
12:00	13:30	Lunch (on your own)
13:30	15:00	Joint Session continues
15:00	15:30	Body and Mind Break (Coffee)
15:30	17:00	Joint Session (final session)
17:45		Welcome Reception

10 May, Tuesday

WGFTFB

9:00	9:30	Opening address and meeting housekeeping
9:30	10:30	Report from SSGESST (Bill Karp)
10:30	11:00	Body and Mind Break (Coffee)
11:00	12:00	Report from FAO (Frank Chopin)
12:00	13:30	Lunch (on your own)
13:30	14:20	Discussion on future of FTFB and JFATB
14:20	14:40	Summary of WKSEINE (Barry O'Neill)
14:40	15:00	Summary of SGTCOD (Bent Herrmann)
15:00	15:30	Body and Mind Break (Coffee)
15:30	15:50	Summary of SGELECTRA (Bob Van Marlen)
15:50	16:20	Mobilization of sediment by demersal otter trawls (FG O'Neill)
16:20	16:50	Ecosystem Risk Assessments for Fisheries (Susie Brown)
16:50	17:00	Closing

11 May, Wednesday

9:00	9:15	Housekeeping issues
9:15	9:25	Introduction to ToR D INNOVATION (Bob Van Marlen)
9:25	9:35	Introduction to ToR C SMALL (Barry O'Neill)
9:35	9:45	Introduction to Tor B REDFISH (Bent Herrmann)
9:45	10:00	Introduction to ToR A ADVICE (Chair)
10:00	10:30	Topic Group meetings

10:30	11:00	Body and Mind Break (Coffee)
11:00	12:00	Topic Group meetings
12:00	13:30	Lunch (on your own)
13:30	15:00	Topic Group meetings
15:00	15:30	Body and Mind Break (Coffee)
15:30	18:30	Social Event

12 May, Thursday

9:00	9:05	Housekeeping issues
9:05	10:30	Topic Group meetings
10:30	11:00	Body and Mind Break (Coffee)
11:00	12:00	Topic Group meetings
12:00	13:30	Lunch (on your own)
13:30	15:00	Topic Group meetings
15:00	15:30	Body and Mind Break (Coffee)
15:30	17:00	Topic Group meetings

13 May, Friday

9:00	9:15	Summary of National Reports
9:15	9:45	Growth, selectivity, biomass and catch (Eckhard Bethke)
9:45	10:30	ToR A ADVICE: Report, conclusions and recommendations
10:30	11:00	Body and Mind Break (Coffee)
11:00	11:45	ToR D INNOVATION: Report, conclusions and recommendations
11:45	12:00	Future of SELDAT
12:00	13:30	Lunch (on your own)
13:30	14:15	ToR B REDFISH: Report, conclusions and recommendations
14:15	15:00	ToR C SMALL BOATS: Report, conclusions and recommendations
15:00	15:30	Body and Mind Break (Coffee)
15:30	15:45	ToRs for 2012
15:45	16:00	Suggestions for ASC theme session topics 2012
16:00	16:15	Date and venue for WGFTFB 2012 meeting
16:15	17:00	AOB and Concluding remarks (Chair)

Annex 3: WGFTFB terms of reference for the next meeting

The **ICES-FAO Working Group on Fishing Technology and Fish Behaviour** (WGFTFB), chaired by Mike Pol, US, will meet in Lorient, France from 23–27 April 2012 to address the following TORs:

a) Incorporation of Fishing Technology Issues/Expertise into Management Advice. Based on the questionnaire exercise carried out since 2005/2006.

b) A WGFTFB topic group of experts formed in 2011 will meet in 2012 with the following terms of reference:

- i) Create an inventory of gear specifications (such as mesh size, trawl design, trawl orientation) used in harvesting redfish in member countries
- ii) Describe and synthesize research carried on size selectivity with various mesh sizes and configurations and investigate possible technical measures that could reduce the loss of redfish at the surface due to their developed buoyancy
- iii) Collect morphometric information necessary to predict size selectivity
- iv) Examine habitat use, especially water depth and water columns, by major commercial redfish species and application of the information for selective capture by trawls

c) A WGFTFB topic group of experts will be formed in 2010 will meet in 2012 to continue to address the issue of Innovation in fishing gear technology and the success of collaboration between fishers and scientists with the following terms of reference:

- i) Review current technological developments and initiatives in gear technology and give examples of successful developments both in the EU and in other countries globally.
- ii) Discuss the contributions of fishers and scientists in the process of collaboration and identify conditions enabling rapid uptake of new technology, without the risk of introducing new adverse ecosystem effects.
- iii) Consider the use of models with which the effect on the marine ecosystem (concerning target species, fish and benthos bycatches, bottom impact) of introducing new innovative gears in fishing fleets can be appraised.

d) A WGFTFB topic group of experts will be formed in 2012 to investigate relationships among vessel characteristics and gear specifications in commercial fisheries, with a focus on European fisheries. The group will have the following terms of reference:

- i) To review technical specifications of trawl gears used in different fisheries (benthic, demersal and pelagic) with attention, in particular, to the dimensions of floatline, groundrope, circumference or perimeter at various levels of the net, extension piece, codend, otterboard, and other aspects;
- ii) To model and describe relations between engine power and gear-size characteristics of European trawl fleets. Modelling en-

gine power and different parts of the fishing gears as well as between some of these parts and the otter-board size should be investigated.

e) A WGFTFB topic group of experts will be formed in 2012 to evaluate present and future applications of artificial light in fishing gear design and operations. The group will work through literature reviews, questionnaires, correspondence and face-to-face discussions. Specifically the group aims to:

i) Describe and summarize fish response to artificial light stimuli;

ii) Describe and summarize use of artificial light in world fisheries;

iii) Describe and tabulate different light sources to attract fish;

iv) Describe challenges of current use of artificial lights in fisheries and identify/suggest potential solutions;

v) Identify new and innovative applications of artificial light in attracting, guiding, and repelling fish in developing bycatch reduction devices and other sustainable fishing methods;

WGFTFB will report by 14 June 2012 to the attention of the SCICOM.

