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

21-25 April 2008

Tórshavn, Faroe Islands

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Executive summary

The ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB) met in Tórshavn, Faroe Islands from 21–25 April 2008 to address seven Terms of Reference. The main outcomes related to the ToRs are detailed below.

Key Findings

Species separation in demersal trawls (Section 10)

- A summary of the status of knowledge and future directions in research and application on the behaviour and species separation in commercial species would greatly benefit FTFB members and the fishing industry. A WGFTFB topic group will continue to concentrate on behaviour and species separation of commercial demersal species in bottom trawls.
- WGFTFB therefore recommends the publication of an ICES Cooperative Research Report on Species Separation based on the work carried out by the Topic Group. A timetable and structure for this CRR report have been agreed.

Advice to Assessment Working Groups (Section11)

- The overall picture from the questionnaires in 2008 is quite negative. Due to a combination of soaring fuel prices, reduced quotas, decreasing fishing opportunities and volatile prices for several key species notably *nephrops*, haddock, cod, monkfish and hake, there is a general air of despondency in the fleets across Europe.
- There seems to be a general trend of effort reduction across fleets and also widespread evidence of fishermen in many countries reverting to more fuel efficient methods in an attempt to reduce operating costs and maintain economic viability.
- The effects of technological creep are still evident in many fisheries but the concept of negative creep reported in 2006 and 2007 is now becoming more prevalent as vessels try to reduce operating costs to counteract high fuel prices. Most technological creep observed has concentrated on reducing the drag of fishing gear.
- In a number of fisheries, there is some evidence of voluntary uptake of gear mitigation measures. The drivers for uptake are either regulatory i.e. as a means of achieving increased fishing opportunities or economic through improved fish quality. There has also been evidence of some vessels adopting more selective gear as a way of improving public perception.
- Evidence of discarding has been observed in a number of fisheries 2007/2008. The motivations for discarding are a mixture of regulatory or economically driven. Specific examples include cod in Area VIIb-k and in the Baltic Sea.
- Ghost fishing in the deepwater fisheries in Areas IV, VI and VII remains a problem. There are reports of discarded longlines and gill nets along the Scottish west coast deep water grounds and in the northern North Sea and predation of fish catches by Grey seals from gillnet/tangle net fisheries has become an increasing problem on the south coast of Ireland.

- As has become the trend in recent years there are very few reports of new fisheries being developed but a few specific examples are reported such as sea cucumber in Iceland and squid in the Moray Firth and at Rockall.

Gillnet Selectivity Manual (Section 12)

- The original ICES draft static gear selectivity manual was felt to be 80% complete and on the basis of the information available it was agreed that it was a worthwhile exercise to complete the manual. It was felt pertinent to restrict the manual to static nets only i.e. gillnets, trammel nets and tangle nets.
- A timetable for completion of the manual was agreed with a completion date of mid-2009. Subject to technical review, the manual will be considered as a joint ICES/FAO publication. No financial commitment has been made at this stage.

Mitigation Measures for Protected Species (Section 13)

- WGFTFB acknowledges the work carried out by ICES SGBYC in developing the table of mitigation measures and has sought to update this table.
- WGFTFB concludes that the impact of fisheries on Loggerhead turtle needs to be considered urgently given the scale of the problem. Research into the applicability of proven mitigation technologies to reduce the bycatch should be supported.
- WGFTFB has been unable to use the methodology developed in 2008 to assess the efficacy of mitigation measures for protected species. WGFTFB conclude that this methodology is data dependent and for most protected species with bycatch issues such data does not exist currently.

Advice to WGEF on outrigger trawls (Section14)

- WGFTFB concluded that Belgian and UK trials suggest the use of outrigger trawls may lead to an increase in the catch of rays, particularly when vessels specifically target this species. Some technical limitations with this gear for larger vessels relating to gear spread have been highlighted. In practice this means, at least in the short term, that the uptake for this gear will be limited to smaller vessels in Belgium and the impact on ray stocks maybe not that significant although this needs monitoring. This may not necessarily be the case in the UK, where indications are that large beam trawl vessels may adopt this gear, due to fuel costs.

Advice to NIPAG & STACREC on shrimp trawl efficiency (Section15)

- WGFTFB concludes that due to the catching process for shrimp, horizontal opening is more important than filtered volume with respect to catch volumes and this is reflected in the current trends in shrimp trawl design.
- WGFTFB concludes that due to the fundamental differences in the catching process, comparisons between single and twin trawls for fish species and shrimp are not relevant. This is because herding efficiency by sweeps can very much influence capture efficiency for fish but not for shrimp.
- WGFTFB can find no reliable estimates of single vs. twin trawl efficiency based on horizontal spread. Icelandic effort data using trawl circumference shows average catch rates for twin trawls of between 1.25–2.24 times that of a single trawl, with an average of 1.66.

- WGFTFB can find no evidence of multiple rigs being used to improve catch quality. The main tool used that does improve catch quality is the Nordmore sorting grid. There is evidence, however, of fishermen using twin or trouser codends to reduce the risk of gear damage, increase wingend spread and improve catch quality.

WGECO request as part of the OSPAR QSR 2010 (Section 16)

- The integration of fishing gear technology research in the framework for fisheries management is a prerequisite for achieving an ecosystem-based approach. It is recommended that many of the issues evolving from the selected case studies outlined by WGFTFB should be taken into account in a framework for assessing impacts and management measures related to fishing gear based technical measures.
- The efficacy of gear based technical measures is currently infrequently assessed. In this respect WGFTFB conclude that the protocol used in the UK study to evaluate the legislation put into force for the *C. crangon* fisheries is both holistic and effective. The same protocol can potentially be used elsewhere in other fisheries to conduct similar evaluations on the efficacy of gear based technical measures.
- While focus on a more ecosystem-based approach is emerging gradually, little fishing gear research is directed towards other ecosystem components. Therefore there is need to consider biological and ecological impacts of gear configurations and modifications during the research phase and before inception into legislation.
- Research on gear modifications to improve selectivity of commercial fish species through a variety of sorting devices has been proven to reduce bycatch and discards rates, mainly of fish species (Valdemarsen and Suuronen, 2003, Suuronen and Sarda, 2008). The application of these gear modifications can be achieved through regulations or sometimes through voluntary use by fishermen. Regulatory and market incentives can both lead to an improvement of fishing practice.
- From the case studies, it can be seen that communication and education are vitally important when introducing gear based measure into legislation. Regulations are sometimes introduced quickly, but it takes time for the fishing industry to adapt.
- When framing legislation, there is a need to consider all relevant issues (e.g. practicalities, socio-economic and technical aspects, etc.) to ensure that gear measures, proven effective in fishing gear research, meet their objectives after implementation.
- Non-regulatory uptake of technical gear measures can be achieved through various incentives. These incentives can be market-driven, but industry may also be motivated by uptake which has the potential to improve the public perception of fishing.

FAO Reduction of Environmental Impact from Tropical Shrimp Trawling (REBYC 1)

- In 2008, REBYC I will come to an end. Significant progress has been made towards reducing the bycatch of large charismatic species such as marine turtles captured by tropical shrimp trawls, however, significant problems remain with respect to the capture of juvenile fish and sustainable management of tropical mixed species bottom trawl fisheries.

- It is hoped that a second phase project will be implemented and broadened to a greater number of countries and incorporating a broader range of management tools to manage multi species trawl fisheries.

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 used in bycatch and discard reduction; and environmentally benign fishing gears and methods used to reduce impact on bottom habitats and other non-target ecosystem components. Areas of focus should also include behavioural, statistical and capture topics.

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

2 Introduction

Chair: Dominic Rihan,
Bord Iascaigh Mhara,
PO Box 12
Crofton Road
Dun Laoghaire
Co. Dublin
Ireland
mailto:rihan@bim.ie

Rapporteur: Huseyin Ozbilgin
Mersin University,
Fisheries Faculty,
Yenisehir Campus,
Mersin, 33169
Turkey
mailto:huseyin.ozbilgin@ege.edu.tr

Venue: Tórshavn, Faroe Islands
Date: 21–25 April 2008

2.1 Terms of Reference

The **ICES–FAO Working Group on Fishing Technology and Fish Behaviour** [WGFTFB] (Chair: Dominic Rihan, Ireland) will meet from 21–25 April 2008 in Tórshavn, Faroe Islands.

Topics

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

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

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

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

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

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

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

The group will have the following ToRs:

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

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

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

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

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

e) A WGFTFB topic group of experts will work by correspondence to address the following ToR from WGEF:

- Provide more details on the bycatch of rays in outrigger trawls and
- Review temporal changes in the fishing patterns of high seas pelagic fisheries taking pelagic sharks.

f) A WGFTFB ad hoc group will work by correspondence and meet at WGFTFB meeting in April 2008 to address the following Tor's received from NIPAG & STACREC:

- To determine whether twin shrimp trawls (e.g. number of meshes in circumference) are different from single trawls. This would include investigations of the use of twin and triple trawls in other fisheries as

well, for example Greenland halibut directed fisheries, where their deployment may be used to improve catch rate rather than catch quality.

- To study the efficiency of twin trawls and determine how best to represent the effort of these trawls for management purposes.

g) A WGFTFB topic group of experts will be formed to address the following ToR received from WGECO as part of the OSPAR Quality Status Report 2010:

- For each OSPAR region, select and succinctly describe one or more representative examples of gear modifications, which have resulted in changes to the ecosystem effects of these gears, including if possible a range of ecosystem components.

Conveners: Jochen Depestele, ILVO, Belgium

2.2 Participants

A full list of participants is given in Annex 1.

2.3 Explanatory note on meeting and report structure

The approach adopted in 2004 of addressing specific TOR's was adopted for the 2008 meeting. Individual conveners were appointed during 2007 to oversee and facilitate work by correspondence throughout the year. The Chair asked the convener of each ToR to prepare a working document, reviewing the current state of the art, summarising the principal findings, identifying gaps in the knowledge where consultation with other experts was required and recommending future research needs.

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

The chair outlined that were possible this format will be adopted for the foreseeable future. The agenda for the 2008 is as presented in Annex 2.

3 WGFTFB advice and requests during 2007–2008

Overview

During 2007/2008, WGFTFB dealt with the following requests for advice:

- Request from WGEF
- EU request on Baltic Cod Selectivity
- Request from WGSSDS on selection patterns

- Request from ACE on VMS data usage and buffer zones
-
- EU meeting with net manufacturers
- SGMIXMAN
- AMAWGC
- TOR from SGBYC

3.1.1 WGEF Request on Outrigger Trawls

WGFTFB received a request from WGEF to consider the following "*provide more details on the bycatch of rays in outrigger trawls*".

Vanderperren (2008) reports the results from a study carried out in Belgium aimed at testing the use of outrigger trawls in different areas as an alternative to traditional beam trawls. Outrigger trawling as a fishing method replaces the two heavy steel beams on each side normally towed by beam trawlers with two lighter demersal trawls each with its own set of trawl doors. The main benefit is the reduced drag of the lighter gear resulting in a reduction in fuel consumption. Other likely benefits are reduced benthic impact, improved fish quality, diversification into non pressure stock species and increased profitability.

This study details the catches of three Belgian beam trawlers and one Eurocutter, ranging in sizes from 24m-35m LOA and 300hp-1200hp mainly fishing in ICES Areas VIIf, VIIg and IVc, but also in IVb, VIa, VIIa, VIIb, VIId, VIIe and VIIh over the period Q2 2006 to Q2 2007. Mean catch efficiency for the four vessels expressed as kg fish/fishing hour are reported and catches of ray species are found to range from 12.58kg – 25.96kg (average 19.34kg) for the four vessels (See Table 1). In terms of overall catch composition ray represented between 32.35%-45.07% (average 36.65%) of the total catch by weight for the four vessels (See Table 2). The results show ray to be the most important target species based on weight. No breakdown by ray species is given and no discard data for ray are available at this time, although it is likely the majority of the catch is marketable fish. For one of the trials vessels (35m/1200p) the catch composition by ICES area is reported as shown in Table 3.

Table 1. Catch efficiency by species and vessel (marketable catch only).

	Catch efficiency (kg/fish/fishing hour)			
Species	Vessel 1	Vessel 2	Vessel 3	Vessel 4
Ray sp	12.6	23.5	15.4	26
Dogfish	2.7	3.2	3.4	3.7
Plaice	6.1	5.8	6.7	11.2
Sole	3.2	7	5.2	6.5
Lemon Sole	2.1	0.5	1.3	1.2
Anglerfish	1.1	0.1	1.4	1.8
Other Species	10.5	11.5	14.6	21.2

Table 2. Catch composition by vessel.

	Catch composition (%)			
Species	Vessel 1	Vessel 2	Vessel 3	Vessel 4
Ray sp	32.9%	45.1%	32.4%	36.3%
Dogfish	7.1%	6.1%	7.2%	5.2%
Plaice	15.9%	11.9%	14%	15.6%
Sole	8.2%	13.4%	11%	9.1%
Lemon Sole	5.6%	1%	2.6%	1.7%
Anglerfish	2.9%	0.2%	3%	2.5%
Other Species	27.4%	22.2%	29.8%	29.6

Table 3. Catch composition by ICES Area for one outrigger vessel (35m/1200hp).

	Catch Composition (%)									
Species	IVb	IVc	VIIa	VIIb	VIId	VIIe	VIIf	VIIg	VIIJ	Total
Ray sp.	0%	13.6%	37.8%	29.8%	59.7%	0%	50.2%	45%	0%	36.3%
Plaice	44.5%	6%	20.8%	0%	3.2%	32.3%	14%	6.7%	0%	15.6%
Sole	1.1%	22%	16.9%	0%	3.1%	8.4%	13.5%	7.5%	0%	9.1%
Norway Lobster	38.6%	0%	0%	0%	0%	0%	0%	0.3%	0%	6.2%
Dogfish	0%	12%	4.2%	3.9%	0.7%	13.1%	1.3%	7.7%	20.7%	5.2%
Anglerfish	0%	0.1%	3.3%	17%	0%	1.4%	0.4%	3.8%	32.6%	2.5%
Lemon Sole	0.1%	1.5%	0.3%	14.9%	0.3%	0.7%	1.3%	2.6%	10.9%	1.7%
Turbot	2.8%	1.7%	1.7%	0%	0.5%	0.3%	1.4%	1.2%	0%	1.4%
Others	12.9%	43.1%	15%	34.4%	32.5%	43.8%	18.9%	25.2%	35.8%	22%

Based on these catches, ray appear to be the most important species by weight in ICES Areas VIId (59.7%) and VIIf (50.2%) but are also the dominant species in ICES Areas VIIa, VIIb and VIIg. No rays were caught in Areas IVb and VIIe or VIIj. Taking catch by different quarter for the same vessel over the period Q4 2006 – Q3 2007, ray are the dominant species forming 36.1%, 25.7%, 35.6% and 41.1% of the total catch composition respectively.

A short trial carried out by Seafish in the UK, carried out in the south west of England to investigate the effectiveness of outrigger trawls in lowering fuel costs, and indicated similar results with ray forming a high proportion of the overall catch composition. This trial also indicated a reduction of discarding with the outrigger trawl. Total discards from single basket samples taken for each of the nine hauls carried out during the trial amounted to an average of 59% by volume, compared with 71% measured from beam trawlers from comparable surveys (Cornwall Fisheries Resource Centre, 2007).

The Dutch fishing industry has conducted experimental trials with outrigger trawls from February till October 2006 to investigate the possibilities for lowering fuel costs. Four beam trawlers (1350hp – 2000hp) have conducted experiments in the North Sea. The Dutch outriggers are, in contrast with Belgian and UK vessels, specifically targeting plaice and/or Norway lobster, in all quarters except for the winter period. Catches of Norway lobster are 4 to 5 times higher than catches of beam trawlers. More valu-

able fish species, such as sole, brill and turbot are only caught in small quantities compared to beam trawlers, but the catches of plaice are comparable (Bult & Schelvis-Smit, 2007). No data are provided, however, on ray species.

There are a number of potential reasons for the increased ray catch with the outrigger trawl, which relate to changes in fishing behaviour or differences in the dynamics of the outrigger trawl gear as follows:

1) The outrigger trawl is not as effective at catching sole and there is evidence that Belgian and UK fishermen have specifically targeted rays using outrigger trawls to compensate for the decrease in sole catch. In the beam trawl fishery rays were always considered a bycatch species. There are no indications that Dutch fishermen compensate their reduced catch of valuable species by higher ray catches.

2) Vessels involved in this trial regardless of horsepower have been allowed to fish inside the 12 mile and in certain areas this may lead to high ray catches (Polet *et al*., 2007) given there are known to be local populations inside 12 miles e.g. Irish Sea.

3) The main difference in the outrigger gear and beam trawls is the reduced weight and reduced fishing speed, giving rise to a substantial fuel saving, and the increase in spread. In the Seafish trials gear monitoring equipment installed on the gear recorded from 7–9m of spread between the doors per side, with a relatively small net, whereas vessels would be restricted to a 4m beam fishing the same area inside the 12 mile limit. This increased spread and ground coverage is likely to improve catch efficiency for species such as ray.

4) An abundance of larger rays observed in the outrigger catches compared with beam trawls may be a result of the differences in groundgears between the beam trawl and outrigger trawl (Richard Caslake, pers. comm.).

In conclusion the Belgian and UK trials suggest the use of outrigger trawls may lead to an increase in the catch of rays, particularly when vessels specifically target these species. However, it should be stressed that the results also suggest that the use of the outrigger trawl is an economically viable option for smaller vessels (e.g. Eurocutter vessel) fishery, while for larger vessels viability due to reduced sole catches is at best marginal. Polet *et al.* (2007) and Vandeperren (2008) also highlight some technical limitations with this gear for larger vessels relating to gear spread. In practice this means, at least in the short term, the uptake for this gear will be limited to smaller vessels in Belgium and the impact on ray stocks maybe not that significant although needs monitoring. This may not necessarily be the case in the UK, where indications are that large beam trawl vessels may adopt this gear, due to fuel costs.

3.1.2 EU request on Baltic Cod Selectivity

The technical measures regulation for the Baltic Sea (EC No 2187/2005) requires the European Commission to present an evaluation of the selectivity of active gears targeting cod in the Baltic Sea in 2007. The Commission has requested that ICES advise on this issue as follows:

"ICES is requested to evaluate the selectivity of active gears on cod for which cod is recognised as the target species. Those gears are: Trawls, Danish seines and similar gear with a mesh size ≥105mm with either a Bacoma exit window or a T90 codend as defined in regulation (EC) No 2187/2005.

The evaluation should include a comparison of the T90 codend and the Bacoma exit windows concerning their selectivity for cod:

a) In general;

b) With regards to the minimum landing size of 38cm;

c) The rate of discarding;

d) Any additional aspect that ICES may consider desirable in this context.