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	**Term of Reference a)** Fisheries management bodies are often dependant on catch per unit of effort for stock assessment purposes and fishery/fleet based advice. Identification and use of gear parameters that effect fishing efficiency will most likely improve the use of commercial catches for stock assessment purposes. WGFTFB has the expertise to identify such parameters and will work intersessionally, reviewing existing initiatives e.g. EC data collection regulation and provide a list for consideration during the 2010 WGFTFB meeting. The information collated by the WGFTFB has been well received by ICES assessment and other Expert Groups. It is intended to continue with the collation of this information but further developments are needed. WGFTFB has recommended a number of changes to improve the utility and simplicity of this work. The next questionnaire will be based on the emergent issues identified in this report, and focused on 2011/2012. Feedback on the content and value of this years report will be sought from the Assessment working groups and through WGCHAIRS and will be used to improve the survey in 2012. If possible, the EC should be asked to provide up to date information on recent TCM regulations. These will be included in the survey with a request to detail likely outcomes from these measures. **Term of Reference b)** Redfish are primarily harvested by trawls – either pelagic or bottom trawls. Due to their relative small sizes and their distribution in vertical columns, they offer a both opportunity and challenge to sustainable harvesting. In light of a NAFO request for more information on redfish harvesting, trawl codend selectivity, as well as challenges in under-harvesting of redfish resources in Northeast US. **Term of Reference c)** WGFTFB is a joint ICES/FAO WG with a wide range of gear technology expertise and terms of reference which include consideration of technical issues

related to fisheries around the world. Recent WGFTFB reviews of different fisheries have shown that technological advance is becoming a major issue. There are also indications that technological advance is accelerating and that it is often leading to an increase in catching efficiency.

A current EU goal is to develop a common fishery management policy for the EU nations. Collection of updated information on the characteristics of trawlnets used in different European fisheries, with a view to establish limitation in the maximum dimensions of the trawl fishing gears, will contribute to limit the fishing effort and to minimize the environmental impact of these fishing gears.

In this context, the establishment of an ad-hoc topic group on the technical issues concerning all European fisheries will increase also cooperation and transferring technical knowledge among all the countries. The technical issues will cover only those within the remit of WGFTFB.

The study must be carried out on the basis of the information collected in relevant fishing fleets with the collaboration both of the fishing sectors. Information must also be independently collected through the netmakers. Results from research projects and studies, funded either with national or/and EU support, must be used in view of establishing synergies among different scientific domains while avoiding duplications

Term of Reference d)

Innovations are needed in the industry to cope with rising energy costs, the emerging demand for lower greenhouse gas emissions, and requirements deriving from the move to the ecosystem approach to fisheries management (such as reducing bycatch and seabed impact). More responsibility is being placed on industry to ensure they remain ahead of technology to cope with the changing world, and there are many examples of many initiatives being taken by fishers and equipment manufacturers. The trend is more and more to directly finance the industry in such endeavors, e.g. from the European Fisheries Fund (EFF), with the risk of a limited input from the scientific community. Tools are being developed to forecast ecosystem effects from introducing gear modifications and/or gear replacements in fishing fleets, e.g. the MAFCONS model on the effect on benthic communities in the North Sea (EU Project DEGREE). There is a role for a practical approach, but also a need for scientific input in the process in order to avoid that these developments lead to increasing fishing effort (technology creep) and pressure on already overexploited stocks and other possible adverse ecosystem effects. This will be limited to modifications to otter and beam trawls, gear replacement (e.g. alternative gears) aimed at reducing energy consumption, bycatch and/or seabed impact.

Term of Reference e)

Light has been used in fishing for more than one hundred years. Difference fish/shellfish species respond to light differently, and some do not respond at all. Commercial applications of light in purse-seines, lift nets, and squid jigging are widely practiced, especially in Asian-Pacific countries. Fishing lamps such as incandescent lamps, metal halide lamps or fluorescent lamps are commonly used in these fisheries. Different light intensities are used on different fishing grounds targeting a variety of marine fish and invertebrate species. Studies on different light outputs have been conducted including analysis of fishing efforts and catch, underwater light intensity, and monitoring of capture processes. Impacts from light fishing may include lighting power competition, cost impact due to high fuel consumption, environmental impact due to CO2 emission, and biodiversity.

Various light sources are utilized to attract or repel target or non-target fish in the capture process. As new energy efficient light sources are invented and developed rapidly, new applications of light sources might be used to develop energy efficient and environmentally friendly fishing methods. Attractions of

	plankton, which are prey for fish, that are caught in passive gears are one possible application. Repelling of fish by light of certain strength or color in a trawl might improve herding efficiency as well as decreasing weight of the gear and thus drag forces, leading to less energy consumption in trawling. A synthesis of the knowledge will provide up-to-date information on the field, and stimulate researchers for innovative application in modern day fishing gear designs in managing bycatch, reducing discards and fostering sustainable fisheries. The topic will also stimulate east-west information exchange in fishing technology.
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 Group is normally attended by some 40–60 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	The questions of bycatch reduction, gear selectivity, gear monitoring, fisheries information and survey trawl standardization are of direct interest to ACOM
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 similar work in FAO, GFCM, NAFO and also the EU Regional Advisory Councils.

Annex 4: Recommendations

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

Recommendation	For follow up by:
WGFTFB concluded that it was worthwhile for the group to continue to collate fishing technology issues and expertise into management advice on an annual basis subject to further revision of the questionnaire and better quantification of the information where possible, and that the information collated should be shared with other groups.	SCICOM/WGFTFB WGCSE, WGHMM, WGNSSK, AFWG, NWWG, WGWIDE, HAWG, WGNEW, WGANSA, WGMME, WGBYC, GFCM
WGFTFB recommends that: further studies on redfish selectivity must be carried out in a species-specific basis; morphometric data collection for different redfish species, including those species not previously studied should be enhanced; investigations on new gear designs and devices to improve the current rates of escapement of redfish during towing and to reduce stickers should be enhanced; and WGFTFB recommends that the redfish Topic Group work intersessionally and meet again next year.	SCICOM/WGFTFB ACOM to note
WGFTFB recommend that the Topic Group on Innovation in Fishing Gear Technology: i) meet again next year and extend the table of innovation projects with more information from other countries as well as updating project outcomes; ii) have presentations in plenary session; iii) possibly involve other experts (modelling ecosystem effects).	SCICOM/WGFTFB WGECO to note
WGFTFB recommended that the group remain involved in innovation in fishing gears, to act as a contact forum, facilitate learning from one another, to enable setting up international (EU)-projects, to study fish behaviour inside gear, to continue work on seabed impact, selectivity, survival, energy consumption and greenhouse gas (GHG) emissions. It is recommended to further develop and improve methods for assessing ecosystem impact of new technology in close cooperation with other disciplines within ICES, to participate in guiding fisheries in reaching maximum sustainable yield (MSY), and to play a role in education in fisheries.	SCICOM/WGFTFB WGECO to note
WGFTFB recommended that the SELDAT database currently housed as CEFAS be maitained and that efforts to transfer it to the ICES Data Centre be continued.	SCICOM/WGFTFB ICES Data Centre
WGFTFB recommends a joint WGFAST/WGFTFB session be scheduled for the 2014. Formal terms of reference will be developed intersessionally prior to the 2013 meeting.	SCICOM/WGFTFB WGFAST

Annex 4: WGFTFB information for other ICES expert groups and questionnaire sent to WGFTFB members

Questionnaire

Rationale:

Please fill out the attached form in regards to **ToR a): Incorporation of Fishing Technology Issues/Expertise into Management Advice**. This questionnaire contains a series of questions relating to recent changes within the fleets in your 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 recognized. In previous years, this information was only requested from EU nations. I am expanding it to include all participating nations, including North America. Even if you only have anecdotal or casual knowledge of fleet changes, please complete the attached questionnaire. You may also answer the questionnaire using an online form: http://tinyurl.com/3on54sj.

Mike.

Introduction

This questionnaire contains a series of questions relating to recent changes within the fleets in your 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 recognized.

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. Please try to keep your comments restricted to information in the period 2009–2011.

a. *Changes in Fleet Dynamics between **2008 and 2010***

Please describe any geographical or temporal shift in activity, change in gear type or shift in target species you are aware of.

Please describe the principal driving factors for this change (for example. management measures, effort allocation, fuel costs)

Has there been any removal of effort through decommissioning schemes? If yes, which fleets have been affected and has the decommissioning affected older or newer vessels or a combination of both? If so, what proportion of the fleet has opted for decommissioning (express as a percentage of the total fleet)

Have any new vessels entered the fleet?

b. *Technology Creep*
Include such issues as new gear handling methods/equipment; switch from single to multiple trawling; changes in vessel design that could affect effort; new fish finding equipment; etc..

Describe any significant changes in gear usage in specific fisheries (e.g. switch from twin to single rig trawling, beam trawl to seine net).

In which fishery has this change occurred and, if relevant, in what ICES areas?

Describe any other technical changes that may have 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?

Describe any evidence of vessels adapting their operations to improve fuel efficiency.

c. Gear Based Technical Conservation Measures

Other important information could include the level of uptake of TCMs if voluntary, the selectivity of these TCMs and how it compares with earlier estimates, and any other wider benefits e.g. reduced fuel costs, ecosystem benefits etc.

Describe any new TCMs that been introduced into specific fisheries. What are the measures and which fleets and/or areas are affected? Please specify regulations (national or otherwise) and fishery. Have individuals or groups of fishers introduced TCMs at their own initiatives, and if so, why?

Report any incentives that have been introduced to promote the use of more selective gears. Which fleets/areas are targeted and what are the incentives (e.g. additional effort allocations for use of Swedish grids/SMPs)?

What proportion of the fleet has opted to use new TCMs?

Can changes in size or species selectivity be quantified relative to 'standard' gears? What are the changes? (e.g. shift in L50, per cent reduction in bycatch)

d. Ecosystem Effects

Describe any fisheries not previously reported where there are known impacts on non-target species including seabirds and marine mammals, ghost fishing etc.

Describe any measures in place to reduce benthic impact.

Describe any mitigation measures in place and their effectiveness

Have these new fisheries removed effort from others? If so, please provide an estimate in terms of numbers of vessels.

e. Development of New Fisheries

Describe any change in discard patterns in the fishery.

Briefly describe any new fisheries developed in the period 2009–2011.

FTFB report to WGCSE 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 Northern Shelf and Southern Shelf Assessment Areas including the Irish Sea and the Celtic Sea.

It should be noted that the information contained in this report does not cover fully all fleets engaged in Northern and Southern Shelf fisheries; information was obtained from Ireland, the UK-Scotland, Belgium, Netherlands, France and Spain and UK England, Wales and Northern Ireland.

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); eco-

system effects; and the development of new fisheries in the Southern Shelf for hake, monkfish and megrim stocks.

Fleet dynamics

- The shifts in fleet dynamics observed in the Basque fleet over the previous period (2008–2010) are still evident for this new period. In the trawler fleet no relevant changes in gear type have occurred with only two single trawlers shifting to pair trawling. During 2009 and 2010 no effort has been carried out in area VII by the Basque trawl fleet. The effort of this fleet has been concentrated in divisions VIIIabd from October to December by the single trawlers (about 8 boats) and shared between VIIIabd and VI (50% of the fleet) the rest of the year. During 2010 an increase of the effort in area VI has been observed. (Spain (Basque): Implications: Shifts in gears and areas).
- In the Basque pair trawl fleet targeting hake, vessels are tending to make shorter trips, due to low market price. Shorter fishing trips improved the fish freshness and quality. Also, it has been observed that vessels are coordinating their landing times in base ports sequentially during the week, avoiding, spreading supply over the week rather than concentrating landings on Mondays and Thursdays as was traditional practice. Auctions are being held throughout the week which has the potential to raise the market price of the catch. (Spain (Basque): Implications: Shifts in fishing patterns driven by market requirements).
- In the Basque artisanal fleet operating on tuna (trolling lines) and mackerel (handlines) all year, traditional fishing patterns were spread over 8–9 months with about 3–4 months on mackerel and 4–5 months on tuna. The rest of the year the fleet was tied-up. Reductions in the mackerel quota in 2011 has reduced the mackerel season by 1–2 month season for this species and some boats have started fishing with other gears (longlines, gillnets) to fill out the year activity. (Spain (Basque): Implications: Shift of effort into other fisheries due to quota restrictions).
- Three new Belgium vessels using passive gears have been brought into the fleet for passive fishing, replacing beam trawlers. In addition 1 new Scottish seine net vessel has also been brought into the Belgium fleet. This is being driven by high fuel prices (Belgium: Implications: Small changes in fleet dynamics).
- One large Belgium beam trawler is now using the energy-efficient Sumwing as a replacement for standard beam trawl gear. In addition some 25 other beam trawlers are using the Sumwing seasonally. Additional there is growing interest in using the electric pulse trawl among the Belgium beam trawl fleet although none of them are using as yet as they are awaiting authorization to do so from the EU. These changes are driven by high fuel prices. (Belgium: Implications: Changes in gear type).
- There has been shifts in effort from Area Via (West of Scotland) inside the so-called ”French Line”, where 120mm+120mm smp must be used by vessels> 15m and 110mm+110mm smp for vessels < 15m compared to 100mm+90mm smp in the recent of ICES Zone VI. This area is also included in the EU's cod recovery plan so is subject to effort restrictions in addition. The majority of larger Irish vessels (5–6 over 24m) have tended to concentrate their efforts outside the French Line along the 200m depth con-

tour or have moved to Area VIIb-k in the Celtic Sea where there are no effort or gear restrictions. This has meant effectively that effort on the traditional grounds inside the French Line has been reduced considerably. The traditional grounds are now fished by these vessels perhaps for 15–20% of the year compared to 50–60% previously. However, it is worth noting the end of Q4 in 2010 and Q1 2011 that these vessels did fish the traditional grounds primarily to use up their effort and quota allocations. During this time they had very good fishing for megrim, monkfish and hake particularly on the Stanton Banks even with 120mm+120mm SMP (Ireland: Implications: Shift in effort from west of Scotland to other areas).