ICES is specifically requested to advise on the acceptance of the existing gear specifications by the industry and whether they conform to the existing obligations and measures for cod management in the Baltic".

The ICES WGFTFB has addressed this request by soliciting input from a number of specific experts with information and/or comments received from Denmark, Sweden, Poland, Germany, Finland, Latvia and Ireland (former Chair of WGFTFB). The Chair of WGFTFB has taken this information and produced a response as an attempt at addressing the EU's specific request.

Based on the information received WGFTFB concluded the following:

3.1.2.1 General Comments

- On the basis of an earlier meta-analysis carried out by ICES, both Bacoma windows and T90 codends (provided they are correctly used as per the current regulations) give 50% retention lengths of 38–40cm, equivalent to the MLS for cod of 38cm. There is inherent variability in the data sets used in this analysis, however, and this should be borne in mind.
- In order to make a direct comparison between the gear options, data from structured experiments, specifically designed to assess the relative selectivity of the two designs is still required. In particular robust data on the effect of twine thickness, codend circumference and mesh size needs to be collected given the inherent effect of such parameters on the selectivity of the respective gear options.
- A preliminary analysis of new data provided by Poland and Germany give similar L50s of ~ 41cm and Selection Ranges of between 4.8–6.5cm and reaffirm the selective properties of T90 codends.
- A modelling analysis carried out in Denmark indicates that codend circumference has a major bearing on selectivity regardless of whether the codend is constructed in standard diamond mesh or T90.
- Only limited additional information on the selectivity of Bacoma windows is available and the results of the earlier meta-analysis are considered as the most reliable estimates.

3.1.2.2 Selectivity with Regard to Minimum Landing Size of 38cm

- Both gear options give L50s equivalent to the MLS for cod but based on the available information the likelihood of either gear fully corresponding to the management aim of bringing the MLS into agreement with L25 in all areas of the Baltic is still unclear. This is due, in part to the high degree of data variability and other factors such as catch size and catch composition.
- Complimentary technical measures such as real-time closures maybe appropriate in areas where high concentrations of cod are encountered or restricted fishing in areas where flatfish catches are high and the effectiveness of the gear measures maybe negated.

3.1.2.3 The Rate of Discarding

- Unless coverage by observer schemes is extensive compared to overall fishing effort, it is very doubtful that the available discard data will be sufficient to allow detection of gear-specific differences in discard rates. Detection of any differences will be exacerbated by localised differences (i.e. different fleets using T90 or Bacoma in different areas, fishing on different size distributions and catch compositions).
- The limited information available from recent research cruises and discard sampling data indicates similar discard rates of 5–10% for both gear alternatives.
- The effect on selectivity of large catch sizes and differing catch compositions with both gear options needs to be considered, as there is evidence that both are contributing factors to high discard rates.

3.1.2.4 Additional Aspects

- The available information suggests a dichotomy between countries such as Denmark and Sweden whose fishermen prefer to use the Bacoma window and other countries particularly Poland and Germany where the T90 codend is the more attractive alternative.
- There are allegations of circumvention of the gear measures but without documented evidence no assessment of the impact of such practices on selectivity can be made.
- Both gears have their advantages and disadvantages in terms of practicality or perceived benefits in terms of fish quality or fuel efficiency. These are of limited relevance from a stock management perspective but may offer incentives for fishermen to adopt the selective gear options.
- Given the likely negative effects on selectivity, a review of the current regulations regarding permissible gear attachments e.g. chafers, rescue floats etc. should be carried out in order to establish whether there is a need for their continued usage.

Because limited resources were available, only a preliminary analysis could be carried out which, for the most part, served to identify potential data sources for a comprehensive analysis. From a review of all existing literature, only limited selectivity data were found for the fisheries covered by WGSSDS. The majority of these data were historic and may not necessarily represent current fishing practice (i.e. gear type, codend mesh size/material) or stock structures. The summary data identified is shown in Table 4 below. Raw data is available for the Irish trials.

This report was forwarded to ICES and STECF. STECF carried out their own analysis and concluded the following:

"STECF supports the ICES findings and concludes that it has not been possible on basis of the available information to answer the question if the Bacoma and the T90 trawls have similar selectivity properties. Answering the question would require a series of coordinated experiments".

"STECF notes that the current exploitation pattern on cod of the trawl fishery allows the exploitation of immature cod. This result in a suboptimal utilisation of the cod stocks in the Baltic. Improved exploitation pattern with reduced mortality on juveniles will not only provide for higher yields but also contribute to the recovery of the eastern cod stock. Therefore STECF

recommends that measures resulting in improved exploitation pattern for Baltic cod be considered".

3.1.3 Request from WGSSDS on selection patterns

Prior to the 2008 WGFTFB meeting in the Faroe Islands, request from WGSSDS to provide gear selection curves for species with high discard rates was examined.

Limited resources meant that only a preliminary analysis could be carried out, which primarily identified potential data sources for a much more comprehensive analysis. From a review of all existing literature, only limited selectivity data was found for the fisheries covered by WGSSDS with the majority being historic data, which may not necessarily represent current fishing practice (i.e. gear type, codend mesh size/material) or stock structures. The summary data identified is shown in Table 4 below. Raw data is available for the Irish trials.

Table 4. Summary Selectivity Data.

Species	Country	Area	Date	Gear Type	Mesh Size	L50	SR
Haddock[1]	Ireland	VIIj	08/2004	SSC	90mm x 6mm single	30.14	8.31
Haddock[1]	Ireland	VIIj	08/2004	SSC	100mm x 6mm single	34.47	7.34
Haddock[1]	Ireland	VIIj	08/2004	SSC	110mm x 6mm single	36.87	11.36
Whiting[2]	Ireland	VIIg	02/1996	OTB	90mm x 4mm single	23.06	11.64
Haddock[2]	Ireland	VIIg	02/1996	OTB	90mm x 4mm single	19.09	12.73
Plaice[2]	Ireland	VIIg	02/1996	OTB	90mm x 4mm single	16.80	5.46
Megrim[2]	Ireland	VIIg	02/1996	OTB	90mm x 4mm single	19.52	7.62
Whiting [2]	Ireland	VIIg	04/1996	OTB	90mm x 4mm single with 90mm SMP	32.72	12.36
Hake[3]	Spain	VIIIa	12/1998	OTB	70mm x double 4mm	30	10.95
Hake[3]	Spain	VIIIa	05/1999	OTB	70mm x double 4mm	27.2	13.45
Hake[3]	Spain	VIIIa,b	07/1999	OTB	70mm x double 4mm	30.3	1.16

Species	Country	Area	Date	Gear Type	Mesh Size	L50	SR
Hake[3]	Spain	VIIIa,b	11/1999	OTB	70mm x double 4mm	30.7	5.94
Hake[4]	Spain	VIIIa	1999	OTB	80mm	23.5	13.3
Hake[4]	Spain	VIIIa	1999	OTB	100mm	46.2	18.6
Hake[4]	Spain	VIIIb,d	1999	PTB	80mm	22.6	19.2
Hake[4]	Spain	VIIIb.d	1999	PTB	100mm	34.6	6.6
Megrim[4]	Spain	VIIIa	1999	OTB	80mm PA	20.1	2.5
Megrim[4]	Spain	VIIIb,d	1985	OTB	60mm PA	12.8	6.4
Megrim[4]	Spain	VIIIb,d	1985	OTB	70mm PA	20.8	9.1
Megrim[4]	Spain	VIIIb,d	1985	OTB	60mm PA	13.0	5.3
Megrim[4]	Spain	VIIIb,d	1985	OTB	70mm PA	20.3	6.1

[1] Anon., 2005; [2] Anon., 1997; [3] Puente., 2001; [4] Meixide and Pereiro., 1997.

In addition there are a number of catch comparison datasets available from Ireland and France on a range of species, fisheries, gears and codend mesh sizes. These datasets provide simple length frequency data but no L50s. A simple method based on Generalised Liner Mixed Models (GLMM) has recently been developed by Revill and Holst (in prep.) that allows a better analysis of catch comparison data. This method uses polynomial approximations to fit the proportions caught in control and test codends. This method was presented at FTFB as a new method of analysis and some of these datasets could be run through this model if required. Catch comparison datasets available that could be looked at are shown in Table 5.

Table 5. Catch Comparison Data Available.

Species	Country	Area	Year	Gear type	Experiment details
Whiting, Haddock, Hake	Ireland	VIIg	2003	OTB (Twin-rig)	Inclined Separator Panel vs 80 mm x 6 mm single codend
Whiting, cod, haddock	Ireland	VIIg	2000	OTB (twin-rig)	Inclined separator panel vs 80 mm x 3.5 mm single codend
Whiting, haddock	Ireland	VIIg, VIIj	2000	OTB	Inclined separator panel vs 80 mm x 3.5mm single codend
Whiting, haddock, hake	Ireland	VIIj	2000/2001	SSC	90 mm Codend with 90 mm SMP vs 80 mm x 4mm single codend
Whiting, haddock, hake, cod	Ireland	VIIg	2002	SSC	100 mm x 4 mm double vs 80 mm x 4 mm single

Species	Country	Area	Year	Gear type	Experiment details
Haddock, Whiting, Hake	Ireland	VIIg	2002	SSC	Large mesh top sheet net/80 mm x 6 mm codend vs standrad seine/80 mm x 6 mm codend
Haddock	Ireland	VIIj	2001	OTB	100 mm x single 6 mm; 100 mm x double 4 mm; 110 mm x single 6 mm vs 80mm x 6 mm single
Monkfish	Ireland	VIIg,VIIj	2002	OTB (Twin-rig)	Bottom sheet escape panel/100 mm x 6 mm codend vs 100 mm x 6 mm codend
Nephrops, hake	France	VIIIa,b	2003/2004	OTB	Flexible grid/70 mm x 4 mm codend vs 70 mm codend
Nephrops, hake	France	VIIIa,b	2006	OTB	Flexible grid/70mm x 4 mm codend vs 70 mm codend
Nephrops, hake	France	VIIIa,b	2006	OTB	80 mm x 4 mm vs 70 mm x 4 mm
Nephrops, hake	France	VIIIa,b	2006	OTB	70 mm x 4 mm with 70 mm SMPvs 70 mm x 4 mm
Monkfish, Megrim, ray	France	VIIIa,b	1993	OTB	Monkish sorting grid vs 70 mm x 4 mm codend
Monkfish, megrim, ray	France	VIIh, VIIIa	1997	OTB (Twin-rig)	Monkfish sorting grid vs 70 mm x 4 mm codend

In 2008 the EU will focus on mitigation of discards associated with a key number of fisheries in community waters. Given part of this process will be to identify candidate technical measures suitable for these fisheries which will achieve measurable targeted reductions, the whole area of gear selectivity will be revisited by FTFB and also in other fora such as MariFish and STECF. A specific ToR was agreed at FTFB for 2009 which aims:

> *"To review and appraise the current selectivity characteristics of the gears used in the fisheries identified by the EU as candidate fisheries"; and*
>
> *"To propose potential gear modifications that could contribute to the future technical conservation measures needed to achieve the targets proposed by the EU".*

It should be noted that, given one of the candidate fisheries selected by the EU is *Nephrops* fisheries in the Celtic Sea, further analysis of the selectivity of gears used in these fisheries will be carried out, and this should be of assistance to WGSSDS.

3.2 Request from ACE on the use of VMS data

There was a suggestion by ACE for a new EG to work by correspondence to look into e.g. the availability of VMS data, interpretation of these data and the potential for setting up buffer zones for MPAs using this kind of data. It was suggested that relevant ToRs that might otherwise be dealt with by WGDEC be directed instead to this new group.

It was concluded that fishery technologists should be involved with this work and the following ToR was directed to WGFTFB:

"For a range of representative fishing gears operating on offshore waters, begin a consideration of the fishing methods employed (including water depth, warp length, frequency of VMS returns and positional relationship between trawl and vessel) that will influence the dimensions of 'buffer zones' around Marine Protected Areas to ensure that trawls do not damage the seabed."

No action to date has been taken on this request and FTFB await direction from the Secretariat regarding required input from FTFB. The comment was made that there is extensive work going on in this area in the US and this may be useful as reference material.

3.3 Meeting of WGFTFB Chair with EU Commission and Net manufacturers on technical measures regulations

In July 2007, the WGFTFB met with net manufacturers and the EU at the invitation of the EU to discuss the revision of the Technical Conservation Measures regulations currently being undertaken by the Commission. Nine net manufacturers attended this meeting, representing the North-east Atlantic, Bay of Biscay, Mediterranean, North Sea and Skagerrak and Kattegat. A range of issues were discussed at this meeting as summarised below:

1) Codend Definition: The current definition of codends and/or extension piece has been identified as being confusing, given the differences in terminology used in different countries and also differences in trawl design. The Commission are therefore proposing to re-define "codend" as being the last 8 0r 10 metres of the trawl (bottom trawls) only and possibly the last 20m-30m of a pelagic trawl. This would very much be seen as a length for regulatory purposes ("Enforcement length") i.e. codend circumference, twine thickness, mesh size, attachment legislation would apply to this length. There is also consideration of including a minimum mesh size for the whole trawl i.e. in a demersal trawl no mesh can be less than 80mm. Such a condition exists in the Baltic. There was general support for these proposals by the netmakers, except concerns about the implications for *nephrops* trawls if the codend mesh size was increased to 100mm for instance in the future, most fishermen would have to replace the bottom wings and belly sheets, given these are still constructed in 70–80mm currently. There was also some concern regarding pelagic codends given their design and the need for a "pumping" section.
2) Twine Thickness: There is acceptance by the EU that the current regulations on twine thickness are unworkable and the measuring methodology

unenforceable and too subjective. While there is undoubtedly some correlation between selectivity and twine thickness/stiffness, the EU have identified that there are easier parameters that have an effect on selectivity that can be better controlled. The netmakers made the point that basically the twine thickness of twine they provided depended on the customer – give the customer what he wants! The EU proposal is to retain a maximum twine thickness, harmonised by areas but would probably amend the measurement methodology. Labelling/Certification is seen as having a role in ensuring twine thickness.

3) Codend Circumference: The EU have identified codend circumference as having a major bearing and selectivity, largely on the basis of a recent STECF sub-group meeting. They are intent on harmonising the codend circumference regulations for demersal gears and the proposed start point is for a max. of 100 meshes for all gears with a mesh size greater than 70/80mm. The netmakers did not voice any strong objections to this, although more research is needed for the smaller mesh sizes in order to satisfy strength and excessive narrowing of codends.

4) Strengthening Bags: Again the EU has identified strengthening bags as detrimental to selectivity and are intent on prohibiting their use. They accept that are some countries where there use is widespread and would accept derogations if a case could be made on safety grounds. However, the majority of the netmakers did not see this as a major problem (except Ireland in the *nephrops* fishery) although stressed the need for some research to address these concerns. The issue of attachments such as chafers, round straps and strengthening ropes was raised and the point was made that top-side chafers in particular have a detrimental effect on selectivity. The EU agreed to look at this regulation and amend accordingly.

5) Selective Devices: The use of selective devices should be encouraged in the new regulations but specific details would probably be based contained in Commission regulations. Two major issues were raised regarding Square Mesh Panels – position and joining ratio. The EU seem intent on introducing a regulation on position at around 5–6m from the codend to fit in with the codend definition but this position could be altered on a regional basis to match specific fishery problems. Joining ratio was felt important but the current 2:1 ratio seems okay except where there are significant changes in mesh sizes i.e. 120mm into 80mm mesh. The issue of measurement of square mesh was also raised, as there seems to some differences in methodologies being adopted by different inspectorates. The question of appropriate material was discussed and the netmakers felt that both knotted and knotless twine could be used as long as the material used was of a good quality and relatively stiff to maintain shape. There was a lengthy debate on the relative merits of BACOMA vs. T90 and a concern was expressed that the current regulations did not facilitate the use of T90 sections above the codend. The EU seemed broadly in favour of the use of T90.The Dutch netmaker reported on trials with hexagonal mesh codends for release of juvenile horse mackerel.

6) Codend Geometry: There was no major debate on this issue, except it was felt that the current regulations requiring cylindrical codends should apply only to demersal trawls given the differences in designs of pelagic codends, which are often purposely built cone shaped or have wider sec-

tions fro fish quality and to facilitate pumping. The EU accepted this as sensible.

7) Certification/Labelling: There was a general discussion on the possibility of netmakers certifying netting/codends sold to fishermen. The netmakers felt in principle this was feasible to a certain degree i.e. particularly mesh size but did not want to have an legal responsibility once the codend left the factory as they had no control of how fishermen would use the codend subsequently. They were in favour of adoption of the OMEGA gauge given its accuracy and saw this as an integral part of a certification scheme. They agreed collectively to examine this issue more closely and report back to the EU. The EU also mentioned the meeting in Bergen on ISO standards for netting, although none of the netmakers seemed to be aware of this meeting.

8) General Points: The netmakers stressed the need to consider pelagics and demersal trawls separately and not generalise. The issues in pelagic trawls are generally not selectivity issues but for fish quality and optimum water flow. The EU accepted this as reasonable and agreed to ensure this was taken account of in the new regulations.

3.4 SGMIXMAN

The Chair of WGFTFB participated in the Study Group on Mixed Management (SGMIXMAN) meeting in January 2008 at the request of the Chair. At this meeting the continuing input by FTFB to the Assessment Working Groups and appropriate approaches for provision of this input were discussed. A lot of this information has direct relevance to the work of SGMIXMAN and other Expert Groups, in addressing some of the data constraints/deficiencies currently associated with the provision of fisheries-based advice. WGFTFB has strived to provide quantified information but still struggles with how to relate the knowledge (albeit subjective at times) gear technologists have with the signals and trends observed by stock assessment scientists. Put simply FTFB can identify/verify problems or changes not necessarily detected elsewhere but cannot always quantify the effect as a Working Group because the members do not necessarily have access to the detailed data catch or effort data or have the time or skills to do a more complex analysis. A combination of these factors has meant that a lot of this information is lost in the advisory process but nonetheless given that ICES provides stock assessments for only ~ 50% of stocks currently, the need to look at such "soft" fisheries information is still considered necessary by FTFB and this was stressed to SGMIXMAN.

In addition to the provision of fishery information, the issue of effort measurement was also raised by the Chair. This has wider implications for stock assessment than just the development of mixed fisheries management models and FTFB have identified this as a major issue with current management systems for a number of years. This is a complex issue that will not be solved in the immediate future. However, the Chair outlined the ToRs of the Study Group on combining gear parameters into effort and capacity metrics (SGGEM) which was established by FTC to address this issue.

3.5 AMAWGC

The Chair of WGFTFB participated in AMAWGC in February 2007 to discuss the provision of fisheries information. As in 2007 the Assessment Chairs were supportive of the efforts of FTFB although again stressed the need for better quantification of the information. There was also a discussion about the new Benchmark Workshops that

have been introduced into the Assessment process. It was felt that this could be an appropriate forum for formulation and integration of FTFB information.