- A similar pattern has emerged in the Irish Sea (ICES Subarea VIIa). Effort restrictions also apply in this area. Following cuts of 25% in the overall effort allowed in the area in 2009 and in 2010 many vessels have only a limited number of days to fish in the Irish Sea. Many vessels targeting *Nephrops*, the predominant fishery in the area, have been forced to move to other *Nephrops* fisheries in the Celtic Sea. This has included smaller vessels between 12–18m (Ireland: Implications: Shift in effort from Irish Sea to other areas).
- As reported in previous years up to 20+ Irish vessels are now equipped to freeze *Nephrops* at sea. A further 2–3 vessels have since fitted or are in the process of fitting freezing equipment. This undoubtedly has implications for the *Nephrops* fisheries as most of these vessels are efficient 20m+ vessels fishing with twin-rig trawls. The main driver for is this the price of frozen *Nephrops* which has reached as high as €37/kg. (Ireland: Implications: Shift to targeting frozen *Nephrops).*
- There has been a shift in effort in the French fleet from trawls to Scottish seines: There were 3 vessels were converted in 2009, with 6 new vessels entering the fleet in 2010 in Les Sables d'Olonne (Bay of Biscay – designed for Danish seining + trawling) plus a further vessel in Boulogne-sur-Mer and in Port-en Bessin. In VIId there has also been a shift in effort from trawling to dredging for flatfish, mainly sole. This is mainly driven by high fuel prices. (France: Implications: Shift from trawling to Seining and Dredging for flatfish).
- There have also been shifts in effort in the French gillnet fleet. In the Northern Bay of Biscay (VIIIa) three vessels have switched to *Nephrops* potting while 2 netters from Calais (VIId) are now using whelk pots. This is driven by lower gear costs and better prices for landed product (France: Implications: Shifts in effort from gillnetting to potting).
- Two closures have led to displacement of effort or decommissioning of vessels in the French fleet. In the elver fishery in the Bay of Biscay a temporary closure has been introduced from the 1–22 February 2011. A total of 41 boats were decommissioned in this fishery in 2010. The longline fishery for porbeagle shark in the Bay of Biscay has been closed since 2010. The vessels involved have switched to gillnetting and longlining for demersal species (France: Implications: Reductions in effort in the elver fishery and shifts in effort from the porbeagle shark fishery).
- There are indications that Spanish bottom trawlers have varied their spatio-temporal fishing strategy in order to avoid mackerel in their catches, which can be significant at times. This is because of a reduction in the

Spanish mackerel quota in 2011 due to an overshoot of the quota in 2010 (Spain: Implications: Reduced bycatch of mackerel).

- A sixty days fishing closure for Spanish trawlers operating in NW Iberian waters entered into force in April 30 2011. This cessation of activities is in addition to the thirty day closure included under the Hake and *Nephrops* recovery plan. Vessels must tie-up for this 60 day period between the date of entry into force and 31 October 2011. It can be divided into 4 periods of 15 days duration each (Spain: Implications: Reduction in fishing effort by Spanish trawler fleet).
- The Basque trolling and handline fleet in VIIIc have also started to look for other alternatives of diversification driven by mackerel quota reduction, some have diversified to longlines and purse-seines all them in VIIIc (Spain: Implications: Shift of effort into other fisheries).
- The closure of an area on the Porcupine Bank in 2010 (ICES VIIc-k) to protect *Nephrops* stocks has resulted in a shift in the fishing spatial distribution of the Spanish OTB operating in the area. These fleets have either moved to area VI or VIII (Spain: Implications: Displacement of effort following closure).
- There has been no decommissioning in Ireland since 2009. Results of previous schemes were reported in 2009 and 2010 reports. Several vessels have entered the fleet in 2010 and 2011. Most of these vessels are in the range 12–15m and are generally down-scales from larger vessels. The exact numbers of vessels is not known (Ireland: Implications: Down-sizing of vessels)
- There has been an overall reduction in the number of vessels in the French Fleet between 2008 and 2009 (overseas not included) of ~3%. The table below shows the evolution of the fleet in 2008 and 2009:

Length of the boat	2008	2009	Evolution %
< 7 m	1220	1210	0%
7 to 10 m	1759	1736	-1%
10 to 12 m	877	850	-3%
12 to 15 m	259	238	-8%
15 to 18 m	280	262	-6%
18 to 24 m	347	315	-9%
24 to 40 m	193	177	-8%
40 m and more	50	49	-2%
Total	4985	4837	-3%

Source Ifremer – Synthèse des flottilles de pêche 2009 – SIH (preliminary data).

- In Belgium 9 vessels (~10% of the remaining fleet) were decommissioned. These were all beam trawl vessels (Belgium: Implications: Reductions in fleet size).

Technology Creep

- Two Irish vessels (10–12m) have been involved in an experimental fishery for razorfish (*Ensis*) using electric pulses dredges in the southern part of the Irish Sea off Rosslare. Vessels in this fishery traditionally use hydraulic

dredges. Based on the trials the electric pulse dredge appears to reduce damage to the razorfish catch in the fishery by more than 40% and also has less bottom impact as the pulse dredge does not dig into the bottom. These trials are continuing. Up to 40 vessels participate in the fishery in total in the Irish Sea (VIIa; Ireland: Implications: Development of new gear type).

- Up to 5–6 of the largest Irish demersal trawlers (24m+/750hp+) have begun to use semi-pelagic trawls doors (Thyboron type 15VF) fished off-bottom. These doors are rigged with a heavy chain clump between the doors and the trawl. The main motivation for using these doors is to reduce fuel consumption (approximated savings of 5–10% are reported by the skippers) but there may be benefits for reduced bottom impact although this maybe partial negating by the chain clump. No impact on catchability noted (Ireland: Implications: Development of fuel-efficient gear).
- An Irish demersal vessel (27m/1000hp) is now using Dynex warp instead of standard wire warp. Initial indications are that the Dynex warp gives slight improves in fuel efficiency (~5%) but is easier to handle than standard warp and reduces wear and tear on the towing bocks and winches through the reduced weight. No impact on catchability noted (Ireland: Implications: Development of fuel-efficient gear).
- Experiments have been carried out in France on a new engine on a coastal boat in Saint-Jean de Luz during 2010. These trials have tested the efficiency of a mixture of sunflower oil + diesel oil (France: Implications: Use of new fuel source).
- The French demersal fleet has continued to adopt new gears or alter operations to improve fuel efficiency. Initiatives included the use of new optimized doors with minimal bottom contact; optimizing the shape of the trawls and increasing mesh size when possible in the aft part of the trawls; the Use of Dyneema and Breiztop low diameter, high tenacity twines; decreasing speed in transit and fishing; avoiding towing against the tide/current; and landing in harbours closer to fishing grounds. In addition there has been experimentation in the Bay of Biscay and the Channel and North Sea with pelagic doors for bottom trawling (with hydrodynamic weights; France: Implications: improved fuel efficiency).
- In 2010 over 10 large Belgium beam trawlers have been re-engined and have fitted new propellers and Kort nozzles mainly to improve fuel efficiency (Belgium: Implications: Increased fuel efficiency but possibly increased fishing efficiency).
- Basque vessels operating with different gears (trawl, purse-seines, gillnets, handlines) have adapted their fishing operations to reduce fuel consumption mainly by significantly reducing steaming steam to and from fishing grounds (Spain: Implications: Improved fuel efficiency).

Technical Conservation Measures

- Some retailers in Belgium only want to buy MSC certified fish or fish that is classed as sustainable on "fish guides". This is putting pressure on the fishing industry to adopt more responsible fishing practices although to what extent is unclear at present (Belgium: Implications: Unknown).
- Three Irish vessels (~20m/350kw) are now using the "Swedish" sorting grid in the *Nephrops* fisheries in the Irish Sea (Area VIIa). Based on a case

submitted by the Irish government these vessels are now exempt from effort restrictions currently in force in this area. The observations carried out showed cod catches with the grid to be consistently less than 0.1% per trip and with the grid *Nephrops* make up more than 95% of the catches with the grids. A further 3–4 vessels have now either fitted grids or are testing them voluntarily. This represents about 15% of the Irish *Nephrops* fleet in the Irish Sea. (Ireland: Implications: Use of selective gear).

- Five Irish whitefish vessels (24m+/700hp+) have also been granted an exemption from the effort regime in Area VIa (West of Scotland). This represents around 955 of the active Irish vessels in this area. This exemption was granted on the basis that these vessels did not fish in an inshore area of the Donegal coast with historically high cod catches. These vessels must use 120mm mesh size and 120mm (9–12m) square mesh panels inside a restricted area inside the so-called "French Line" but can use 100mm+90mm smp outside this area. These vessels were subject to enhanced coverage by scientific observer sampling which showed on average 0.7% cod in the total catches. The 120mm+120mm smp gear is selective with L50s for haddock, whiting and megrim of 39cm, 46cm and 41cm respectively. Additionally with the 120mm+120mm smp catches of haddock and whiting are reduced by ~40–60% with a reduction in catches of megrim of ~20% mostly in the small size grades which have low economic value (Ireland: Implications: Use of selective gear).
- Up to 12 Irish *Nephrops* twin-rig vessels have voluntarily fitted ~120mm square mesh panels. These vessels are part of a state backed responsible fishing scheme and are an attempt at demonstrating good practice in these fisheries (Ireland: Implications: Use of selective gear).
- Due to the adoption of the OMEGA mesh gauge most Irish *Nephrops* fishers operating in the Irish Sea and on the south coast of Ireland are recorded their codend mesh size in the logbook as 70mm even the codends are nominally 80mm. This is because the OMEGA gauge consistently measures lower than the standard mesh gauge and by recording their mesh size as 70mm they are confident their codends will be measured legal whereas there is a chance if they record the codend as 80mm they could be found to be using an illegal mesh size (Ireland: Implications: Reporting of mesh size).
- French vessels have been involved in ongoing trials in the Bay of Biscay in the *Nephrops* fishery, primarily to improve escapement of juvenile hake and *Nephrops* selectivity. Devices such as square mesh cylinders, flexible grids, square mesh panels and a combination of the devices have been tested (France: Implications: testing of selective gears).

Ecosystem Effects

- As reported in previous years from Ireland predation of fish catches by mainly Grey seals form gillnet/tanglenet fisheries continues to be a problem on all coasts of Ireland. Many inshore fishers have now stopped gillnetting as the level of damage is so high. Seals have been reported up to 80–90 miles off the coast. More than 30 vessels in the size range 10–20m are affected by this phenomenon. It has been reported by fishers that seals are not only targeting gillnets but also vessels jigging around wrecks and

rough ground for white Pollack as well from lobster and crab pots and even trawls (Ireland: Implications: Increased predation by seals).

- Difficulties with using pingers in gillnet fisheries are still being reported in France and Ireland. In Ireland Pingers are still only being used sporadically while further tests with existing commercial pingers in France gillnets have not been successful and practical difficulties still remain (France: implications: Practical difficulties with acoustic pingers).
- During the last quarter of 2010 Irish vessels operating in Area VI discarded large quantities of saithe and hake as the quota was exhausted. Discarding of hake in particular was reported to be very high in this area. Throughout the year there was also a certain amount of highgrading of hake due to the very low market price for hake below 1kg (~40cm in length; Ireland: Implications: High discarding).
- Discarding of juvenile haddock and whiting has been very high in the Celtic Sea from around quarter 2 onwards in 2010. This is due to very large year classes of these species coming through into the fishery. There are reports of boats catching 2–3 tonnes to every 1 tonne retained. Attempts have been made in Ireland to introduce remedial methods and some positive steps have been taken in relation to some of the *Nephrops* fleet but other vessels (particularly the seiners) are more reluctant to improve the selectivity of their gears on the basis that losses of marketable fish will be too high (Ireland: Implications: High discarding).
- A descriptive analysis of data from The "Spanish Discards Sampling Programme" for the Basque trawler fleets, reveals a increase in mackerel discard amounts during 2010, as a consequence of the early closure of the fishery (March), and the inability of the trawlers to avoid catches of mackerel . It is expected that, large amounts of mackerel discarded will be generated in 2011 as a consequence of the quota reduction imposition (Spain (Basque) Implications: Increased discarding).
- Basque: During the beginning of 2011 national regulation forbidden mackerel catch to all the national fleets until the 15 February. The trawl fleet operating in ICES VIIIc and usually fishing mackerel in the beginning of the year was obliged to discard great quantities of mackerel because in that season mackerel is abundant in the areas were this fleet operates. At the beginning of 2011 the trawl fleet operating in ICES VIIIc discarded large quantities of mackerel due to high abundant in the areas were this fleet operates but no quota entitlements (Spain (Basque): Implications: High discarding of mackerel).

Development of New Fisheries

- The French scallop industry is attempting to develop dive fishing for scallops in Northern Brittany. Five vessels used to prosecute a fishery for abalone by diving and have managed to obtain licences to dive for scallop in 2008 in the Rance River. In 2010, they have also been allowed to fish scallop in one area near Saint Malo. The legislation that applies to these vessels is almost the same than as for scallops dredging in terms of catch and effort limitations. In another area in Northern Brittany (area open only 15 days per year), fishers that received licences to dredge for scallop can also choose to dive for them instead. Uptake has been restricted to one vessel to date. (France: Implications: Low impact fishing method).