3.6 SGBYC

The Chair of WGFTFB participated in the Study Group for Bycatch of Protected Species (SGBYC) in January 2008. The main issue of relevance to FTFB was ToR a):

> *"Review of methods and technologies that have been used to minimise bycatch of species of interest, including methods that have failed".*

This term of reference is linked to ToR (d) addressed by WGFTFB (Section 13). The Study Group compiled a preliminary list of methods and technologies that have been used to minimise bycatches of species of concern, and spent time reviewing the problems associated with the application of pingers (acoustic deterrent devices) in static gear as a cetacean bycatch mitigation measure. Although mandated in the US and EU, pinger deployment has proven difficult to implement for a variety of reasons. In reviewing these reasons, the Study Group proposed a framework for the development and implementation of future mitigation measures. The SG recommended that any further mitigation plans for minimising cetacean or other protected species bycatches should be introduced only after careful consideration of all of the above mentioned factors.

4 ICES draft science plan 2007–2013

Bill Karp the FTC Chair led a discussion on the ICES Draft Science Plan 2008–2013. The discussion mainly centred on the 17 identified themes and the prioritisation of seven of these themes. Apart from one of these seven themes, the remit of WGFTFB is largely outside these priority areas and therefore concerns were expressed by FTFB members that there was a danger participation in the Group may diminish, if Institute Directors do not feel gear technology is considered an important issue by ICES. There were also concerns expressed regarding the proposal of ICES acting as a project co-ordinator in the future. The feeling was that this could bring ICES into direct conflict with national laboratories. The conclusion from this debate was that while WGFTFB supported the need for change within the ICES structure, the seeming demotion of fisheries assessment and measurement of fisheries impact was felt a danger to the continued existence of the Working Group. A response to this plan was drafted by Bill Karp and WG chair taking account submissions from other WGFTFB and WGFAST members. This response was forwarded to ICES Secretariat.

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

The Study Group on the Development of Fish Pots for Commercial Fisheries and Survey Purposes (SGPOT) SGPOT was proposed by the topic group on "Alternative fishing gears" that met at the FTFB meeting in 2005 and 2006. SGPOT had its first meeting 21–22 April 2007 in Dublin, Ireland and this second meeting was held in Tórshavn, Faroe Islands 19–20 April 2008 prior to the FTFB meeting.

The group work was attended by 24 participants representing 14 countries. The agenda followed the Terms of Reference closely.

A review of worldwide use of fish pots that was initiated at last year meeting was continued. It seems difficult to identify worldwide catch data for fish pots as these are generally mixed with other gears. In order to partly address this the group decided to make an extensive list of use of fish pots in commercial use, as research tool and

emerging use of fish pots, as this was felt a valuable platform for exchange of information.

In a discussion of new fish pot research several examples were presented. In Norway the two-chamber pot has been redesigned with a single entrance and modified to float off bottom. Trials carried out have yielded a 45% higher catch rate of cod. In Sweden the deformation of the Norwegian pot when floated off bottom in high current has been tested in flume tank as this had proved a major problem in Swedish trials. New attachments and extra buoyancy were tested to counteract deformation with good results.

A discussion on the fundament research needs on fish behaviour to improve the catching efficiency and also enhance the use of pots as assessment tools had a slow start as this seems to be a complex subject and involving a wide variety of variables. Although it was agreed lessons can be learned from other baited gear, the behavioural component is much more important for fish pots. The discussion centered on attraction variables and what predisposes a fish to be caught and actual capture process examples were discussed. Group members agreed to further on this issue and prepare text to be discussed by the Group.

In a discussion on design and ecosystem effects the main issue was ghost fishing and also the need to develop responsible codes of practice. There was a lengthy discussion with regard to design and operation of fish pots.

The terminology to be used for defining fish pots was discussed and it was agreed a generic figure with common terms will be developed. The group also discussed the definition of a fish pot as the group had reservations with the draft definition as presented by the FTFB Topic Group on Gear Classification.

The group also discussed gear conflicts, which seems to be one of the main contributors to ghost fishing. Spatial and temporal separation of gears seemed to be the best method to avoid conflicts but also designs incorporating features such as rounded corners and few surface lines may reduce conflicts.

The outline of a Cooperative Research Report was discussed and group members were assigned to prepare text for the report with a deadline of Christmas 2008. SGPOT will work by correspondence and meet at the FTFB meeting 2009.

6 Report from Working Group on Quantifying All Fishing Mortality (WGQAF)

Philip MacMullen, Chair of the newly-formed WGQAF, described to FTFB members the proceedings and recommendations of the first meeting of WGQAF.

The new WG was an evolution from the previous SGUFM, chaired by Mike Breen. The meeting had involved a series of presentations of background information, research results and discussion topics. These included:

- Alan Fréchet – Inclusion of Escape Mortality in Stock Assessment,
- Phil MacMullen – Industry/Science Solutions in a Data Poor Elasmobranch Fishery,
- Mike Breen – Ghost Fishing in Static Gears (Pots), and
- Irene Huse – Purse Seine Slipping Mortality in North Atlantic Mackerel (and herring).

The WG had also discussed a number of topics in some detail. Most of these explored the way the WG should operate and future areas of work:

- the inconsistency in dealing with all components of F in stock assessments,
- the need to look at the uncertainty associated with discard & other sources of mortality data and how this could best be accommodated in the assessment process,
- revisiting the definitions of 'bycatch' & associated terms,
- the potential importance of industry self-sampling as a means of gaining more comprehensive mortality data,
- IUU and the potential for obtaining useful information from industry sources and the supply chain,
- the potential significance of mortality in non-quota and non-commercial species,
- the use of multispecies and ecosystem monitoring to help identify gaps in fishing mortality data,
- issues relating to the recovery of lost fishing gears, and
- the need for improved outreach within ICES and at national levels

Future terms of reference would be framed around:

- continued work on application of UM data to stock assessments,
- a review of information on IUU available from fishing companies and options for using same,
- review the status and content of US National Bycatch Report,
- a review of best practices for reducing 'collateral' mortality in fisheries, and
- a review of the potential for self sampling to address mortality questions.

A number of specific actions were also identified

- update reports on incorporation of components of F in stock assessment through direct contact with WG chairs and AMAWGC,
- developing lines of communication with WGECO,
- proposing a joint topic group on definitions of bycatch & associated terms with WGFTFB for 2009 meeting,
- to meet for 1–2 days before WGFTFB in 2009, and
- to encourage more (and broader) participation in the WG

7 FAO request for clarification on Bycatch terminology

Over the last four decades, much concern has been expressed by fishery managers and conservation/environmental groups that bycatch and discards may be contributing to biological overfishing and altering the structure of marine ecosystems. In the last two decades, the search for solutions to bycatch problems has intensified.

While the term "discards" is self explanatory, the same cannot be said for term "bycatch". In 1992 Murawski[1] noted "the use of the term bycatch adds considerable con-

[1] *In* Alverson, D.L., Freeberg, M.H., Pope, J.G., Murawski, S.A. A global assessment of fisheries bycatch and discards. FAO Fisheries Technical Paper. No. 339. Rome, FAO. 1994. 233p.

fusion to a topic that is already complex to both scientists and managers".... *The term is relatively imprecise in that it constitutes a value judgment and may be inaccurate when used over any extended time to describe an element within a multi-species catch. In essence, "yesterday's bycatch may be today's target species*."

Presently, there is no international standard definition of bycatch. Some national bycatch definitions exist but there is inconsistency between definitions. Older definitions of bycatch include retained incidental species and discards while in more recent definitions the retained incidental catch is excluded. Some of the changes to bycatch definitions (e.g. Australia and USA) reflect (i) the trend from single species to multi-species management and (ii) recognition that ghost fishing mortality and encounter mortality may be high for some gear types in some situations.

The term bycatch is confusing, with protagonists and antagonists in the bycatch debate selecting definitions that favour their position.

The need for a coherency on terms used to describe catch components

While there is a broad-based agreement that all species retained for sale should be part of an effective fisheries management plan and that discards should be minimized, the use of the term bycatch in this context is extremely problematic.

From an FAO perspective, a review of definitions and terms would be worthwhile if it removed the ambiguity associated with terms such as bycatch, target species, incidental catch etc. Further, a review would be justified if it led to replacement or revision of terms and that these new terms / revisions were accepted by ICES member and non member countries.

Accordingly, FAO requests that FTFB to consider the following;

- The compilation and assessment definitions and terms associated with catch, bycatch and discards;
- Whether the term "bycatch" has outlived its usefulness as a universal descriptor of part of the catch;
- The drafting of a new definition(s) of terms used to describe the various catch components.

8 Update on Gear Classification Topic

The Chair gave an update of the current position regarding the production of a new gear classification manual as a replacement of the existing 1971 FAO Technical Paper 222. The development of this manual had been a ToR for WGFTFB in 2006 and 2007 and significant progress has been made in completing a final draft. However, a number of factors since the last WGFTFB meeting in 2007 had meant that the process had now stalled. This was due to the fact that the original conveners of this ToR have either retired or have taken up positions in the private sector. Also the individual who had been identified to produce the drawings for the manual had indicated that they were not now willing to complete this task. The text therefore remains about 90% complete but no alternative illustrator has been identified. FAO indicated that they remain committed to the completion the manual and reported to WGFTFB on a proposed way forward. This would entail identifying an individual to finishing drafting text and an alternative illustrator to complete the diagrams. This was agreed by FTFB as the best way forward. No financial commitment has been made towards publication costs at this stage.

9 WWF Smart Gear Competition

Dr Andy Revill, CEFAS, UK, presented information about the 2007 WWF "Smart Gear" competition. Initiated by WWF in 2005, the competition the competition has now 22 worldwide sponsors including private companies such as Mustad and Sealord as well as research institutes such as CEFAS, DFO and Seafish. The objective of the competition is to inspire innovative, practical, cost-effective ideas that allow fishermen to fish "smarter" – to better target their intended catch while reducing by-catch. The competition is open to all: fishermen, professional gear manufacturers, teachers, students, engineers, scientists and backyard inventors. The numbers of entries received to date have been:

2005: 50 entries from 16 countries

2006: 83 entries from 26 countries

2007: 70 entries from 22 countries

Entries are judged by an international panel made up of gear technologists, fisheries experts, seafood industry representatives, fishermen, scientists, researchers and conservationists. The Grand Prize winner for 2007 was the "eliminator" trawl designed by a team from the US. The "eliminator" trawl was designed to allow access to areas previously closed because of mixed species fishery, and potential of catching cod. It has the ability to allow fishermen to access abundant supplies of haddock while avoiding bycatch of cod. It is currently under assessment and will soon be adopted into NOAA legislation. The runner up prize went to a bird-scaring device called the "traffic cone" developed in Argentina. This device is currently under trial in the southern hemisphere with further trials planned in Alaska. The second runner-up was a nested cylinder bycatch reduction device developed in the US. The designer of this device is working with WWF, Ocean Conservancy and NOAA Fisheries to assist with certification trials for Gulf of Mexico shrimp fisheries. There will be no competition in 2008 to allow fund raising and attraction of additional sponsors but it is expected to run in 2009.

10 ToR a): Species Separation in demersal trawls

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

10.1 General Overview

Bottom trawl fisheries on the both sides of the Atlantic Ocean, as well as in the Mediterranean Sea, target a number of groundfish species and species groups. Here "groundfish" includes all fish species targeted by bottom otter trawls. In recent years, some species in the demersal complex have become heavily exploited while others have shown good recovery. For example, in the northeastern USA, the New England Fisheries Management Council reported substantial increases in overall biomass of twelve managed groundfish species but the growth was not uniform among species or stocks. Among those stocks, Georges Bank haddock (*Melanogrammus aeglefinus*) spawning biomass showed the greatest increase in recent years. On the other hand, cod (*Gadus morhua*) stocks are still being "overfished" and experiencing "overfishing". Along with the cod stocks, all four yellowtail flounder (*Limanda ferruginea*) stocks in the northeastern US are considered as "overfished" and experiencing "overfishing". This phenomenon of mixed fisheries of healthy and depleted stocks is not unique to fisheries in the northeastern USA.

Often, the status of one of the stocks captured in a trawl fishery may call for decreasing fishing mortality (e.g. cod and plaice in the North Sea, hake in the Western Atlantic and Mediterranean waters and associated recovery plans). Of the mixture of different fish species encountered and caught, retention of only some species may be desired.

Excluding such species from catching by separating them early in the fishing process and releasing them *in situ* from the net will likely contribute to stock recovery, as survival rates prior to haulback of gear can be high in many cases. Therefore, there is a need to define, develop, synthesize, and distribute means and strategies to selectively harvest healthy stocks while causing minimal mortalities to the depleted stocks by avoiding their interactions with the gear, releasing them at early stages of capture or at least at fishing depth. This report is a result of a topic group of ICES-FAO Working Group on Fishing Technology and Fish Behaviour which met in 2007 in Dublin, Ireland and in 2008 in Tórshavn, Faeroe Islands. The report reviews behavioural differences among demersal species near demersal trawls and methods to separate them in bottom trawl fisheries.

10.2 Terms of Reference

The topic group was charged to:

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

Some groundfish species or stocks of these species are in low biomass, or overfished, while others are in healthy conditions. Efficient exploitation of healthy stocks while reducing or eliminating the capture of overfished stocks would provide industry and management means for sustainable utilization and management of the resource. Many members of WGFTFB have been involved in the area of research for many years. The topic group will concentrate on behaviour and species separation in commercial species. A summary of the status of knowledge and future directions in research and application would greatly benefit FTFB members and the fishing industry.

10.3 List of Participants

Arill Engås	IMR	Norway
Kristian Zachariasssen	FFL	Faeroe Islands
Benoît Vincent	IFREMER	France
Ludvig Krag	DTU-Aqua	Denmark
Bent Herrmann	DTU-Aqua	Denmark
Mathias Paschen	BFAFI	Germany
Daniel Valentinsson	IMR	Sweden
Michael Pol	Mass. Div of Fisheries	USA
Dave Reid	FRS	Scotland
Ólafur Ingólfsson	MRI	Iceland
David Chosid	Mass. Div of Fisheries	USA
Oleg Lapshin	IMR	Russia
Eduardo Grimaldo	Univ of Tromso	Norway
Paulo Fonseca	IPIMAR	Portugal
Emma Jones	FRS	Scotland
Pingguo He	Univ of New Hampshire	USA
Emmon Jackson	BIM	Ireland
Rikke Petri Frandsen	DTU Aqua	Denmark
Irene Huse	IMR	Norway

Rosyioi Imron	Directorate of Fish	Indonesia
Jose Alio	INIA	Venezuela
Waldemar Moderhak	SFI	Poland
Abdelhak Lahnin	INRH	Morocco
Adnan Tokac	Ege University	Turkey
Altan Lök	Ege University	Turkey
Bob Van Marlen	IMARES	Netherlands
Chris Glass	Univ. of New Hampshire	USA
Gerard Bavouzet	IFREMER	France
Hans Polet	ILVO	Belgium
Haraldur Einarsson	MRI	Iceland
Jens Floeter	VTI-OSF	Germany
Ken Arkley	SFIA	UK
Bundit Chokesanguan	SEAFDEC	Thailand

10.4 Actions

The group developed a strategy and framework for considering the terms of reference in Dublin. Over the intervening year, an outline for a final report or possible cooperative research report was developed, and some text was produced. In Tórshavn, the group further developed the report outline by subdividing into groups. The result of this effort was the production of a timeline for completion of the overall report and an expanded outline with responsible section leaders defined. Additional text was also developed during the meeting.

10.5 Timetable for completion of work

- Complete draft sections and send to He or Pol by: 13 December, 2008. Responsible party: section leaders
- Send to ToR a) group for and improve draft document via email. Group members to submit comments to Section leaders by 13 February, 2009 (Responsible party: All ToR a) members)
- Section leader to submit revised final draft Final draft report ready by 13 March, 2009
- Responsible party: Section leaders
- Distribute the final draft report to ToR a) members final comments and return comments by 13 April, 2009 Responsible party: P. He & M. Pol
- FTFB members by: One week before FTFB in May 2009
- Verbally present at the next FTFB meeting in May 2009 (Request some time for presentation and discussion)
- Submit to ICES for publication in Cooperative Research Report by 31 July 2009 (if there are no serious problem with the final draft)

10.6 Recommendations

1) WGFTFB recommends the publication of an ICES Cooperative Research Report on Species Separation based on the work carried out by the Topic Group.

Annex 7 gives the proposed outline of the CRR report, subject to change. Responsible section leaders are also indicated.

10.6.1 Summary of Haddock Symposium 2007 as it relates to species separation

M. Pol

Mass. Division of Marine Fisheries, 1213 Purchase St, New Bedford, MA, 02740, USA

Abstract

A symposium on haddock conservation, harvesting and management was held in Portsmouth, New Hampshire, USA on 25–26 October 2007. Approximately 100 scientists, fishermen, managers and others from 5 countries attended the two-day meeting. Twenty presentations and 11 posters were exhibited. Four talks on haddock behaviour, including a keynote by Clem Wardle, were described. Four more papers on avoidance of haddock were also described. Eight papers on separation of haddock in different zones of a demersal trawl were summarized. Five papers on separation of haddock in static gears were also summarized.

10.6.2 Can Yellowtail Flounder be harvested without bycatch of cod and haddock on Georges Bank? Real-time spatial-temporal fishing strategies

C. Glass

University of New Hampshire, 39 College Road, Durham NH, 03824, USA

Seasonal and year-round closures of fishing grounds have been useful tools for the Northeast Multispecies Fishery Management Plan (FMP) of the New England Fishery Management Council (NEFMC). These closures have proven effective in improving the status of several species covered under the FMP, and in particular, the status of Georges Bank (GB) yellowtail flounders.

The status of GB yellowtail flounder has improved markedly since the implementation of Closed Area II in 1994. The spawning stock has increased from 2600 mt in 1992 to 33,500 mt in 1999. Mean biomass has also increased from 4,500 mt to 49,600 mt in the same time period. In 2001 the TRAC Advisory Report on Stock Status estimates the SSB to be between 37,000 and 50,500 mt (80% probability) and the mean biomass to be between 48,000 and 66,500 mt (80% probability). This brings the GB yellowtail flounder biomass well above the rebuilding target of 49,000 mt.

Here we report on a cooperative research program between the fishing industry and scientists on an observer based survey program to document the quantity and composition of catch and discards, and assess whether the rebuilt GB yellowtail flounder stock, within Closed Area II, can be accessed on a seasonal basis without significant bycatch of cod and haddock.

Results from this study demonstrate that cod, haddock and yellowtail flounder show spatial and temporal separation and that yellowtail can be harvested without a significant bycatch and discard of either cod or haddock. Furthermore, the results show evidence of clear spatial/ecological separation between major species showing evidence of ecological niche separation. The results are discussed in terms of their implications with regard to management of rebuilding and rebuilt stock access.

Key words: Yellowtail Flounder, Cod, Closed area, bycatch, spatial distribution.

Discussions

The author was asked how stable the patterns were between seasons. The explanation was made that the study was conducted over three years and therefore the patterns

were not fully know for the longer term. It was also explained that some fishers did not want the closed area to be opened as fishing on the borders of the closure was economically attractive and the opening of the area caused a reduction in viability.

10.6.3 UK trials with the eliminator trawl and a new simple method for catch comparison analysis

Andrew Revill*, Rene Holst**

**Centre for Environment Fisheries & Aquaculture Science (CEFAS), Pakefield Road, Lowestoft, NR33 0HT, UK*

***National Institute of Aquatic Resources, Technical University of Denmark (DTU-Aqua), Box 101, DK-9850 Hirstshals, Denmark*

Abstract

This study reports on the first known trailing in European waters of a new Rhode Island (USA) design of fishing trawl, known as the 'Eliminator'. We found that this trawl could be used to selectively harvest haddock (Melanogrammus aeglefinus) and whiting (Merlangius merlangus) in the North Sea while allowing cod (Gadus morhua) and other species to escape. Catches with the Eliminator trawl were consistently dominated by both whiting and haddock while cod numbers (of all lengths) were reduced by 89% compared to a control trawl. Cod accounted for 2% by weight, of the marketable fish caught in the Eliminator, contrasted by 10% in the control trawl. As North Sea cod stocks are overexploited and at risk of being fished unsustainably, this trawl may be a useful tool to integrate within the ongoing Northern European cod recovery programme.

We propose a simple method based on Generalised Linear Mixed Models (GLMM) to analyse catch comparison data and use polynomial approximations to fit the proportions caught in the test codend. The method provides comparison at lengths of the two gears by a continuous curve with a realistic confidence band. We demonstrate the versatility of the method by analysing the data from these trials, which spans a range of species with different selective patterns.

Discussions

The author provided a demonstration of the data analysis with R routines for analysing catch comparison data. This was presented to interested researchers during the meeting and will be circulated to FTFB participants.

11 ToR b): Advice to Assessment WG's

11.1 General Overview

This ToR was introduced at plenary by Dave Reid (FRS, Scotland) and a background for the ToR was given. ICES is now asked to provide advice that is more holistic in nature, including information on the influence and effects of human activities on the marine ecosystem. From the fishing technology perspective this includes information on how fishermen are responding and adapting to changes in regulatory frameworks e.g. the introduction of effort control; technological creep; fleet adaptations to other issues e.g. fuel prices etc. In response to this WGFTFB initiated a ToR in 2005 to collect data and information that was appropriate for fisheries and ecosystem based advice. In 2006, the FAO-ICES WGFTFB was formally requested by the Advisory Committee on Fisheries Management (ACFM) to provide such information and to

submit this to the appropriate Assessment Working Group. This type of information is becoming more and more important at both international and national levels. It demonstrates that the community of gear technologists have an important role to play in this and that our expertise is considered to be highly valued.

11.1.1 Terms of Reference

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

11.1.2 General Issues

The conveners issued a circular questionnaire to the appropriate WGFTFB members in EU countries as well as Norway, Iceland and the Faroe Islands during February 2008 (see Annex 8). It contained a series of questions relating to recent changes within the fleets observed and also highlighting gear/fleet/fishery related issues that are important but are not currently recognised by Assessment WG's. Where possible, contributors were requested to quantify the information provided or state how the information has been derived e.g. common knowledge, personal observations, discussions with industry etc. For the first time in 2008 information on Mediterranean fisheries was supplied to GFCM.

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

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

Responses to the questionnaire were received from:

IMR, Norway	IMARES, Netherlands
IMR, Sweden	FRS, UK-Scotland
CEFAS, UK-England	FREMER, France
BIM, Ireland	IMR, Iceland
AZTI, Spain	FFL, Faroe Islands
ILVO, Belgium	CNR-ISMAR – Italy
SFIA, UK-England	

The conveners worked by correspondence and met in Faroe Islands, 23–25 April during the WGFTFB meeting to collate the information provided. The full information for individual ICES Expert Groups is given in Annex 8 but some of the general issues raised are summarised as follows:

Fleet Dynamics

The overall picture from the questionnaires in 2008 is quite negative. Due to a combination of soaring fuel prices, reduced quotas, decreasing fishing opportunities and

volatile prices for several key species notably nephrops, haddock, cod, monkfish and hake, there is a general air of despondency in the fleets across Europe. There seems to be a general trend of effort reduction across fleets and also widespread evidence of fishermen in many countries reverting to more fuel efficient methods in an attempt to reduce operating costs and maintain economic viability. There are also targeted decommissioning schemes now in operation in France, Belgium, Ireland, Netherlands and the Basque region of Spain, although it is still too early to tell what effects these schemes will have on overall effort levels. Specific changes in fleet dynamics include the following:

- Effort associated with French purse seine vessels targeting anchovy and bluefin tuna has transferred to targeting red mullet, squid and whiting with Danish Seines in the Bay of Biscay. A similar trend has been observed in Ireland, with a switch from demersal trawling for monkfish and megrim to Danish Seining for roundfish. It is estimated that this has increased the Irish Seine net activity from 5 to 10 vessels in the space of one year
- French trawlers targeting whiting which traditionally operate in VIId have switched effort into IVb due to reduced catch rates in VIId and to reduce fuel consumption by decreasing the number of individual trips but increasing duration.
- The UK beam trawlers have reduced fishing activity levels due to high fuel prices. Many are now focussing on scalloping as opposed to fish.
- There has been a shift for Scottish vessels from using 100mm-110mm for whitefish on the west coast ground (area VI) to 80mm *Nephrops* codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries.
- There is a gradual shift from beam trawling on flatfish to twin trawling on other species e.g. gurnards, and *Nephrops*, etc. in the Dutch fleet. A number of beam trawlers decided to shift to other techniques such as outrigging or fly-shooting in the British Channel. Caused by TAC limitations of plaice and sole and rising fuel costs.
- At least five large Icelandic stern trawlers have switched from single to twin rig trawling targeting cod and haddock.
- As a result of increasing fuel prices several large Faroese 'Deep-Sea' trawlers have plans to move to pair trawling.
- In France there have been increasing attempts to develop pot and trap fishing particularly in non trawling areas and deep slope and reefs.

Technology Creep

The effects of technological creep are still evident in many fisheries but the concept of negative creep reported in 2006 and 2007 is now becoming more prevalent as vessels try to reduce operating costs to counteract high fuel prices. Most technological creep observed has concentrated on reducing the drag of fishing gear. Several vessels in Iceland have begun tests with dynex rope warps instead of conventional wire warp. The savings in drag are estimated at 20–30% although whether the potential fuel savings can offset the increased costs for fitting out with dynex is unknown at this stage. Net designs incorporating T90 netting or low drag high tenacity twines have also been tested in a number of countries.

Technical Conservation Measures

In a number of fisheries, there is some evidence of voluntary uptake of gear mitigation measures. The drivers for uptake are either regulatory i.e. as a means of achieving increased fishing opportunities or economic through improved fish quality. There has also been evidence of some vessels adopting more selective gear as a way of improving public perception. This is particularly noticeable in the Netherlands beam trawl fisheries. Specific examples include:

- In the Blue whiting fishery, both Icelandic and Faroese vessels are using flexible grids with 55 mm between bars to exclude cod and saithe from catches of blue whiting. Trials with this approach being conducted in Norway, no uptake yet. There are predominantly large cod and saithe in the areas where the Blue whiting is caught, thus the grid is believed to reduce bycatch of those species by >90%.
- The Dutch beam trawl fleet is sensitive to the bad reputation of beam trawl and this is stimulating research into selective nets and reduced bottom impact. Combined research activities were started in 2007, mostly catch comparison experiments but there is an industry focus to solve this image problem.
- Belgium beam trawlers operating in VIIg are reported to be using larger mesh (150mm) belly panels in order to reduce retention of weed and other benthos. Belgium fishermen's organisations are promoting the use of benthic drop out panels and full square mesh cod-ends and uptake is likely to steadily increase. One vessel is currently using these devices voluntarily but other vessels are scheduled to adopt these modifications during 2008.
- Encouraged by access rights, Basque vessels which target mixed demersal species in VIIIabd close to the French coast, are voluntarily using square mesh panels to reduce discards.
- During the first Quarter of 2008 a "day at sea" in Kattegat without the grid was counted as 2.5 days. This has further increased the incentives to use the sorting grid to the point were 80% of all *Nephrops* landings in the first quarter of 2008 were caught with sorting grids (20% previous years).
- A large number of 110mm SMPs have been bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet.
- Pelagic vessels in Scotland and Ireland have been fitting escape grids/panels. These are believed to allow release of juvenile mackerel, horse mackerel and herring. Recent trials gave equivocal results. Uptake around 50% in Irish fleet and 10% in Scottish fleets. Possible reduced mortality on recruiting year classes, but no data on survival rates from escaping fish is available and therefore could be a source of unaccounted mortality.

Ecosystem Effects

Evidence of discarding has been observed in a number of fisheries 2007/2008. The motivations for discarding are a mixture of regulatory or economically driven. Specific examples include:

- In Ireland there has been widespread of cod in 2007 and 2008 in ICES Areas VIIb-k due to early exhaustion of the cod quota.

- Similarly in Ireland there has been a considerable increase in the quantities of small nephrops on the Smalls grounds in 2007 and 2008 leading to very high landings by boats from the East coast with a high proportion of tails to whole nephrops. There are a number of boats (up to 10 vessels) that have participated in this fishery but do not tail due to low crew numbers and this has lead to high discarding/upgrading.
- Potential discard problems are also reported following the introduction of the 5% bycatch limits for spurdog on west coast and North Sea grounds. They can be encountered in large congregations but it is almost impossible for vessels to identify them using sonar etc so they are difficult to avoid and are therefore caught and discarded.
- The Swedish Baltic cod trawl fishery has been concentrating effort close to coastal areas, both due to a high abundance of fish and high fuel prices. This costal area has been considered to be an important nursing area for predominately juvenile cod and discarding maybe high

Ghost fishing in the deepwater fisheries in Areas IV, VI and VII remains a problem. There are reports of discarded longlines and gill nets along the Scottish west coast deep water grounds and in the northern North Sea.

In Iceland a number of gillnetters have shifted over to longlines as a result of pressures over bycatch of seabirds and small cetaceans. The level of bycatch is not known but is felt to be quite high given the shifts in fishing method

Predation of fish catches by Grey seals from gillnet/tangle net fisheries has become an increasing problem on the south coast of Ireland. Many inshore gillnet fishermen are considering shifting into other fisheries as the problems have become so bad.

A number of measures have been continued to be taken by the beam trawl fleets in Belgium and Netherlands. In Netherlands there are reports of voluntary use of longitudinal release holes in the lower panel of the trawl, which open when nets are filled with benthos, and also Benthic Release Panels. Similar initiatives are ongoing in Belgium. In Norway, one vessel has carried out experiments using pelagic trawl doors fished off the seabed (approx. 5 m) with a clump (weight) connected 50 m behind the doors to ensure proper bottom contact. This method is being used to target gadoids in the Barents Sea but with reduced seabed contact.

Development of New Fisheries

As has become the trend in recent years there are very few reports of new fisheries being developed but a few specific examples are reported are as follows:

- A new fishery has developed in Iceland for sea cucumber. This new fishery has not significantly removed effort from other fisheries. But after a collapse in the scallop stock (Breiðafjörður 2003 Chlamys islandica) some smaller fish boats previously targeting scallops have now shifted to the cucumber fisheries
- Up to eight Irish pelagic vessels have continued to fish for boarfish (*Capros aper*) during Q4 2007 and Q1 2008. Two vessels fished for this species in 2006 and approximately 8 vessels in 2007.
- There has been an increase by Dutch vessels in *Nephrops* fisheries using twin trawls. Outrigger trawls are also replacing beam trawls, or flyshooting (seining) mainly for non-quota species such as red mullet and cuttlefish.

- Squid fishery in Moray Firth continues to develop when species available on grounds. There has been increased catches of squid reported at Rockall in Q2 of 2008

11.1.3 Information for Individual Assessment Working Groups

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

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

11.1.4 Recommendations

1) The topic group will continue to collate this information on an annual basis, based on the issues related above and subject to further revision of the questionnaire and better quantification of the information where possible.
2) WGFTFB should continue to receive feedback from the different Expert Group's and AWAWGC, to assess the usefulness of the information supplied and also target specific areas that are identified of particular importance to individual assessment WG's. WGFTFB are committed to assisting in the provision of information to the new Benchmark workshops planned for winter 2008/2009.
3) WGFTFB will expand the provision of information to other relevant groups such as GFCM in the Mediterranean.

12 ToR c): Static Gear Selectivity Manual

12.1 General Overview

The ICES Static Gear manual has a history extending back to 1988 when it was first suggested to formulate it. The current draft has described procedures for gillnet selectivity but procedures for longlines and pot selectivity are not well developed and this has meant that the manual has not been completed. Given the increasing importance of all types of static gears and particularly pots it is important that this manual is now finished. A topic group will be formed to work by correspondence and to meet and discuss and agreed an Action Plan timetable for completion of the Manual at the 2008 meeting of FTFB. The topic group will identify gaps in the knowledge and review available literature pertaining to the measurement of the selectivity of all static gears. This topic group met from the 22–24 April in Tórshavn, Faroe Islands. Nine WGFTFB members participated and Rene Holst from Denmark held a conference call with the Topic Group. Following their discussions the convener reported back to plenary WGFTFB.

12.1.1 Terms of Reference

The topic group had the following ToRs:

i) Review the current draft of the Static Gear Manual;

ii) Review available literature on the measurement of selectivity of all Static Gears and identify gaps in the knowledge; and

iii) Agree a structure for the completion of the manual and identify a drafting committee to complete this task.

12.1.2 General Issues

12.1.2.1 Actions Taken

The Topic Group identified three different gillnet manuals, either complete documents or draft. In addition to the draft ICES manual that dates back to 1998, there are the following two documents:

i) Manual on estimation of selectivity for gillnet and longline gears in abundance surveys. Holger Hovgård (Danish Institute for Fisheries Research, Charlottenlund, Denmark) and Hans Lassen (International Council for the Exploration of the Sea Copenhagen, Denmark) FAO FISHERIES TECHNICAL PAPER 397. (2002)

ii) Manual For Gillnet Selectivity. René Holst, Niels Madsen, Paulo Fonseca, Thomas Moth-Poulsen and Aidia Campos. EU, (1997). Selectivity of gillnets in the North Sea, English Channel and Bay of Biscay. AIR2–93–1122. 61 pp + Appendices.

As a first step the Group considered these three manuals of existing static gear selectivity manuals and identified the strengths, weaknesses and gaps in knowledge. None of the manuals were considered a "finished" document and the statistical analysis in all three needed to be updated. There was very little information on other static gears such as longlines and pots and any of the analysis included seemed less than robust.

12.1.2.2 Agreed Plan for Completion of manual

Having considered the relevant documentation the Group agreed a plan for completion of the ICES manual. The ICES document was felt to be 80% complete but on the basis of the information available it was felt pertinent to restrict the manual to static nets only i.e. gillnets, trammel nets and tangle nets. This was not seen as a major issue as the measurement of selectivity of longlines and pots is a developing science. It was also identified that a lot of the relevant information needed to complete the manual was contained in the EU project but it would be necessary to write to the EU for permission to use and update this information so as not to breach copyright laws.

With regard to the overall content of the manual the main issues identified were as follows:

i) The original text needs some editing to improve the grammar.

ii) The Statistical methods need updating.

iii) The boundaries and applicability of the manual need to be detailed i.e. the methods should not be used for species where the selectivity is not well defined (fish with spikes).

iv) Graphics and diagrams are required.

v) It would be very useful to add case studies, documenting relevant experiments and analysis carried out.

vi) The finished document will need to be peer reviewed before publication.

12.1.2.3 Provisional timetable for completion of work

The Topic Group outlined a provisional timetable for completion of the manual as follows:

- May (Chair FTFB) – Contact EU (permission)
- May-July (Italy and Belgium) – review recent literature for any new issues, methods (i.e. paint etc).
- Italy will consolidate findings and advise UK and Denmark
- July – Italy to supply UK with Italian case study
- July – France to supply graphics to UK
- July – Italy to search for suitable case study involving hanging ratios (if not found use Danish case study on twine diameter)
- July- Sept – Denmark to update statistics and incorporate case studies
- July - Sept - UK to draft final report and distribute to Italy, Denmark, France, Belgium
- Oct – France, Belgium and Denmark to return draft with comments
- Nov – UK to amend report and be offered to FAO for external review
- Dec – Review complete(subject to offer being accepted by FAO)
- 2009 – Consider the possibility of a joint FAO/ICES publication noting that issues of publication coats and copyright ownership need to be discussed.

This was presented and agreed at plenary as the best way forward, although there were some reservations about not including longlines and pots in the manual but given the information is incomplete and to include this would be a major task that in the opinion of the Topic Group could not be completed in a reasonable timeframe.

12.1.3 List of Participants

Andy Revill	CEFAS	UK
Gianna Fabi	ISMAR-CNR	Italy
Fabio Grati	ISMAR-CNR	Italy
Jacques Sacchi	IFREMER	France
Dirk Verhaeghe	ILVO	Belgium
Kris van Creaynest	ILVO	Belgium
Peter Munro	NOAA	Alaska
Frank Chopin	FAO	Italy
Jonathen Dickson	FAR	Philippines
Rene Holst	DTU-Aqua	Denmark (by phone)

12.1.4 Recommendations

1) WGFTFB recommend that the Topic Group work to the timetable outlined to produce the manual. This will be presented to WGFTFB at the 2009 meeting.

12.2 Individual Presentation

12.2.1 Size selectivity of basket traps for the gastropod *Nassarius mutabilis* in the Adriatic Sea

Gianna Fabi and Fabio Grati

Istituto di Scienze Marine – CNR, L.go Fiera della Pesca, 260125 Ancona, Italy

Abstract

Fishing of *Nassarius mutabilis* is performed along the coast of the central and northern Adriatic Sea from autumn to spring by small-scale vessels using basket traps with a 19-mm mesh size. This fishery usually gives higher income than any other set gear, but in the last years landings have shown a general decrease. Management measures such as Minimum Landing Size (shell height = 20 mm) and mesh opening of the sieve used to sort individuals larger than MLS are currently enforced. Nevertheless, large amounts of small specimens are commonly caught and sold.