- There have been largely unsuccessful attempts to develop a jig fishery for squid with light (Japanese technology) in the South of the Bay of Biscay (VIIIb; France: implications: Unknown).
- Trials have been ongoing in France in the English Channel and North Sea on cod and whiting selective devices (large mesh "eliminator" trawls, flexible grids – SELECMER and SELECCAB project). There have also been trials to test a system of real-time closures to protect cod stocks in the North Sea

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, Skagerrak and Kattegat.

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, UK England, Wales and Northern Ireland, France, Belgium, Netherlands and Norway.

Fleet dynamics

- The total number of vessels in the Dutch fleet in 2010 has dropped to 590 with a total installed power of 430,000 hp (~320,000 Kw) although two new vessels did enter the fleet in 2010. In the remaining fleet there has been increasing use of the SumWing in flatfish and shrimp beam trawling, recently with integrated the pulse trawl (PulseWing). There is also a switch Scottish seining and twin-rigging and a few vessels with static gears. Main driver is fuel price. The average price in 2010 was 0.45 €/litre, compared to 0.33€/litre in 2009. Constraint is also the low price for plaice (2009: 1.38 €/kg and in 2008: 1.89 €/kg). Slightly higher sole prices (+1.5 €/kg) were obtained. Flatfish beam trawling made a small profit since seven years (Netherlands: Implications: Shifts from traditional beam trawling to other gears).
- There is continued interest in pulse trawling in the Netherlands although under EU regulations a derogation is still required. A total of 36 applications for pulse trawling have been made to the Netherlands Ministry, of which 22 are currently operational. A derogation is still required for pulse trawling (Netherlands: Implications: Switch from beam trawling to pulse trawling).
- After the Swedish decommissioning schemes in 2010 a small number (at least one) of <10m trawlers have been introduced to the fleet, since these are less than 10 meter they are not included in the regulation of effort but the trend is replacing large vessels for smaller vessels although this smaller vessels are still reasonably efficient. This is driven by a combination of economic factors (Sweden: Implications: Reduction in fleet size).
- Three new Belgium vessels using passive gears have been brought into the fleet for passive fishing, replacing beam trawlers. In addition 1 new Scottish seine net vessel has also been brought into the Belgium fleet. This is

being driven by high fuel prices (Belgium: Implications: Small changes in fleet dynamics).

- One large Belgium beam trawler is now using the energy-efficient Sumwing as a replacement for standard beam trawl gear. In addition some 25 other beam trawlers are using the Sumwing seasonally. Additional there is growing interest in using the electric pulse trawl among the Belgium beam trawl fleet although none of them are using as yet as they are awaiting authorization to do so from the EU. These changes are driven by high fuel prices. (Belgium: Implications: Changes in gear type).
- There has been a shift in effort in the French fleet from trawls to Scottish seines: There were 3 vessels were converted in 2009, with 6 new vessels entering the fleet in 2010 in Les Sables d'Olonne (Bay of Biscay - designed for Danish seining + trawling) plus a further vessel in Boulogne-sur-Mer and in Port-en Bessin. In VIId there has also been a shift in effort from trawling to dredging for flatfish, mainly sole. This is mainly driven by high fuel prices. (France: Implications: Shift from trawling to Seining and Dredging for flatfish).
- There has been an overall reduction in the number of vessels in the French Fleet between 2008 and 2009 (overseas not included) of ~3%. In 2010 a further 4 trawlers have left the fleet. The table below shows the evolution of the fleet in 2008 and 2009:

Length of the boat	2008	2009	Evolution %
< 7 m	1220	1210	0%
7 to 10 m	1759	1736	-1%
10 to 12 m	877	850	-3%
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15 to 18 m	280	262	-6%
18 to 24 m	347	315	-9%
24 to 40 m	193	177	-8%
40 m and more	50	49	-2%
Total	4985	4837	-3%

Source Ifremer – Synthèse des flottilles de pêche 2009 – SIH (preliminary data).

- In Belgium 9 vessels (~10% of the remaining fleet) were decommissioned. These were all beam trawl vessels (Belgium: Implications: Reductions in fleet size).
- There has been an increase in effort in the Eastern Channel by Dutch and Belgium beam trawlers for flat fish and by Scottish seine net vessels for mixed demersal species. No indication are available as to the scale of these increases (Belgium and Netherlands: Implications: Increased effort in VIId)

Technology Creep

- Fuel costs were reduced in the Dutch cutter fleet in 2008 from 35% (now 50 M€) to 25% in 2009 due to adaptations in gear and operation. Reports show that the use of the SumWing can save up to 300 tonnes of fuel per year per boat (Loa = 40 m), and with the pulse trawl up to 800–1000 tonnes annually. The use of the SumWing, Pulse Trawl and Pulse/Wing beam trawls

are reported to have resulted in a shift in grounds in ICES Area IV, and also add fishing time, due to faster hauling speed. This is not well documented but may result in increased a change in effort patters and increased fishing time (Netherlands: Implications: Improved fuel efficiency).

- In 2010 over 10 large Belgium beam trawlers have been re-engined and have fitted new propellers and Kort nozzles mainly to improve fuel efficiency (Belgium: Implications: Increased fuel efficiency but possibly increased fishing efficiency).

Technical Conservation Measures

- Some retailers in Belgium only want to buy MSC certified fish or fish that is classed as sustainable on "fish guides". This is putting pressure on the fishing industry to adopt more responsible fishing practices although to what extent is unclear at present (Belgium: Implications: Unknown).
- In Sweden the use of rigid sorting grids has increased in Kattegat between 2009 and 2010 from 48% of total TR2 effort in 2009 to 61% in 2010. In Skagerrak the use of sorting grid has increased from 50% 2009 to 53% 2010 of total TR2 effort. The TR2 effort is by far the most important gear category in both Skagerrak and Kattegat constituting 80–90% of total effort. Almost 100% have opted to use this device (Sweden: Implications: Widespread use of sorting grid).
- Selection panels were introduced and supported by the government in Dutch *Nephrops* trawling to decrease bycatches of cod. There are no indications as yet of the impact of using these panels (Netherlands Implications: Use of selection device).
- Extensive testing of the OMEGA mesh gauge has been continuing in the Netherlands. Tests had been done in the laboratory and also at sea with 17 trips on 10 different vessels. The objective series of measurements had shown that the meshes became more elongate with repeated testing. This is characteristic of synthetic fibrous material. Measurements on board ship involved 20 measurements from each row of meshes in a net. Each individual mesh measurement was repeated 3 times. As in the laboratory, each repeated test showed a greater elongation of the mesh. All the tests had been done with a new Omega Gauge straight from the factory. The result of these tests was that 3 nets fell below the 79mm limit (set for nominal 80mm nets). Essentially the results suggest that if you measure an individual mesh three times you will get an increasingly bigger reading. The results of this study are due to be released soon but are interesting in terms of enforcement of mesh size regulations (Netherlands: Implications: measurement of mesh size).