In order to avoid the catch of undersized individuals, the selectivity of basket traps was evaluated in a comparative study. Three experimental nets (colour white; mesh openings 23, 26, 28-mm) were fished in conjunction with two commercial nets (mesh opening 19-mm) of different colours (black and white) and one control net (colour white; mesh opening 5-mm). One hundred and twenty traps were randomly arranged in one set deployed on a muddy bottom (10 m depth) and hauled five times in September 2004. According to commercial fishing practice, traps were baited with horse mackerel and soak time was 24 hours. Size selectivity was estimated with the SELECT method commonly adopted for trouser trawl experiments using CC2000 software (Constat, 2000).

Selectivity parameters were estimated for a pool of curves, but the logistic model gave the best results. Goodness of fit test based on model deviance gave high p-values in all cases, being the lowest one 0.74 for the 19-mm trap (black).

H50 increased from 15.9 mm for the white 19-mm trap up to 24.1 mm for the 28-mm one. Around 3,000 specimens were caught with the control traps, 988 with the black 19-mm traps, 576 with the white 19-mm traps, 263 with the 23-mm traps, 114 with the 26-mm traps and 7 with the 28-mm ones. Percentage of individuals larger than MLS gradually increased from 14% in the control 5-mm traps up to 100% in the 26-mm and 28-mm ones. Comparison between black and white 19-mm traps did not show any significant difference, both in terms of L50 and of catch yields. These results indicated that the 19-mm mesh commonly used by fishermen is not adequate to sustainably exploit *N. mutabilis* due to the large amount of undersized specimens in catches, while the 23-mm mesh represented a good compromise between commercial fishing yields and protection of undersize animals.

Discussion

The author was asked how the small *Nassarius* were thought to be escaping from the pots but the author could not provide any explanation. It was stated that in a Canadian study no improvement in mesh size selectivity could be achieved for whelk pots where the catch sizes were very high and the species exhibited similar behaviour. It was explained that in the present study catch for 500 pots were only about 100 kg and this relatively low catch rates was felt to be the likely cause of difference in the selectivity achieved. The question was asked as to whether the escapees survived but this was unknown and the main reason for trying to increase selectivity was a motivation to increase efficiency through reduced sorting times.

13 ToR (d) Mitigation Technologies for Protected Species

13.1 General Overview

This ToR was proposed by Alessandro Lucchetti and Antonello Sala of CNR-ISMAR at the WGFTFB meeting in Dublin 2007. The group worked by correspondence during 2007/2008 and met at FTFB in 2008 in Tórshavn, Faroe Islands. An overview of this topic and a paper on 'Turtle Excluder Devices Experiments in the Central Adriatic Sea' were presented at plenary by Alessandro Lucchetti.

13.1.1 Terms of Reference

The Topic Group addressed the following ToRs:

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

13.1.2 Identification of technical mitigation measures

Prior to WGFTFB, the ICES Study Group for Bycatch of Portected Species (SGBYC) had produced a "Compendium of Mitigation Methods deployed to minimise bycatch of protected species" at their meeting in January 2008 (See Section 3.6). This table was considered by the WGFTFB Topic Group and additional information incorporated from FTFB members, including the participants from FAO REBYC (Reduction of Bycacth in Tropical Shrimp Trawling) project. The group also tried to identify technical or practical difficulties associated with mitigation measures which were deemed experimental by SGBYC.

Based on the information gathered by the Topic Group, the table was revised accordingly as shown in Annex 9. Table 6 below summarises the entries broken down into measures currently legislated for, being used voluntarily or purely experimental by broad species categories as follows:

- Small Cetaceans
- Whales
- Pinipeds
- Sea Turtles
- Seabirds
- Other large fish species such as sharks and rays

Table 6. Summary table of mitigation measure by species.

Species Category	Legislation	Voluntary use	experimental
Small Cetaceans	4	4	15
Whales		3	2
Pinnipeds	2		6
Sea Turtles	13		9
Seabirds	2	3	5
Other Large Fish Species	5		3

It was agreed that this table was extremely informative and accordingly should b be circulated to all WGFTFB members for further updating. The updated version would then be forwarded to SGBYC And other relevant Expert Groups.

The Topic Group also considered the specific case of loggerhead turtle bycatch in Mediterranean fisheries on the basis of a study presented by Alessandro Lucchetti. The full case study is presented in Annex 10. Data on the level of bycatch of protected species in the Mediterranean is extremely sporadic but given the number of fisheries with potential impacts the levels are undoubtedly significant. The specific case study presented cites estimates of more than 60,000 turtles caught annually in trawl, longline and static gear fisheries with mortality rates of individuals caught ranging from 10–50%. The actual catches are anticipated to be far higher given that many countries do not report any bycatch. The report details research carried out with different mitigation measures for trawls and longlines and recommends the need for further research and enhanced data collection programmes to provide a better understanding of the scale of the problem. The use of TEDS, modified to match the catch composition in Mediterranean bottom trawl fisheries, as well as simple gear modifications in longline fisheries such as using mackerel instead of squid, deeper setting and the use of circle hooks are recommended for further investigation, given they are proven mitigation technologies in other parts of the world.

13.1.3 Assessment of efficacy of the technical measures

The Topic Group considered the response by SGBYC to the following TOR:

"*Review of methods and technologies that have been used to minimise bycatch of species of interest, including methods that have failed*".

This report identified that in a number of fisheries, mitigation measures to reduce bycatch of protected species (cetaceans, pinnipeds, turtles and large fish species) had been introduced (e.g. new type of hooks, TEDS, acoustic deterrents etc.) and in some cases there was evidence that bycatch had been reduced, but little or no attempts had been made to quantify this reduction.

The ToR addressed by SGBYC was seen by WGFTFB as a pre-cursor to the work to be completed in attempting to develop a framework for such an assessment. The Topic Group considered the report by SGBYC and concluded that it was very comprehensive and had identified all elements that should be addressed when introducing mitigation measures for minimise protected species bycatch.

The Topic Group then considered the findings in the context of the methodology used by WGFTFB in reviewing the efficacy of recent (2003) technical measures introduced into the North Sea *C. crangon* fishery (Sieve nets / grids) aimed at reducing dis-

carding of juvenile whitefish (ICES, 2007). This assessment considered social, biological and economic factors along with technical issues in the design and use of the technical measure.

The Topic Group attempted to apply this methodology to the case study on loggerhead turtle bycatch in Mediterranean fisheries to determine whether it was possible to assess the efficacy of potential measures that could be used in these fisheries. It was concluded, however, that given only limited information was available it was not possible to carry out the assessment. The Topic Group considered more established mitigation technologies such as acoustic deterrent devices into gillnet fisheries and the use of TEDS in shrimp trawl fisheries but the data required on levels of bycatch, uptake of the devices and the potential impact of the measures on the protected species stock are not at a current level of resolution to allow an assessment to be made. It was felt unlikely that in the short term that such an analysis would be possible for any mitigation measure for the reduction of bycatch of protected species.

13.1.4 List of Participants

Alessandro Lucchetti	ISMAR-CNR	Italy
Dominic Rihan	BIM	Ireland
Håkan Vesterberg	Swedish Board of Fisheries	Sweden
Huseyin Ozbilgin	Mersin University	Turkey
Sven Gunnar Lunneryl	Swedish Board of Fisheries	Sweden
Pascal Larnaud	IFREMER	France

13.1.5 Conclusions

1) WGFTFB acknowledges the work carried out by ICES SGBYC in developing the table of mitigation measures and has sought to update this table.
2) WGFTFB concludes that the impact of fisheries on Loggerhead turtle needs to be considered urgently given the scale of the problem. Research into the applicability of proven mitigation technologies to reduce the bycatch should be supported.
3) WGFTFB have been unable to use the methodology developed in 2008 to assess the efficacy of mitigation measures for protected species. WGFTFB conclude that this methodology is data dependent and for most protected species bycatch issues such data does not exist currently.

13.1.6 Recommendations

1) WGFTFB recommend that the Compendium of Mitigation Methods deployed to minimise bycatch of protected species developed by SGBYC and expanded on by WGFTFB should continued to be updated as information on work being undertaken globally becomes available.
2) WGFTFB recommend that GFCM encourage Mediterranean States instigate data collection programmes to provide a better understanding of the bycatch issues in Mediterranean fisheries, particularly in non-EU countries.
3) WGFTFB recommend that research in the Mediterranean on mitigation technologies be carried out under commercial conditions and include consideration of socio-economic effects of introducing such technologies.
4) WGFTFB recommend as a matter of priority that GFCM instigate further development and testing of Turtle Excluder Devices in trawl fisheries in

the Central Adriatic, Tunisia and the North-east Mediterranean given the level of turtle bycatch in these areas.

5) WGFTFB recommend that GFCM instigate research and pilot projects to ascertain whether simple modifications to longline gears such as the use of circle hooks, different bait types and setting depths used extensively in other parts of the world e.g. US and Hawaii to reduce turtle bycatch are appropriate in the Mediterranean.

13.2 Individual Presentations

13.2.1 Turtle Excluder Devices Experiments in the Central Adriatic Sea

Alessandro Lucchetti, Antonello Sala, Marco Affronte

CNR, Italy

Abstract

There are three turtle species in the Mediterranean Sea: the leatherback (*Dermochelys coriacea*), the green (*Chelonia midas*) and the loggerhead turtle (*Caretta caretta*). Loggerhead sea turtles are listed as endangered in the Red List of Threatened Species of the International Union for Conservation of Nature and Natural Resources (IUCN). In the Mediterranean Sea, they represent the most abundant species of marine turtles. The Central-Northern Adriatic Sea, for its shallow waters (<100 m) and rich benthic communities is considered one of the most important foraging areas in the whole Mediterranean area for the loggerhead turtle population during the demersal phase of their life cycle.

In the Mediterranean Sea, turtles are usually threatened by longline and driftnet fleets, very often used illegally. Nevertheless, in the Central-Northern Adriatic Sea a growing number of sea turtles are accidentally caught by bottom trawlers in the last number of years. Few unofficial observations report that most of the incidental catches occur in late winter and spring in coastal areas. Incidental catch probably occur during towing operations when turtles are foraging on the bottom. It is estimated that in this area more than 4000 turtles per year are caught by trawls. One of the most important gear modifications used globally to protect sea turtle, especially the juvenile and sub-adult size classes, is the use of Turtle Excluder Devices (TEDs). TEDs actually represent a management measure widely employed in several areas of the World but no specific testing in Italian waters is recorded.

There are a variety of hard TED designs available for fishermen but generally it is very difficult to introduce new technical solutions, taking into account that innovations can be easily accepted only if economic losses in terms of marketable fish catches are insignificant. During the LIFE project TARTANET, we projected and tested at sea five different TEDs with the aim of finding the best way mitigation technologies for Italian waters. The first two TEDs tested at sea were a simple oval grid type, made of aluminium and plastic respectively. They were not satisfactory because of the losses of many commercial species and therefore they were felt not commercially acceptable in the short term.

Two other experimental low-cost and semi-rigid grids (TARTEDs), similar in shape but made first in plastic and then in a composite rubber-material, were tested. They were a fixed-angle TED with a single hoop used to strengthen the TED frame and to maintain TED angle. The hoop and the deflector grid were sewn to the trawl exten-

sion in order to "fix" the angle of the TED in the trawl. In fact the angle at which the TED operated during towing (30° to 55° from the horizontal) is an important factor in preventing fish loss.

Both the TARTEDs were very efficient because they allowed the release of large quantities of debris (plastic materials, wood, stones, etc). This characteristic positively affected the fish quality of the commercial catch portion. Moreover, the losses of commercial species were insignificant in most tows. In order to evaluate the effectiveness of the TARTEDs in releasing turtle-shape bodies, some tests were performed using a simulate "turtle" using a container 40X40 cm deployed along the towing direction. All tests showed positive results and all the waste materials included the container and even a carapace of a dead turtle was released from the turtle escape opening.

Finally, comparative sea trials were carried out, testing a traditional Super Shooter TED and the semi-rigid TARTED. Fishermen were very interested in testing this technical solution especially as debris separation grid. During winter they usually exploit typical fishing grounds of the Central Adriatic Sea, characterized by a great amount of sea cucumbers (Holothuroidea). These areas, which represent an important habitat for several commercial species, are actually overexploited by trawlers and the use of TEDs should avoid the catch and the death of sea cucumbers allowing the protection of this typical fishing grounds.

In conclusion, the two low-cost TARTEDs, compared to the Super shooter TED, were easier to rig and they seem to be more efficient in releasing debris with insignificant economic losses, furthermore the characteristics of the materials of the semi-rigid TARTEDs make the handling easier during hauling. The simulation experiments suggest they are also effective at realising turtles from trawls.

Discussion

The scale of the problem in the Mediterranean as presented was commented on by a number of participants and the importance of the need to develop mitigation technologies for all gear methods was emphasised. Experiences with longline fisheries in the US were highlighted including the use of circle hooks and deep setting of longlines. These methods while useful are not 100% reliable.

14 ToR e): Request form WGEF

See section 3.1.1.

15 ToR f): Ad hoc Topic Group on Shrimp Trawl Efficiency

15.1 Request

In the NIPAG report of 2006 the following recommendation was made:

> *"During the NIPAG assessments in 2006 there was a discussion of the use of double trawls in the shrimp fishery and how best to represent the effort of these trawls. They may not exert twice the effort as a single trawl. STACREC noted the importance of this issue and encouraged Contracting Parties to study the efficiency of twin shrimp trawls. STACREC noted that for bottom trawls one factor in standardizing effort is to count the number of meshes in the circumference of the trawl opening. Given the importance of estimates of effort to shrimp assessments STACREC recommended that the appropri-*

ate method to estimate effort from twin trawls (bottom and midwater) be referred to the ICES Fishing Technology Working Group".

STACREC (June 2007:80) and the Scientific Council of the NAFO/ICES Pandaleus Assessment Group (October-November 2007:218) responded to the request of the NIPAG (SCS 06/27, p. 47) to forward the question of the efficiency of single and double trawls to the April 2008 meeting of the ICES/FAO WGFTFB. The request received was as follows:

> *"During deliberations of various shrimp stocks it was noted that twin trawls, and in some cases triple trawls, were being utilized for the improvement of catch quality rather than catch rate. It was pointed out that the physical attributes of some twin trawls (e.g. the number of meshes in the circumference) may not be too different from single trawls. NIPAG considered that further investigations should be conducted to address this as it is could be very informative in interpreting standardized catch rate indices. This would include investigations of the use of twin and triple trawls in other fisheries as well, for example Greenland halibut directed fisheries, where their deployment may be used to improve catch rate rather than catch quality".*

This request was forwarded to ICES-FAO WGFTFB in 2007. WGFTFB has addressed this request by soliciting input from a number of specific experts with information and/or comments received from Iceland, Canada, Norway, Faroe Islands and UK-Scotland. The Chair of WGFTFB has taken this information and produced this document as an attempt at addressing the specific request and the findings and recommendations were agreed at the WGFTFB meeting in April 2008 in the Faroes Islands. It should be noted that the views expressed do not necessarily reflect fully the views of all the contributors.

15.2 Shrimp Trawl Evolution

The fishery for Pandalus shrimp has been in existence for a large number of years beginning in Iceland in the 1930's in inshore waters, and moving to the offshore fisheries in the 1970's. The trawls used have increased in size from simple two panel trawls to large four panel nets fished as twin or even triple rigs, designed to take account of diurnal variations in shrimp behaviour. In the past 20 years or so, stronger netting materials have been introduced, vessels have shifted from steel bobbins to rubber rockhoppers and in general, the trawl design has undergone considerably refinement to maximise efficiency.

In 1991, after a visit to the Danish fisheries, an Icelandic *Nephrops* skipper succeeded with towing two trawls simultaneously, increasing the shrimp catch significantly. In 1993, an Icelandic factory trawler, 'Sunna SI' managed to fish with two shrimp trawls. In her first trip, she had to go ashore for more crew to cope with the increased catches. Since then, most large shrimp trawlers have changed to twin trawling. In Norway, the first vessels using twin trawls entered the fishery in 1996. Since then, efficiency has increased continuously, and in 2002 approximately 35 Norwegian vessels had the technology to use double or even triple trawls. Since 2002, the majority of the yield is taken by twin trawl.

Modern shrimp trawls are characterised by having wider horizontal spreads than traditional trawls of a similar size. This is largely to maximise swept area of the groundgear and also allows towing in areas of rough ground without damage to the trawl. There are also specially designed trawls with high vertical openings shrimp trawls suitable for night fishing in areas where shrimp are lifting off the bottom.

15.3 General Comments

It is important in the first instance to point out that all shrimp species like *Pandalus borealis* are captured by a pure filtering process. Therefore, the area swept by the small meshes (< 50mm) is what determines the capture efficiency. Horizontal opening is thus more important than filtered volume with respect to catch volumes. Wingend spread is more important for shrimp trawl efficiency than a high vertical opening and consequently using circumference of the trawl is not a particularly accurate measure of efficiency for shrimp trawls.

Given the fundamental differences in the catching process, comparisons between single and twin trawls for fish species and shrimp is not considered by WGFTFB to be very relevant as herding efficiency by sweeps can very much influence the capture efficiency of fish. Long sweeps in a single trawl rigging can compensate for twin trawls for many fish species but not necessarily for shrimp. The overarching conclusion is that if the same size of trawl is used as a single or twin trawl, the twin trawler will almost double the catch although there is evidence of single trawlers having the same towing power as a twin rig vessel often increases the trawl size including the fishing line length, and can catch more than half of the twin trawler. Measurements in Canada showed in comparison with a single trawl, by using the twin trawl method the swept volume increased from 106m² to 193m² an increase of 82%. Swept area increased from 1,739m² to 2,067m², an increase of 19%.

The relationship between wingend spread and shrimp catch is further borne out by a study carried out in Newfoundland (DeLouche *et al.*, 2005). This study provided valuable information on shrimp distribution and size in the bottom waters. It also raised questions as to the trawl gear designs that are currently being used commercially to harvest northern shrimp. The results from this work clearly demonstrated that the upper 1/3 of the typical trawl that is used to harvest shrimp is not an effective harvesting tool. In this study it was found imperative that 100% of the swept area of the trawl be actively catching shrimp. Based on the findings of this report any trawl design must have a reduced vertical opening and a higher horizontal spread. Essentially trawl design should look at maintaining mouth area by reducing the vertical opening of the trawl and increasing the wingspread. By doing this the trawl will now be targeting shrimp where they are known to exist in high densities. With this design it is possible that more energy may required to tow the trawl, thereby burning more fuel, but fishing trips may be reduced by several tows as well, thereby saving on fuel.

In Norwegian shrimp fisheries there is a tendency towards increasing the fishing line length and to use larger meshes in the upper panels. Among the larger shrimp vessels there are no single trawlers left although in the coastal shrimp fisheries some vessels are still operating a single trawl. There are currently three Norwegian trawlers are presently operating three trawls.

15.4 Icelandic Effort Data

Having said that shrimp trawl efficiency is related more to wingend spread than vertical opening, there are no analysis known to WGFTFB that have attempted to assess relative efficiency of single and twin rig trawls for any species, including shrimp using this parameter. Thus the only reliable estimate of single vs. twin rig efficiency is based on Icelandic data.

By extracting data from logbooks, MRI in Iceland have compared catches h^{-1} from all single and double rig hauls taken with 2400 – 3600 mesh circumferences trawls from

1994 to 2000 in Icelandic waters. The catches are standardized for 3000 mesh trawl, i.e.

$$\text{Standardised catch } h^{-1} = \text{catch} \times 3000 \times h^{-1} \times (\text{actual trawl circumference})^{-1}$$

Comparing the mean catch rates for every year from single trawl hauls with those from double trawls, average catch rates for twin trawls of 1.25 – 2.24 times that of a single trawl, with an average of 1.66 were found in this analysis. The between-year variations cannot be explained, but perhaps a more detailed analysis, taking into account time of year, area, vessel size etc. would reveal the reasons for these differences.

Table 7. Mean catches and number of vessels fishing with 2400 – 3600 mesh circumference trawls, single and double rig, from 1994 – 2000 in Icelandic waters.

Year	1994	1995	1996	1997	1998	1999	2000
No. vessels with double rig	1	2	1	4	6	8	2
No. vessels with single rig	24	29	22	38	37	37	32
No. hauls with double rig	420	708	115	405	1168	705	208
No. hauls with single rig	7373	6927	6067	11377	9319	7542	8052
Mean shrimp catch h^{-1} :Double	665.9	590.1	571.8	513.5	443.2	194.8	235.8
Mean shrimp catch h^{-1} :Single	297.3	308.8	367.5	354.5	228.7	156	178.9
Catch rate: double / single	2.24	1.91	1.56	1.44	1.94	1.25	1.32

A further comparison was carried out by MRI, Iceland for twin and single rig gears in the Flemish Cap fisheries in March - October for the period 1994 to 1999. Catches of Icelandic vessels from 4513 hauls with twin rig and 5334 with single rig were standardized to catch/h pr. 3000 mesh circumference calculated as 40mm mesh size (which was about the average size of the trawls). Overall catch ratio twin rig: single rig was found to be 1.90, st.dev = 0.30. There were seasonal variations in the catch ratio, from ~2 in March – May, to 1.5 – 1.7 in September – October (ratio = 2.465 - 0.0816 × month, $p < 0.005$, $3 \leq \text{month} \leq 10$). See Table 8 below.

Table 8 Comparison of cpue of single trawls and double trawls by month over a period of six years. The area is the NW area (No. 3) of Flemish Cap. Kg/hr is standardised to a trawl size of 3000 meshes (40mm mesh size), i.e. estimated headline height of 13–14m.

		Single trawl				Double trawl				
Year	Month	Kg/hr	No. tows	Av. Size of trawl	3000 Meshes Kg/hr	Kg/hr	No. tows	Av. Size of trawl	3000 Meshes Kg/hr	Coefficient Double/single
1994	7	210.3	276	3056	206.4	509.8	74	3000	509.8	2.469
	8	151.5	95	2562	177.4	406.4	54	3183	383.0	2.159
1995	6	258.8	98	2644	293.6	480.8	61	3315	435.1	1.482
	7	258.2	209	3042	254.6	476.0	176	2736	521.9	2.050
	8	190.1	135	2893	197.1	348.0	120	2820	370.2	1.878
	9	165.6	103	2965	167.6	218.4	61	2354	278.3	1.661
	10	233.0	53	4000	174.8	290.8	54	2888	302.1	1.729
1996	3	246.3	254	2823	261.7	551.8	151	3000	551.8	2.108
	4	215.2	624	2815	229.3	415.2	238	2859	435.7	1.900
	5	199.2	679	2762	216.4	380.8	316	2838	402.5	1.860
	6	205.0	572	2909	211.4	382.2	321	2792	410.7	1.943
	7	191.3	352	2997	191.5	310.6	219	2792	333.7	1.743
	8	160.9	101	2735	176.5	285.6	89	2712	315.9	1.790
	10	157.8	128	2734	173.2	220.4	72	2795	236.6	1.366
1997	5	169.7	80	3340	152.4	261.2	142	2669	293.6	1.926
	6	198.6	163	3228	184.6	295.8	141	2718	326.5	1.769
	7	242.6	179	3251	223.9	326.0	132	2565	381.3	1.703
	8	240.6	170	3241	222.7	366.2	96	2688	408.7	1.835
	10	233.2	70	2485	281.5	401.2	67	2868	419.7	1.491
1998	5	236.1	76	3332	212.6	564.6	172	2995	565.5	2.660
	6	256.6	63	3046	252.7	639.2	93	3067	625.2	2.474
	7	260.8	160	2932	266.8	586.4	139	2980	590.3	2.212
	8	319.7	62	3069	312.5	520.6	164	3009	519.0	1.661
	9	222.2	55	3358	198.5	353.0	282	3045	347.8	1.752
	10	306.3	59	4115	223.3	362.2	212	3118	348.5	1.561
1999	4	252.1	100	3342	226.3	497.8	96	3072	486.1	2.148
	5	270.4	135	3539	229.2	481.4	210	3305	437.0	1.906
	6	274.8	198	3408	241.9	531.4	298	3434	464.2	1.919
	7	282.9	85	3460	245.3	548.2	263	3477	473.0	1.928
Average		227.9	183.9	3106	220.9	414.21	155.6	2934	419.79	**1.899**
Stdev		44.2	169.1	383	39.6	115.4	83.8	255	99.0	0.301
St. Error		8.4	32.0	72	7.5	21.8	15.8	48	18.7	0.057
Number of months										29
Total No. of tows			5334				4513			

15.5 Catch Quality versus Catch Rate

WGFTFB could find no evidence of multiple rigs being used to improve catch quality. The sole motivation for using multiple rigs (twin or triple rigs) would appear solely catch efficiency due to increased horizontal spread. The main tool that has improved catch quality is the use of the Nordmore grid, which gives cleaner shrimp catches. There is evidence, however, of fishermen using so called twin or trouser codends in a number of fisheries including the Pandalus shrimp fishery. These include:

- UK Distant water cod fishery in Iceland and Greenland
- South African Hake fishery
- UK- Scottish and Irish *Nephrops* fisheries

The motivation for using trouser codends, which in Canada are seen as an alternative to twin-rigs, are considered threefold:

- Reducing the risk or impact of gear damage on catches by splitting the catch;
- Increased wingend spread due to the increase in width of the trawl needed to accommodate the additional codend; and
- Catch quality due to a splitting of the catch.

Compared to a single trawl of a given size, a twin codend can achieve a 20% increase in footrope spread. Experimentation with three codends has indicated that it is possible to increase this to 47% compared to a single trawl. It is also important to note that in trouser codend trawls the footrope swept area increase is concentrated in the middle section of the net, not in the wings. The wider centre area is a major advantage when targeting shrimp.

15.6 List of Participants

Dominic Rihan	BIM	Ireland
Haraldur Einarsson	MRI	Iceland
John Willy Valdemarsen	IMR	Norway
Dick Ferro	FRS	UK-Scotland
Olafur Ingolfsson	MRI	Iceland
Harald DeLouche	MI	Newfoundland
Kristain Zachariassen	FFL	Faroe Islands

15.7 Conclusions

1) WGFTFB concludes that due to the catching process for shrimp, horizontal opening is more important than filtered volume with respect to catch volumes and this is reflected in the current trends in shrimp trawl design.

2) WGFTFB concludes that due to the fundamental differences in the catching process, comparisons between single and twin trawls for fish species and shrimp are not relevant as herding efficiency by sweeps can very much influence the capture efficiency for fish.

3) WGFTFB can find no reliable estimates of single vs. twin trawl efficiency based on horizontal spread. Icelandic effort data using trawl circumference shows average catch rates for twin trawls of between 1.25- 2.24 times that of a single trawl, with an average of 1.66.

4) WGFTFB can find no evidence of multiple rigs being used to improve catch quality. The main tool used that does improve catch quality is the Nordmore sorting grid. There is evidence, however, of fishermen using twin or trouser codends to reduce the risk of gear damage, increase wingend spread and improve catch quality.

15.8 Recommendations

1) WGFTFB recommends the issue of shrimp trawl efficiency be addressed to SGGEM as a case study for consideration

2) WGFTFB recommends further analysis of the Icelandic or other suitable datasets by SGGEM.

3) WGFTFB recommends that SGGEM should consider whether horizontal wingend spread can be used as an effort parameter for this fishery.

16 ToR g): WGECO request as part of the OSPAR QSR 2010

16.1 General Overview

With increasing public and political concerns on marine fisheries and environmental issues, fisheries science and management has become increasingly complex. The move to the ecosystem based approach to Fisheries Management has gained momentum as the multiple uses of marine resources have broadened to take account of ecosystem considerations and the recommendations from the numerous international agreements, conferences and summits held on the subject. Some of the most important of these include:

- The 1972 World Conference on Human Environment.
- The 1982 United Nations Law of the Sea Convention.
- The 1992 United Nations Conference on Environment and Development and its Agenda 21.
- The 1992 Convention on Biological Diversity.
- The 1992 Habitats Directive
- The 1995 United Nations Fish Stocks Agreement.
- The 1995 FAO Code of Conduct for Responsible Fisheries.
- The 2001 Reykjavik Declaration.
- The 2002 World Summit on Sustainable Development.
- The 2002 Green Paper of the European Commission
- UN 2006 General Assembly to ensure protection of vulnerable marine ecosystems
- The 2007 Committee on Fisheries of the UN FAO on IUU and protecting the marine environment
- The 2007 Integrated Maritime Policy for the European Union

ICES is in the process of restructuring its Science and Advisory processes and is collaborating with HELCOM and OSPAR, among others, in the evolution of a holistic ecosystem-based approach to fisheries management. WGFTFB have been discussing the subject of fishing impacts for a number of years and has addressed it as a specific ToR in 2004 (ICES, 2004). Much of this though has been in isolation with limited dialogue between other EG's including WGECO. WGFTFB has recognised this and has discussed internally the need to define its new research direction, beyond the traditional focus of bycatch reduction, into developing environmentally responsible fisheries (ERF) in support of the ecosystem approach to fisheries management. The stimulus for these discussions were prompted by the ever increasing 'international calls for ban on bottom trawling on high seas' and also debate at the '2006 ICES Symposium on Fishing Technology in the 21st Century: Integrating Fishing and Ecosystem Conservation' held in Boston (Glass *et al*., 2007). Since WGFTFB works closely with and has industry people as part of their membership it felt that it should be

16.1.1 Terms of Reference

Recognizing the need for better integration between WGFTFB and WGECO, at last year's FTFB meeting in Dublin (ICES, 2007) an ad hoc group made a first attempt to address this and explore ways of enhancing links with other ICES WG's. WGFTFB also addressed a joint ToR with WGECO on the impacts of *Crangon* beam trawl fish-

eries in the North Sea in 2007. Later in 2007 at the ICES ASC in Helsinki a ToR was formulated between the Chairs of WGFTFB and WGECO as follows:

> "*For each OSPAR region, select and succinctly describe one or more representative examples of gear modifications, which have resulted in changes to the ecosystem effects of these gears, including if possible a range of ecosystem components.*"

The work contributes to WGECO ToR b) which will pull together an environmental assessment of the impact of fisheries, in preparation for the OSPAR QSR. It is also seen as means to begin the wider debate on how to properly assess the effect and impact of gear based measures through the development of a proper assessment framework. This will be worked on at WGECO in 2009.

16.1.2 General Issues

To address the specific TOR, a Topic Group was convened and worked by correspondence prior to WGFTFB. Representative case studies were identified by the Topic Group to illustrate the positive and negative impacts of different gear based technical measures. The identified cases studies were first introduced at plenary and then the Topic Group convened to draft the documents. These were then presented at plenary and recommendations agreed. The case studies identified are as shown in Table 9 below.

Table 9. Case studies, identified for the description of representative examples of gear modifications that are designed and selected for the mitigations of ecosystem effects.

Case study	Fishing gear	Target species	OSPAR-region	Ecosystem component
1 (IRL)	Gill net	Mixed demersal	OSPAR-Region II, III & IV	Marine mammals
2 (Eng)	Demersal otter trawl	Norway lobster (*Nephrops norvegicus*)	OSPAR-region II	Fish species
3 (B, NL, UK)	Flatfish beam trawl	Mixed, demersal fish species, mainly sole (*Solea solea*) and plaice (*Pleuronectes platessa*)	OSPAR-regions II, III, IV	Fish species Benthic invertebrate species
4 (B, DK, F, GER, NL, UK)	Shrimp beam trawl	Brown shrimp (*Crangon crangon*.)	OSPAR-region II	Mainly commercial fish species
5 (Faroe islands)	Pelagic otter trawl	Blue whiting (*Micromesistius poutassou*)	OSPAR-region I & V	Fish species

The case studies are presented in full in Annex 11. They are written in the following format:

i) Brief overview of the situation prior to mitigation measures/regulation.

ii) The drivers that initiated gear measures being developed or introduced.

iii) A description of what was done in terms of mitigation measures.

iv) A description of what management measures were taken after the research i.e. was the mitigation measure introduced into regulation or was it only tested and then used or not used voluntarily

v) A description of how the impacts of the gear modifications have been assessed.

vi) A description of how successful this has been in terms of reducing impacts.

16.1.2.1 List of Participants

Jochen Depestele	ILVO	Belgium
Dominic Rihan	BIM	Ireland
Tom Catchpole	CEFAS	UK
Kristain Zacchariassen	FFI	Faroe Islands
Phil MacMullen	SFIA	UK (Part-time)
Andy Revill	CEFAS	UK (Part-time)
Dick Ferro	FRS	UK-Scotland (by correspondence)
Barry O'Neill	FRS	UK-Scotland (by correspondence)

16.1.3 Conclusions

The integration of fishing gear technology research in the framework for fisheries management is a prerequisite for achieving an ecosystem-based approach. It is recommended that many of the issues evolving from the selected case studies should be taken into account in a framework for assessing impacts and management measures related to fishing gear based technical measures.

Fishing gear technologists tend to focus on single or multiple commercial fish species. With the exception of charismatic species, very little fishing gear research is focused on non-target fish species and benthic invertebrates; although such gear modifications might have an effect on non-target fish and invertebrate species. Most of the fishing gear research is driven by the fisheries management objectives, which is in its turn mainly driven by the healthiness of commercial fish stocks. There is gradually a focus on a more ecosystem-based approach, but very few fishing gear research is yet focusing on other ecosystem components. Therefore there is need to consider biological and ecological impacts of gear measures during the research phase and before inception into legislation.

Fisheries gear research has and is focusing on the reduction of physical habitat impacts (e.g. EU-project "DEGREE"), but few of these efforts have been implemented in the actual fisheries and this is reflected in the fact that the authors could not identify a good case study to address this.

Research on gear modifications to improve selectivity of commercial fish species through a variety of sorting devices has been proven to reduce bycatch and discards rates, mainly of fish species (Valdemarsen and Suuronen, 2003, Suuronen and Sarda, 2008). The application of these gear modifications can be achieved through regulations or sometimes through the voluntary use by fishermen. Regulatory and market incentives both can lead to an improvement of fishing practice.

From the case studies, it can be seen that communication and education are vitally, when introducing gear based measure into legislation. Regulations are in some cases quickly introduced, but it takes time for the fishing industry to adapt. Case study 5 (blue whiting fisheries and the use of a flexi-grid) illustrates that the compliance and

acceptance of gear measures can be high, as a consequence of the involvement of the Faroese fishing industry in the actual fishing gear research and the implementation of the legislation. The first case study (gill net fisheries and the use of pingers) however, is a clear illustration where the very limited involvement of the fishing industry in the development of Acoustic Deterrent Devices, its application and implementation through legislation leads to much scepticism towards its use. The proven positive effects of acoustic deterrent devices for certain cetacean species and fisheries have been largely undermined and the measure has been ineffective in meeting its objectives.

Another vital aspect for an effective use of gear modifications is a good framing of the legislation. There is a need to consider all relevant issues (e.g. practicalities, socio-economic and technical aspects, etc.) to ensure that gear measures, proven effective in fishing gear research, meet their objectives after implementation.

Non-regulatory uptake of technical gear measures can be achieved through several incentives. The incentives can be market-driven, but uptake leading to an improvement of the fisheries image is also present. One example is the use of the benthos release panel. In this case, the drivers are economic incentives and an improvement the image of fisheries towards the public perception and supermarkets (achieved through e.g. the UK Clean fishing competition). The use of selective methods by fishermen in other cases is apparent, when fishermen face or are subjected to a reduction in fishing opportunities through other restrictive measures (e.g. access to closed areas, increase in fishing days, etc.). This has been apparent in the adoption of the Nordmore grid in Norwegian shrimp fisheries, where fishermen had to adopt more selective gear to remain I the fishery (Graham *et al.*, 2007).

WGFTFB conclude that the protocol used in the UK-study (Catchpole *et al.*, 2008) to evaluate the legislation put into force for the *C. crangon* fisheries is both holistic and effective. The same protocol can potentially be used elsewhere in other fisheries to conduct similar evaluations on the efficacy of technical measures. This protocol includes an evaluation of the legislation text, performance of the gear modifications, including environmental effects and a socio-economic evaluation. This can be supplemented by evaluating the efficacy of technical measures through proper use of data gathered under the Data Collection Regulation, e.g. Enever *et al.* (submitted). Data collection programmes can be used to evaluate the gear measures put into force. However, these evaluations have to be used in association with survey data, to document changes in discards and/or landings/catch.

16.1.4 Recommendations

1) WGFTFB recommends that WGECO use the findings of the case studies presented in the context of the OSPAR QSR 2010.

2) WGFTFB recommends that the case studies presented be used to assist in the development of a framework that can be used to assess the efficacy of gear-based technical measures introduced to reduce the environmental impact of fishing

17 FAO Reduction of Bycatch in Tropical Shrimp Trawling (REBYC) project

17.1 Overview

Frank Chopin and Janae Fogelgren, FAO, FIIT, Rome (Francis.chopin@fao.org & Jannae.Fogelgren@fao.org)

The ICES Working Group on Fishing Technology and Fish Behaviour (WGFTFB) was created in 1983. In 2002, the Food and Agriculture Organisation (FAO) joined with ICES to co-sponsor the WGFTFB, giving the working group a global mandate. Recognizing the value of the WGFTFB and the need for enhanced collaboration between ICES and FAO, a National Coordinators (NC) workshop of the FAO-GEF-UNEP project EP/GLO/201/GEF was hosted by FAO FIIT. Back to back meetings of the NC workshop were held prior to the FTFB meeting.