Ecosystem effects

- French fishers have reported changes in the size and (age) distribution of cod and generally more abundance of cod in the North Sea and Celtic Sea. This may lead to discarding issues later in the year as occurred in 2010 (France: Implications: Possible discarding of cod).

Development of New Fisheries

- One Belgium otter trawler is targeting squid in area VIId as an alternative for the winter months. Several Belgian netters have also carried out trials

with gillnets for turbot, cuttlefish pots and fish traps in 2010. Numbers of vessels involved are small but there is some displacement from other fisheries (Belgium: Implications: Testing of new fisheries).

- There has been an increased fishery for greater weever (*Trachinus draco*) in the Kattegat during 2010 and 2011, mainly as a consequence of low catches of *Nephrops* and cod during the first quarter of the year. The weever is also one of few species that are without limiting quotas and few regulations attached to it in the Kattegat. (Sweden: Implications: development of new fishery).

FTFB report to AFWG and NWWG

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 solely.

Fleet Dynamics

- The cod fishery in NAFO Division 3M was reopened after being closed for 15 years. Several Spanish vessels fished in the area when the fishery was opened in 2010. Spain had an entitlement of 90 days which was fully utilized. There was also a shift in the pair trawl fleet operating in the Arctic area (ICES Subareas IIa, IIb) in recent years. The number of pairtrawlers has decreased from 4 pairs to only one pair in 2010. The pairtrawlers have been converted to trawlers in some cases. Overall in ICES Subarea despite a reduction in the number of vessels there has not been a reduction of fishing effort and the quota is fully utilized, since any surplus of quota has been redistributed to active vessels. Several new trawlers which alternate their fishing activities between the former Arctic area and NAFO have also entered the fleet in recent years. (Spain: Implications: Shifts in area and fishing method).

Technical Creep

- In 2009 a semi-pelagic trawl technique for saithe was successfully developed and introduced in the Norwegian fishery. The most successful trawl is designed with hexagonal front part meshes and rigged with pelagic trawls off bottom. Better efficiency, less fuel consumption and reduced bottom impact are reported, but currently not quantified. (Norway: Implications: Increased fuel efficiency and lower bottom impact).

Technical Conservation Measures

- A combined grid device that releases undersized fish and small sized shrimp is being developed in Norway and is being used voluntary by some vessels fishing shrimp in the Oslo fjord. (Norway: Implications: Voluntary uptake of TCM device).

Ecosystem Effects

- The development of a pelagic trawl fishery for cod and other gadoids in the Barents Sea will reduce benthic impact significantly. Pelagic trawling is permitted for trawlers that have applied for such a licence. (Pelagic trawling is still illegal north of 65 deg. N. (Norway: Implications: Reduced bottom impact).

FTFB report to WGWIDE, HAWG, WGNEW and WGANSA

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, England, Wales and Northern Ireland, Spain and Norway.

Fleet Dynamics

- In the Basque artisanal fleet operating on tuna (trolling lines) and mackerel (handlines) all year, traditional fishing patterns were spread over 8–9 months with about 3–4 months on mackerel and 4–5 months on tuna. The rest of the year the fleet was tied-up. Reductions in the mackerel quota in 2011 has reduced the mackerel season by 1–2 month season for this species and some boats have started fishing with other gears (longlines, gillnets) to fill out the year activity. (Spain (Basque): Implications: Shift of effort into other fisheries due to quota restrictions).
- National management measures in Spain failed to protect mackerel quotas in 2010 (ARM/271/2010) and as a result the quota was exceed by 79% and a reduction in the Spanish mackerel quota for 2011. This has led to an early closure of the fishery (3–5 March for purse-seine and trawl fleets respectively) in 2011. This has affected a large number of vessels with significant reductions in effort. (Spain: Implications: Reduction in effort in mackerel fisheries).
- About 20% of the artisanal fleet in the Basque region of Spain operating with trolling lines for tuna and handlines for mackerel are planning to decommission their vessels in 2012. This is due primarily to the reduction in mackerel quota as a result of the overshoot in quota in 2010 (Spain: Implications: reduction in fleet size).
- The Basque trolling and handline fleet in VIIIc have also started to look for other alternatives of diversification driven by mackerel quota reduction, some have diversified to longlines and purse-seines all them in VIIIc (Spain: Implications: Shift of effort into other fisheries).

Technical Conservation Measures

- In the Basque artisanal fleets daily or weekly quotas (depending on the fishery) have been introduced by the fishers voluntarily in mackerel fishery (handliners and purse-seiners) and in the anchovy fishery (purse-

seiners). This is mainly driven by higher market prices for better quality landed product but also by restrictive quotas in both fisheries. All vessels in these fisheries are complying with these measures (Spain (Basque) Implications: Voluntary quotas limits introduced).

Ecosystem Effects

- Basque: During the beginning of 2011 national regulation forbidden mackerel catch to all the national fleets till the 15 February. The trawl fleet operating in ICES VIIIc and usually fishing mackerel in the beginning of the year was obliged to discard great quantities of mackerel because in that season mackerel is abundant in the areas were this fleet operates. At the beginning of 2011 the trawl fleet operating in ICES VIIIc discarded large quantities of mackerel due to high abundant in the areas were this fleet operates but no quota entitlements (Spain (Basque): Implications: High discarding of mackerel).

Development of New Fisheries

- In recent years a large-scale fishery for Boarfish (*Capros aper*) has been developed by the Irish pelagic fleet with landings of ~78,000 tonnes in 2010. This species prior to 2010 was non-quota. However, following notification from the EU that the mesh size they were using in this fishery (i.e. ~32mm) was illegal under EU technical measures regulations as this species was not listed in the species annex to this regulation. According to the EU the vessels should have been using 100mm. The Irish authorities argued that this would effectively close the fishery as the large mesh size would make it uneconomic. Following political negotiations in 2011 a quota was set for this species at 33,000 tonnes with an Irish quota allocation of 22,500 tonnes. This represents a significant decrease in the fishing opportunities for the Irish pelagic fleet. In addition new measures to allow targeting of boarfish with the 32mm mesh size seem set to be agreed (Ireland: Implications: development of large-scale commercial fishery)

FTFB report to WGMME, SGBYC and WGNEW

Ecosystem Effects

- Some Italian fishers in the central Adriatic Sea operating with demersal and pelagic trawl, on a voluntary basis have started to use pingers as deterrent for dolphin. They believe these devices will reduce predation and hence increase the efficiency of their gear. (Italy: Implications: Possible reduction in cetacean bycatch).
- As reported in previous years from Ireland predation of fish catches by mainly Grey seals form gillnet/tanglenet fisheries continues to be a problem on all coasts of Ireland. Many inshore fishers have now stopped gillnetting as the level of damage is so high. Seals have been reported up to 80–90 miles off the coast. More than 30 vessels in the size range 10–20m are affected by this phenomenon. It has been reported by fishers that seals are not only targeting gillnets but also vessels jigging around wrecks and rough ground for white Pollack as well from lobster and crab pots and even trawls (Ireland: Implications: Increased predation by seals).