The 2008 NC workshop was Chaired by Jonathan Dickson (The Philippines) and Rapporteured by Oumarou Njifonjou (Cameroon). In order to make the results of the NC meeting available to the ICES FTFB WG, three presenters [Jose Alio - Latin America, Bundit Chokesanguan – SE Asia and James Ogbonna – Africa] were selected to present an update on bycatch reduction and change management activities from each region to plenary. Additionally, each NC was offered the opportunity to present a summary of their recent research in the form of a brief paper. This report contains abstracts of each report submitted by each NC. More detailed reports are given in Annex 12.

17.2 National Report Summaries

17.2.1 Philippines

Jonathan O. Dickson: Bureau of Fisheries and Aquatic Resources (jod_bfar@yahoo.com)

The pilot implementation project was carried out in Samar Sea (Calbayog City) from September 1, 2005 to December, 2006. The experiments involved 18 shrimp and fish trawlers with a total landed catch of 1,295 tonne of fish from 991 fishing trips. The average catch per-unit effort (CPUE) for shrimp trawls (*panghipon*) was just below 1 tonne (948 kgs) per fishing trip while CPUE for fish trawl (*palupad*) was 2.4 tonnes per fishing trip. Fishing season (peak months) was clearly identified as the months of October and November with reduced catches in July- August.

Of the total estimated catch of 711 tonnes from shrimp trawls for the study period, more than one third (37.9%) was comprised of lizard fish (*Saurida* spp), followed by *nemipterids* (*Nemipterus hexodon, Scolopsis* sp., 10%) and about 1% of shrimps. The discards were comprised of juveniles of commercially important species as well as other small-sized fish of low or no commercial value and are commonly utilized as aquaculture feed was 15.6%. The composition of discards in shrimp trawls indicates a high incidence of juveniles of commercially important species, among which were the lizard fish 8.1% (*Saurida* sp.), purple spotted bigeye 5.4% (Dilat, *Priacanthus tayenus*), cardinal fish 9.2% (*Muong, Apogon* sp., hairtail (*Espada, Trichiurus* sp.).

The efficiency of JTED V15 for releasing trash/discard fish was the best device tested Shrimp trawl with a reduction of 59%. V10 gave a reduction of 20% and this was way below the set target of 40% and was therefore rejected during the 1st quarter of implementation trials. For commercial fish catches only the V15 gave a reduction of

10%, and this was apparently the reason why fishermen were hesitant in using this device during the trials. H15 and V10 gave an increase of 11% in commercial catches, while V12 gave an increase in 5%. With the fish trawls the reduction in trash/discard catch was more apparent with the V12, V15 and H15 JTEDS with 54%, 58% and 46% respectively. Again V10 with 20% gave reductions below the threshold. Interestingly, the commercial catch indicated a significant increase with the V15 with a 66% higher catch and H15 likewise gave an increase of 18%. Reductions in commercial catches were observed with the V10 and V12 of 23% and 3% respectively.

A large amount of maturity data has been collected for Short bodied mackerel and *nemipterids* species has a good data in terms of maturity. The data collected for Rastrelliger *kanagurta*, locally known in Calbayog or Short bodied mackerel, showed that its longest average length appeared in April with 225mm and its shortest average length in May. Average length was found to be directly proportional to the highest result on average Gonad Weight. The highest Gonado Somatic Index (GSI) was recorded in April with 3.25 and 2.25 Gms, respectively. Mature samples were likewise observed in April, May and July. Mature samples were further observed in October and December. Most of the samples were, however, observed in April, which indicates that summer is the potential spawning season of this species. *Nemipterids,* as it is locally known, in the area had its longest average length in August with 179mm and its shortest average length in May (174mm). With regards to average GSI, December showed the peak with 1.91 followed by September and October with 1.89 and 1.90 respectively. The same trend was seen with regards to average gonad weight. Moreover, the majority of the samples gathered were immature (stages I- III). Significant percentages of fully mature samples were observed throughout the sampling period with December showing the highest number followed by October and July, September and November.

17.2.2 Southeast Asia

Bundit Chokesanguan, SEAFDEC, Thailand, (bundit@seafdec.org)

The demonstrations and experiments on the use of JTEDs were conducted in Thailand, Brunei Darussalam, Vietnam, Malaysia, the Philippines, Indonesia and Myanmar.Aside from the main aim on the introduction of the devices to member countries, the research was also carried out to develop adjust and modify for the best performance of the Juvenile and Trash Excluder Devices (JTEDs). Various kinds of JTEDs were used in the experiment; there is Rigid Sorting Grid, Rectangular shaped window and semicurved window with different grid intervals for each device. The results show that each type and design of JTEDs gave different performance on escapement rate of juvenile and commercial catch. The escapement rate ranged from 56.69–77% for juveniles and 9.72–47.31% for the commercial or target catch. Furthermore the estimated selection curve of fish length was also considered. Based on this experiment the Rigid Sorting Grid with 1.2 and 2 cm grid intervals gave better performance than other devices in maximizing the juvenile escapement while minimizing the loss of commercial or target catch. The mean total length (TL) paralleled to the size of the grid interval. It is recommended that the Rigid Sorting Grid with 1.2 and 2 cm grid intervals is appropriate to recommend to the region. However, other importance factors such as the fishing ground, kind and size of target catch in each country have to be well considered.

17.2.3 Indonesia

Ari Purbatyanto, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, Bogor, Indonesia

Research and engineering appropriate BRDs for developing the eco-friendly trawl net in Indonesia were conducted on fishing ground around Dolak islands waters in Arafura Sea from November 29 to December 9, 2007. The flume tank demonstration was performed at Fishing Technology Laboratory, Department of Fisheries Resources Utilization, Bogor Agricultural University. The objectives of the research were to evaluate technical performance of BRDs (TED super shooter, square mesh window, and fish eye); to collect baseline data on the catch composition of trawl net without BRD; to compare effectiveness of three different types of BRDs tested in reducing the bycatch from a commercial shrimp trawl fishery in Arafura sea in term of changes in catch composition, catch weight and catch value; and to demonstrate the BRDs performance in the laboratory flume tank.

The result of the study showed that the square mesh window and fish eye showed similar good technical performance in comparison with the US-TED. Although the US-TED has low technical performance, it was better than the standard TED, particularly from the view point of material used that give a little bit simple in handling compared to the standard TED. The total of 26 hauls were carried out successfully consisted of 45 species of fish, 2 species of shrimp, and some species of crabs. From those species of fish, 21 species of economic fish was utilized by the fishers. The fish eye has high effectiveness in reducing bycatch up to 13.36%, and then followed by square mesh window (reduced the bycatch up to 5.98%). The US-TED, however, failed to reduce the bycatch (conversely increased the bycatch by 4.66%). All the BRDs used have influenced on the shrimp loss i.e., 21.25% for the fish eye, 22.13% for the square mesh window, and 32.29% for the US-TED.

Flume tank observation from the three different types of BRDs showed a significant technical performance and escaping behaviour of fish. The highest escapement of fish was from square mesh window. Whilst the fish eye and US-TED and fish eye have low escapes. The position of fish eye and exit hole of the US-TED has an effect to the escapement process. The grid angle of 57.1º was suitable for allowing the unwanted animal to escape.

It is recommended that three BRDs can be implemented. Although there are needed further study to increase the effectiveness of the square mesh and fish eye, mainly to decide the appropriate position of those BRDs on the codend for optimum function of the BRDs to reduce the bycatch. Further research need to be conducted in long duration of fishing trials that representing the fishing season.

Keywords: appropriate BRDs, eco-friendly, technical performance, catch composition, effectiveness, bycatch, Arafura Sea.

17.2.4 Iran

A. Mojahedi, Iranian Fisheries Organisation, Deputy for Fishing and Fishing Harbours, Tehran, Iran.

Research activities on Bycatch reduction started in 1992 at Persian Gulf Fisheries Research Centre (Boushehr) and First BRD fabricated in the same year. After these initial measures, square mesh efficiency in Shrimp trawl net was investigated and 100

mm Square mesh window, showed improved results in excluding small fishes. 2 years after the use of SMW was made obligatory in shrimp trawl nets and achieving not ideal results, Iran Fisheries Organization in cooperation with FAO, launched new round of experiments in 1997. Different types of BRD's have been experimented during these trials, such as: RES, NAFTED, Fisheye and cone. Initial outcomes showed that NAFTED is efficient for excluding large aquatics.

Broad range studies performed during years 2000–2001, on bar devices (NAFTED & Grid) and SMW comparison and results pointed out that Grid Type (NORDMOR Grid) is the most efficient one comparing with other devices. Regarding achieving results, during 2006, 100 Grid 8mm devices, have been fabricated and applied for Industrial trawlers.

Regarding this fact that, more than 90% of shrimp capture, harvested by artisanal fishing vessels fleet and graduation adjustment plan for Industrial trawlers which practically will reduce Industrial shrimp trawler numbers, therefore it is necessary to experiment and promote BRD's on artisanal vessels. Then the aim of the project based on excluding juvenile and small fish. All measures in project framework planned to achieve this goal. Net modification is the first option for excluding juvenile and small fish, and further options could be most effective device which will be selected through experiments and advices we receive from international consultants.

17.2.5 Bahrain

Ebrahim A.A. Abdulqader, Bahrain Center for Studies and Research, Kingdom of Bahrain, eabdulqader@bcsr.gov.bh

Among the 29 direct fisheries identified in the Bahrain's waters it believed that shrimp trawling and Spanish mackerel drift gillnetting are responsible for most of the bycatch quantities generated in Bahrain's waters. 315 boats are involved in shrimp trawl fishing; while small boats made up 24% of these boats. The 1999–2000 BRD trials were the only systematic work conducted in Bahrain. The experimental Bycatch Reduction Device (BRD) is composed of an oval-shaped solid grid and 2" radius square mesh (RSM) to exclude at two stages large animals and smaller finfish species respectively. The overall results suggested a 30% reduction in finfish species on a weight basis, while it maintained crab and shrimp catches. BRD experiments revealed that among the 92 finfish species found in the bycatch, 30 finfish species were able to escape from the net and 14 finfish species were unable to escape. This BRD experience indicates that increasing the selectivity of trawl nets is beneficial to the shrimp fishery and maintains the biodiversity of the marine habitat. It also suggests that selectivity is an effective management measure to reduce the fishing intensity on Bahrain's shrimp stocks. Despite the early participation of the Kingdom of Bahrain in this GEF/FAO global program, the benefits obtained are minimal. Several concepts are outlined to form the core of a future national plan for Kingdom of Bahrain under this global program.

17.2.6 Cuba

Luis Font Chávez, Fishery Ministry, Havana, Cuba, jfont@cip.telemar.cu

Constructive characteristics of trawl nets used in tropical shrimp fisheries, present a marked negative effect on benthic populations and bottom species, constituting a threat for conservation of biological diversity and marine environment. Nevertheless and taking into account that the catch of this resource represents an important economic and social source, it is necessary to promote the use of lower impact catch

technologies and that their introduction in the fishery be technical and economically feasible. Results reached up to present in the project have been aimed to the design, construction and test at experimental and commercial level, in Santa Cruz del Sur Fishing Enterprise, of a less harmful fishing technology to environment, being verified important advantages as: to allow an escape of near 25% of bycatch, thus reducing the negative effect on fish populations and specially juvenile stages of Lane snapper (*Lutjanus synagris*) and also increasing the fishing gear selectivity to the catch of Pink shrimp (*Farfantepenaeus notialis*), with no detriment of the present observed levels and consequently an increase in the catch exportable value. At the same time, regulatory measures on the fishery have been dictated which substantially contribute to the protection of shrimp populations and species composing bycatch. Other foreseen results are related to the reduction of net constructive costs and fuel consumption. Project execution has been characterized by the active participation of managers, technical personnel of the Enterprise, as well as captains and fishermen of shrimp vessels, who have contributed with valuable experiences and practical execution in the project development by participating in cruises, conferences, workshops and advanced qualifying courses for the personnel dedicated to net construction. The new fishing system will be introduced in Santa Cruz del Sur Fishing Enterprise at the end of ban of 2008–2009 seasons.

17.2.7 Trinidad and Tobago

Suzuette Soomai, Fisheries Division, Ministry of Agriculture, Land and Marine Resources, soomaisue@yahoo.com

Three periods of gear trials were conducted over 2006 and 2007 in the artisanal fleet and one period in 2007 in the semi-industrial and industrial fleets, overall covering an estimated 25% of the national trawl fleet. Gear trials involved modifying the existing trawl net, testing of two bycatch reduction devices (BRDs) namely the fisheye and square mesh panel, and testing of a new monofilament trawl net received from Mexico and aimed at reducing the level of discards of bycatch caught in the artisanal shrimp trawl fishery. Overall results are insufficient to determine the effectiveness of each BRD in reducing discards. Modifications to the existing net and the new monofilament net however showed favourable results with regard to making fishing operations more efficient. Joint gear testing between the Fisheries Department and the fishing industry has been beneficial in educating fishers and promoting co-management of the trawl fishery. Technical assistance from the National Fisheries Institute of Mexico and from the FAO was instrumental in technology transfer and enhancing fisheries research in Trinidad and Tobago. Gear testing allowed for collaboration with Venezuela on joint research in the Gulf of Paria and the Columbus Channel where the shrimp and groundfish resources are shared.

17.2.8 Venezula

Luís Marcano and José Alió, (lmarcano@inia.gob.ve ; jalio@inia.gob.ve

Discarded by catch of the industrial shrimp fleet in Venezuela is about 60% and is considered a major environmental impact in the country. Tests were conducted to reduce discards in the industrial and artisanal shrimp fleets. The industrial shrimp fishing is performed by 260 Florida type vessels, targeting shrimp and fish. The use of TED is mandatory. Testing of bycatch reductions devices (BRD) like fish eye showed a significant reduction in discards but also severe losses of commercial catch. The square mesh panel did not provide significant reductions of discards. The lower or lifted lower rope rendered an average 25% reduction in discards and no significant

loss of commercial catch. The artisanal shrimp fishing is done with small trawls and beach seines. The former was modified with Nordmore grid, square panel and fish eye. Better results were obtained with the fish eye, which showed a reduction in discards close to 70%, but a 30% shrimp loss was confronted. Tests of BRDs will continue after FAOGEF project ends in 2008, organizing workshops with fishers to show construction and use of the devices, and sharing of results with researchers and fishers of countries in the region is to be promoted.

17.2.9 Mexico

Dr Miguel Angel Cisneros Mata, Chief Director, Instituto Nacional de Pesca

PACIFIC COAST

A 10 day's cruise onboard commercial vessel at the west coast of Baja California Peninsula face operations problems since there was a huge presence of a crustacean known as "langostilla" (Pleuroncondes planipes); trawls sets were rather short and non representative in all shrimp fishing ground areas.

Due to engine brake-down of BIP XI, an 8 days cruise for sea trials in the Upper Gulf of California was made; results confirmed advantages of prototype RS-INP-MEX, in previous trials. Comparison of bycatch reduction and catch efficiency of prototype was possible since a set of traditional trawl nets were tested; all expenses were covered by the Walton Foundation through WWF.

ATLANTIC COAST

Arrangements were made to use commercial trawlers for testing of new net designs and the introduction of BRDs at Tampico, Tamaulipas and Ciudad del Carmen, Campeche. Since the fleet composition and technical characteristic of trawl nets has changed, a survey was carried out in those two ports, for data collection of 30 shrimp trawlers.

Two meetings were held with vessel owners from the Atlantic coast, where the stockholders asked to include testing of new otter boards (High Lift) used in the Pacific phase of the project, in order to achieve further fuel savings.

Due to lack of researchers it was decided that all sea trials were going to have place during the shrimp ban of the Atlantic; cost of testing/fishing operations will be cover by the stockholders, except DSA payment of researchers and new gear and devices.

Research for artisanal shrimp fisheries have started in the Upper Gulf of California in order to reduce the impact of enmeshing shrimp nets on endemic endangered porpoise (*Vaquita*); also, due to mixed presence of juvenile white shrimp (*Litopenaeus setiferus*) while trawling for REBYC

Reduction of Environmental Impact from Tropical Shrimp Trawling, through the introduction of Bycatch Reduction Technologies and Change of Management Sietebarbas shrimp (*Xiphopenaeus kroyeri*), a new project will start in 2008 in the Atlantic coast, to introduce a new trawl net with short front upper panel or no front upper panel.

17.2.10 Columbia

Mario Rueda & Farit Rico, Instituto de Investigaciones Marinas y Costeras (Invemar), mrueda@invmar.org.co

Quantification of tropical shrimp trawling impacts and mechanics to reduce it on both on Caribbean and Pacific coasts were evaluated. The methodological approach

included census of the fishing technology, monitoring, workshops, trials and fishing experiments. The census revealed that vessels and net designs are more than 30 years old. Monitoring of fishing operations showed the following catch composition: shrimp 8%, incidental catch 27% and discards 65% for the Caribbean; while for the Pacific shrimp is 5%, incidental catch is 43% and discards is 52%. With this in mind new trawl nets were designed, introducing new netting materials and BRDs (fisheye and TED). 12 Trawl nets prototype were manufactured during 2 workshops, where 60 fishers were trained in fishing trials. These trawl nets were used in fishing experiments comparing catches of an experimental vessel (using prototype nets) with those of a control vessel (using traditional nets) to test reduction of bycatch and fuel consumption if possible. For the Caribbean 80 hauls paired showed that the bycatch was reduced as follows 20% (fisheye), 41% (TED), 54 (fisheye + TED); while for the Pacific 240 hauls showed reductions of 28% (fisheye), 23% (TED) and 57% (fisheye + TED). In the Caribbean the fuel saved was 17%, whereas on the Pacific the save was 25%. Current decrease of the shrimps stocks and high fuel prices, are part of the issues that the fishery management agency in Colombia faces to change of management.

17.2.11 Costa Rica

Antonio Porras Porras, INCOPESCA, porrasantonio1@yahoo.com

Costa Rica is localized in Central American. In Costa Rica, the project concerns Pacific waters. This area has all shrimp trawling fishery, but which are currently severely threatened by over fishing, contamination and global environment effects. The project is under the supervision of the Costa Rican Institute of Fisheries and Aquaculture, INCOPESCA. The semi-industrial sub sector has 72 registered shrimp trawlers vessels (49 operating) based in Puntarenas. These vessels are shrimp trawlers with large quantities of juveniles. Bycatch and trash fish constitute mostly 70% of the products caught.

Sea trips were organized from June 2007 to March 2008 and were undertaken on board of the commercial vessel "Cap. Yerald". This vessel reduced the expenses in the research phase (in kind contribution of the private sector). The trawler used two nets while fishing. This practice permitted a comparative study between the prototype net, the traditional net, and tested BRD's. The Square mesh window and the eye fish inside of the codend.

Eleven fishing trips were carried out and included fifty four tows, each of this trawling were of five of six hours long. However, in a preliminary way, we obtained at least a 20% reduction of bycatch and the conclusion that for each kilogram of shrimp, seventy kilogram of bycatch are fished.