- Difficulties with using pingers in gillnet fisheries are still being reported in France and Ireland. In Ireland Pingers are still only being used sporadically while further tests with existing commercial pingers in France gillnets have not been successful and practical difficulties still remain (France: implications: Practical difficulties with acoustic pingers).

Development of New Fisheries

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- There has been an increased fishery for greater weever (*Trachinus draco*) in the Kattegat during 2010 and 2011, mainly as a consequence of low catches of *Nephrops* and cod during the first quarter of the year. The weever is also one of few species that are without limiting quotas and few regulations attached to it in the Kattegat. (Sweden: Implications: development of new fishery).

FTFB report to GFCM

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 Mediterranean Sea.

It should be noted that the information contained in this report does not cover fully all fleets engaged in fisheries; information was obtained from Italy and a limited amount of information from France.

Fleet dynamics

- As a result of measures under Regulation (EC) 1967/2006 from June 2010 in the Northern Adriatic Sea the use of towed gears has been prohibited within 3 nautical miles from the coast while the use of beach-seine and boat seine targeting *Aphia minuta* (Gobidae) and juveniles of sardine (*Sardina pilchardus*) is prohibited without a specific management plan. This affects a large number of Italian vessels and is shifting effort into other fisheries and other areas (Italy: Implications: Shifts in effort as a result of management changes).
- A derogation to the above measures has been introduced in January 2011 whereby the use of trawlnets between 0.7 and 1.5 nautical miles off the

coast (at a depth greater than 50 m) is authorized in the following Regions: Liguria, Sicilia, Calabria. (Italy: No major implications)

- Following the adoption of an Italian Ministerial decree since 2009 bottom trawlers using twin trawls are obliged to fishing one day less a week than single rig trawlers. (Italy: Implications: Reduction in effort using twin-rigs)
- In 2011 some fishing vessels change their activity from rapido trawl to midwater pelagic trawl and from midwater pelagic trawl to bottom trawl. This is mainly for economic reasons. (Italy: Implications: Shifts in effort between métiers).
- In order to reduce fishing effort, in the last years some local fisheries have voluntarily reduced their fishing time from 5 days (legal limit) to 3.5 days. This is mainly for economic reasons. (Italy: Implications: Reduction in effort).
- In the French fleet there has been a shift from the "Thonaille" drifting gillnet to trammelnetting for sole. This due to questions over the legality of the Thonaille gear (France: Implications: Shift from tuna to sole fishery).
- A month long trial has been carried out by French gillnetters targeting crawfish with crawfish traps as an alternative gear off Corsica. No results are available (France: Implications: None at present as trial fishery).

Technical Creep

- In the last 3–4 years some Italian bottom trawlers of the central-northern Adriatic, switched their activity from single to twin-rig trawling (named by the Italian fishers: "Rete gemella"). The main characteristic of the twin-rig are four-panel trawls with small or large lateral panels (named Americana trawl, in Italian). These nets also have large meshes in the wing section and are manufactured in Raschel knotless-PA and knotted-PE netting. The nets are designed to have increased vertical and horizontal openings are thought to be highly efficient. (Italy: Implications: More efficient trawls).
- Some Italian fishing vessels using the rapido trawl (multi-rig trawl) have decreased the width of the beam from 4 to 3–3.5 m in order to decrease bottom contact and fuel consumption (Italy: Implications: Improved fuel efficiency).

Technical Conservation Measures

- In order to reduce mortality rates for juveniles and discards of dying marine organisms by fishing vessels, Council Regulation (EC) No 1967/2006, concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean, establishes that *"…from 1 July 2008, the net referred to in point 1* (that is "towed nets") *shall be replaced by a square-meshed net of 40 mm at the codend or, at the duly justified request of the shipowner, by a diamond meshed net of 50 mm"*. Italian fishers were not prepared for this change and most of them, particularly in the South of Italy still do not accept the modification from the traditional mesh size. The fishing fleet of central-northern Italian seas are more collaborative, but they do not accept the square mesh and use the 50mm diamond mesh size codend (Italy: Implications: Poor selectivity).

- There is widespread misinterpretation of certain technical measures among Italian fishers leading to limited impact of new rules introduced. Given that the length of the codend is not well defined, the fishers have adopted to use shorter netting panel (about 50–100 cm) at the final part of the codends with legal mesh size, leaving the rest of the net unchanged (smaller mesh size). In addition the measurement of codend circumference remains largely unchecked by fishery inspectors. Overall the technical changes introduced Under Regulation (EC) 1967/2006 remain INEFFECTIVE (Italy: Implications: Poor implementation of technical measures regulations).
- In Spain, several studies have been carried out in Mediterranean waters. In the Balearic Islands, a change from 40 mm diamond-shaped mesh to a 40 mm square-shaped mesh resulted in changes in the selectivity parameters (L50) and a reduction in the biomass discarded. The entire Spanish fleet has now adopted this new mesh size (Spain: Implications: Increased selectivity).

Ecosystem Effects

- Some Italian fishers in the central Adriatic Sea operating with demersal and pelagic trawl, on a voluntary basis have started to use pingers as deterrent for dolphin. They believe these devices will reduce predation and hence increase the efficiency of their gear. (Italy: Implications: Possible reduction in cetacean bycatch).
- Some Italian fishers have introduced a window into the lower panel of bottom trawls in order to reduce the catch of shellfish, sea urchin, stones etc. but this is countered by fishers increasing the number and weights of tickler chains and the weight of groundropes (Italy: Implications: Unknown).

Annex 5: Questionnaire sent to WGFTFB members on Vessel survey standardization and calibration methodologies

List of questions:

i) How many bottom trawl surveys currently occur in your region (with aim of demersal finfish biomass estimates)?

ii) Do any of these use commercial vessels or are they government research vessels only?

iii) Are there any commercial-only bottom trawl surveys (completely staffed and outfitted by industry)? How successful has this been?

iv) For commercial vessels, what is the arrangement for standardizing gear, gear performance, and sampling catch? How successful has this been?

v) Are any multi-vessel surveys? If yes, how are catch rates standardized among vessels? How successful has this been? What other challenges have occurred?

vi) Has your region ever had to change vessels or gear during a time-series? If yes, what was done to calibrate the catch rates of the old vessel to the catch rates of the new vessel? Are there any other issues to consider?

vii) Are you planning any upcoming vessel or gear changes requiring calibration and what do you anticipate the process will entail?

viii) Are there any other contacts you would recommend with experience with the above?

Emma Jones and her team would be keen to phone you to talk about these issues if possible, although a quick e-mail response would also be helpful in focusing the discussion.