The National coordinator participated on two training/demonstration activities organized in Cuba and Mexico (Demonstrations/Sea-Trials on fisheye BRDs and Suripera net used). Two training workshops on BRDs and Prototypes net were organized and some fishermen and net makers were trained on how to build the nets. A practical training was also organized on board of a commercial vessel in Puntarenas. Two kinds of BRDs, the Square mesh window codend and the fisheye were tested and compared with a traditional codend. Three workshops on REBYC and Costa Rican Project result were organized in El Salvador, Nicaragua and Panama countries in April, 2008. Sixty five participants were in these workshops (three day for each one) and to fishers, stakeholders, technicians, and governmental authorities were preparation.

17.2.12 Nigeria

James Ogboona, Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos, jamescogbonna@yahoo.com)

Nigeria is one of the participating countries involved in GEF/UNEP/FAO Shrimp Fisheries Project titled: 'Reduction of Environmental impact from Tropical Shrimp Trawling through the introduction of Bycatch Reduction Technologies and change of management'. The main objective is the reduction of bycatch in shrimp fisheries.

Nigerian Institute for Oceanography and Marine Research, (NIOMR) Lagos is currently implementing 2 complementary research activities in the Eastern Gulf of Guinea sub region of West Africa on the following:

a) The development/adaptation of appropriate bycatch reduction technologies for the shrimp trawlers in Nigeria and Cameroon. This technical part of the project involved the construction of prototype Bycatch Reduction Devices (BRDs) and Turtle Excluder Device (TED) for fleet testing on board conventional shrimp vessels in Nigeria and Cameroon. The awareness created has extended to other States in the sub region including Togo Republic, Republic of Benin, Gabon, Sao Tome & Principe and Equatorial Guinea.

b) The design and conduct of a socio-economic survey of the shrimp trawl fisheries and the trading of their bycatch

The technical development/adaptation of reduction technologies Turtle Excluder Devices (TEDs) are installed in the codend extension of shrimp trawl nets as a management tool to reduce fishery related sea turtle mortality. Trawl nets with bycatch reduction devices (BRDs) are also constructed in order to mitigate the problem of juvenile and immature fish bycatch in shrimp trawling. The combinations of TED and BRD in the same trawl net are expected to function perfectly well and complement each other without any drastic reduction in the quantity of shrimps. The data recorded during comparative demonstration trials of trawl nets fitted with TED, BRD codends and the traditional square mesh codend, are shown in Table 1. As shown in Table 2 the results of analysis of variance (ANOVA) indicated that there was no significant variation in the mean values of shrimps caught by the various trawl net codends.

17.2.13 Cameroon

Oumarou Njifonjou, IRAD-SRHOL PMB, Cameroon, (Njifonjo@caramail.com)

In Africa, the project concerns Nigeria and Cameroon waters. This area has vast fisheries resources, which are critical to the food security of the region, but which are currently severely threatened by over fishing, urban runoff and offshore petroleum exploitation. The project is under the supervision of the Fisheries Department and is implemented in Cameroon by the Fisheries and Oceanography Research Station (SRHOL). The Artisanal shrimp fisheries utilizes more than 1000 fishermen and for the moment the Industrial sub sector has 41 registered shrimp trawlers from Nigeria and 30 based in Douala. Most of these vessels are shrimp trawlers with small mesh sizes and this inevitably results in large quantities of juveniles. Bycatch and trash fish constitute mostly 95% of the products caught and 75% of the finfish landed are juveniles caught before first maturity. The increase of the shrimp fishing effort over the years, the high level of fish caught by shrimp trawlers, the continue reduction of the

sizes of fish landed, the high price of fish on the markets and the political will to conserve and sustain the fisheries resources are the main motivation for the establishment of bycatch reduction legislation/regulations. In the new fisheries Law to be promulgated, BRDs and TEDs utilization has been introduced as one of the basic requirements for the license application.

17.3 List of Participants

Andres Seefoo	INAPESCA	Mexico
Antonio Porras	IFA	Costa Rica
Bundit Chokesanguan	SEAFDEC	Thailand
Frank Chopin	FAO	Italy
James C. Ogbonna	Fisheries Dept	Nigeria
Janne Fogelgren	FAO	Italy
Jonathan Dickson	BFAR	Phillipines
Jose Alio	INIA	Venezuela
Luis Marcano	INIA	Venezuela
Mario Rueda	INVMAR	Columbia
Oumarue Njifonjou	IRAD/SHOL	Cameroon

17.4 Conclusions

In 2008, REBYC I will come to an end. Significant progress has been made towards reducing the bycatch of large charismatic species such as marine turtles captured by tropical shrimp trawls, however, significant problems remain with respect to the capture of juvenile fish and sustainable management of tropical mixed species bottom trawl fisheries.

It is the hope of FAO and the NCs that a second phase project will be implemented and broadened to a greater number of countries and incorporating a broader range of management tools to manage multi species trawl fisheries. This approach is echoed by the EC in European Parliament Resolution P6_TA-PROV (2008) 0034 on "Reduction in unwanted bycatch and elimination of discards in European Fisheries". Given then there are other concerns with bottom trawls that also need to be addressed, perhaps there is the opportunity for an International Plan of Action.

Discussion

Questions were raised as to why fishermen continue to use BRDs if they are losing income. A number of the FAO representatives replied to this. In the case of Nigeria there had been a certain amount of embarrassment at government level with the high level of bycatch, so they made the use of BRDs and TEDs are compulsory but introduced a fuel subsidise to incentives compliance. In Mexico there are no economic gains in landing bycatch and there are incentives such as reduced fuel consumption, improved catch quality and saving sorting time so using the devices is acceptable to fishermen. In the Philippine although there is are some financial gains from landing bycatch species, financial support from fishing companies has encouraged fishers to use BRDs.

The analogy of US imposing trade embargoes on countries whose fleets did not use TEDs in shrimp fisheries was used to indicate how economic drivers are a strong incentive to adopt selective gears. It was stated that a similar policy may be applied by the US in the near future with the use of circle hooks being made mandatory in surface longline fisheries for tuna and swordfish fisheries.

18 Summary of Other Presentations

An open session was held on Tuesday 22 April at which the following presentations were given to plenary.

18.1 Nordic Project; Research in big mesh pelagic trawls

Frodi B. Skúvadal

Faroese Fisheries Laboratory, Noatun 1, P O Box 3051, Tórshavn, Faroe Islands

Abstract

A Nordic project involving the Faroe Islands, Iceland and Norway researching pelagic trawling is being undertaken with funding from the Nordic Council. The focus areas of this project are optimization of large mesh pelagic trawl designs, with regards to water flow and fish behaviour, minimizing bycatch of non target species and the use of pelagic trawls for demersal species. The pelagic fisheries in these countries are similar with regards to fishing units, gear and fished stocks. The form of the collaboration is through workshops, participation on cruises and collaborative meetings.

Measurements of flow have been made with ADCPs (Acoustic Doppler Current Profilers) that measure speed and direction of the flow in a profile inside the trawl. The methodology is to use one ADCP on the headline and one in the belly section, close to the codend. Collections of escapees have been carried out by means of small mesh collection bags attached to the aft belly of the trawls. Observations of fish behaviour have been made with acoustic and optical devices.

Preliminary Faroese results from flow measurements inside large mesh pelagic trawls suggest that there is a reduction of two thirds in velocity in front of the codend compared with the velocity at the headline. These measurements were made in a 2300 m pelagic trawl with a 70 m long codend. Results indicate that the size of the codend has a reducing effect on the water velocity in front of the codend. Further flow measurements and behaviour observations of fish inside the aft belly of pelagic trawls will be made in 2008 and 2009.

Discussion

It was pointed that the Dutch had conducted experiments with similar measurements and found that T90 releases more water than standard diamond mesh. It was also explained that there is a need to be careful when interpreting the results from other referenced studies on flow changes around trawls as most of them were conducted in much smaller gears which may not be representative.

18.2 Direct observations of large mesh capelin trawls; evaluation of mesh escapement and gear efficiency

Haraldur Arnar Einarsson, Einar Hreinsson, Sigurður Þór Jónsson,

MRI-Iceland

Abstract

This paper describes methods for observing large pelagic capelin (*Mallotus villosus*, Müller) trawls, evaluation of meshing and mesh escape, *in situ* school density and catching efficiency. Gear monitoring sensors were used to measure gear opening pa-

rameters and vertical position. Information on trawl geometry was collected with a headline sonar, sonar and cameras mounted on a remotely operated towed vehicle (ROTV), and data from depth recording sensors. The cross section area for each net section was used to calculate the volume of seawater filtered by each mesh size. Capelin behaviour was observed by the use of underwater cameras, HL-sonar, and ROTV mounted sonar. Acoustic data were collected with a calibrated 38-kHz echo sounder to evaluate mean volume density of capelin in number of fish per cubic metre. The observations provided valuable information's of the gear shape and performance. Capelin showed strong reaction to artificial light, by swimming downwards few seconds after the lights were turned on. Capelin was seen escaping mesh sizes from 80 mm to 16 m. Meshing was recorded in 80 to 800 mm meshes, highest in the 80–160 mm range. Sonar images showed both escaping capelin and capelin being herded in mesh sizes from 16m down to 200 mm. No escapement was recorded through meshes 60 mm and smaller. Measurements of trawl geometry, capelin density, and catch volumes, indicate low catching efficiency. A theoretical model for quantitative estimates of the efficiency, based on cross section density measurements, and a practical methodology for acquiring such density measurements are described in the paper.

18.3 Design and test of a topless shrimp trawl to reduce pelagic fish bycatch in the Gulf of Maine pink shrimp fishery

Pingguo He[1], David Goethel[2] and Tracey Smith[1]

[1] Ocean Process Analysis Laboratory of Institute for the Study of Earth, Oceans and Space and New Hampshire Sea Grant, University of New Hampshire, 142 Morse Hall, Durham, NH 03824, USA. Email: pingguo.he@unh.edu. [2]. F/V "Ellen Diane", 23 Ridgeview Terrace, Hampton, NH, USA 03842

Abstract

A new innovative shrimp trawl was designed, and tested in the flume tank, and at sea to evaluate its potential of reducing finfish bycatch in the pink shrimp fishery in the Gulf of Maine. The trawl design removed the square and the top part of the section after the square (first belly section), to become "topless". A five-day sea trial was carried out using the alternative tow method to compare the new topless net and a control net (commercial net). The target species was the pink shrimp (*Pandalus borealis*) and the major bycatch species was Atlantic herring (*Clupea harengus*) (90.6% of all bycatch by weight). Comparative fishing indicated that the new topless net reduced bycatch of Atlantic herring by an average of 86.6%, and at the same time produced a modest increase (13.5%) in the catch of the pink shrimp. There was some increase in the bycatch of flounders (American plaice, *Hippoglossoides platessoides*, and winter flounder, *Pseudopleuronectes americanus*), though overall amount of flounder bycatch was less than 1% of the total catch. The reduction of herring was most likely due to the fish escaping over the headline where the top panel was removed. The increased bycatch of flounders (and increased catch of shrimp) might have been resulted from a wider wing end spread and subtle differences in the footgear between the new and control nets. The substantial reduction of the major bycatch species (herring) without a reduction of target species (shrimp) proved the concept of the topless shrimp trawl and may have a profound impact on other shrimp trawl fisheries around the world.

Discussion

The author was asked if diurnal effects were taken into account but as essentially this is a daylight fishery, the experiments were conducted accordingly during daylight hours so diurnal effects were not an issue. It was also stated that the shrimp rise during the night. The question was also raised if there was difference in fuel consumption with the new design. This was not specifically measured but drag of the new gear was similar at the same towing speed to the conventional gear.

18.4 FISHSELECT - a tool for predicting basic selective properties for netting

Bent Herrmann, Ludvig A. Krag, Rikke P. Frandsen, Niels Madsen, Bo Lundgren

DTU Aqua, Technical University of Denmark

Abstract

In towed fishing gears like trawls, technical regulations aim at retaining marketable fish and releasing non-marketable fish. Different species have different morphological characteristics such as cross-section shape and their potential for deformation during mesh penetration. Identifying the optimal mesh size and mesh shape is therefore a complex procedure depending both on the species morphology and the defined minimum landing sizes (MLS). We present a new methodology, FISHSELECT, developed to make a first prediction of the basic selective properties of different netting panels. By applying the methodology and the specially developed tools, we identify and record the species specific morphological features that are decisive for mesh penetration. Data on these features are processed in an integrated software tool to produce design guides for different netting panels. The design guides provide a powerful tool that facilitates the predictions of optimal netting designs for a given fishery. Examples on application of FISHSELECT are presented for Cod, Haddock, Plaice, Turbot, Lemon Sole, Sole and *Nephrops.*

Discussion

The question was raised whether the model takes into account rigor-mortis effects in the "Fall Through" experiments. The author replied that this affect was expected to be significant and so fresh, very recently killed fish were used for this reason.

Regarding seasonal variations in morphology for given lengths of fish, this was not studied fully but will be taken into account in future work. However, the experience with cod at pre spawning stage in January did not show much difference as the compressed morphology for this species did not change much.

It was highlighted that simulations made in the study confirm that for round fish using square mesh is the optimum way to reduce the variation in selectivity by maintaining a relatively constant mesh shape but for flat fish L_{50} is reduced in square mesh codends.

18.5 Technical and selective properties of T90 meshes codend-extension tandems made of different netting stiffness

W. Moderhak,

Sea Fisheries Institute, 81–332 Gdynia, ul. Kollataja 1, Poland

Abstract

Four T90 codend-extension combinations were investigated on the Polish research vessel BALTICA in years 2006 and 2007. The study showed that the construction of the extension influenced the selectivity of the codend even if the codend has the same construction each time. The results obtained during the study show that the best solution is when the codend and the extension are made of the same netting, or when the extension is made of stiffer netting than the codend. Studies in this subject should be continued.

Discussion

The question was raised if catch quantities in the codend as taken into consideration in the experiments. The author replied that the catch was stimulated by drag for which the corresponding catch amount was unknown. A previous study by O'Neill et al (2004) was referred to which attempted to measure the drag forces acting on codends.

18.6 Fuel Saving Initiatives in the French Fishing Industry

Benoit Vincent,

IFREMER, Lorient, France

Abstract

The Fishing Gear Technology unit of IFREMER has been working on energy savings for some years. We present different applications, particularly collaboration with tropical shrimp Malagasy fishing companies and collaboration with regional fishing companies. The work is based on an optimization of the trawl and doors, using flume tank trials and numerical simulation. The method used is detailed as well as typical results and potential savings. The importance of the communication and exchange with fishermen and net makers are also underlined.

Discussion

The question was raised as to whether with the low drag gear whether there was difference in catch efficiency. The author replied that there was not in Madagascar but in the shrimp fisheries, fishers preferred to use smaller meshes in the rear part of the net. It was felt that the low drag nets may not always work in certain conditions such as high current or bad weather. Therefore, there is need for them to be tested in a variety of conditions before suggesting to the industry for commercial uptake.

18.7 Modelling flow through and around nets using computational fluid dynamics

Øystein Patursson

Abstract

Computational fluid dynamics (CFD) modelling and measurements have been used to investigate current flow through and around net panels and fish farming cages. For the numerical computations a porous media model was used to represent the net allowing efficient computation of both exterior and interior flow fields. The model was calibrated using tow tank measurements on a net panel at different velocities and angles of attack. The CFD method was able to reproduce the drag and lift coefficients of the net panel and the velocity reduction behind the net panel with satisfactory accuracy.

The approach was validated for a small size gravity cage by comparing CFD predictions with tow tank measurements of drag force on the cage and velocity reduction inside the cage and in the wake region. The validation process showed very good agreement between measured and modelled velocities inside the cage and a slight discrepancy in the wake region.

The same approach should be applicable to trawls as well, but a new study is needed for the calibration and validation of the model to different types of net and the new geometry.

Discussion

It was highlighted that for the trawl simulations there is a need to find a new system without using fixed frames. It was pointed that rigid net elements may be a solution and work done in East Germany and at the University of Arnhem using a lattice grid arrangement were referred too.

18.8 Comparison of selective properties for nettings when used in normal direction versus in 90 degrees turned direction (Poster)

Bent Herrmann, Ludvig Krag, Niels Madsen

DTU Aqua, Technical University of Denmark

Abstract

Experimental studies have indicated that the size selective properties of normal (T0) diamond mesh nettings used for trawl codends can be improved by turning the netting orientation 90 degrees (T90). The potential effect of T90 has also been investigated by simulation techniques. A T90 codend has been introduced in the Baltic cod fishery as a legal alternative to the BACOMA codend. But how big is the T90 effect and how dependent is this effect on the varying loading acting on the netting throughout the fishing process? How dependent is this effect on the netting characteristics like mesh size and twine thickness? We apply the FISHSELECT and NETVISION methodologies in a pilot study to demonstrate how the T90 effect can be investigated and quantified. Initial results for a few netting designs are reported to demonstrate the applicability of the used methods.

NETVISION is a method to acquire and describe shapes of meshes in trawl nettings when these are loaded in directions T0 and T90. NETVISION uses image analysis

techniques to collect the mesh shapes data in a netting panel. The extracted mesh shapes are loaded into FISHSELECT to predict and compare estimates for L50. FISHSELECT and NETVISION can handle parametric as well as non-parametric mesh descriptions. By combining NETVISION and FISHSELECT we quantify the difference between T0 and T90 netting for different loading situations and estimate the *T90-EFFECT* based on the ratio between the estimated L50 values. If the T90 orientation has a higher L50 value than the T0 orientation then the T90-EFFECT is larger than 1.0 for that specific loading situation. This is exemplified for cod based on FISHSELECT-data. We used four pieces of netting with quite different characteristics with respect to the ratio between twine thickness and mesh size and investigated the influence of these design parameters on the T90-EFFECT. Based on realistic estimates of the drag forces acting on codends when towed we investigated four different loading conditions.

The shapes of meshes in four different nettings under different loading conditions are shown. The T90-EFFECT is quantified in each case. The results imply that the T90-EFFECT is dependent on the loading condition and is affected by the netting characteristics. For a net with a relatively large mesh size compared to the twine thickness a relatively small load will close the meshes in both netting orientation (T0 & T90). The opening of a fully stretched T90-mesh is defined by the size of the knot which is small for netting 1 due to the thin twine. A larger T90-EFFECT is found for nettings 3 and 4 where the mesh size is relatively small compared to the twine thickness. This will increase the mesh resistance against closure for the T90-orientation thus requiring a larger load. The thicker twine results in a larger knot size thus improving the shape of the fully stretched mesh in the T90-orientation. Results for netting 2 are between those found for netting 1 and for netting 3–4.

This pilot study demonstrates the potential of using FISHSELECT and NETVISION to investigate and quantify the selective properties for nettings under varying loading conditions. The preliminary results imply that:

- The T90-orientation can improve the size selection for cod compared to the T0-orientation.
- The T90-EFFECT is very depending on the loading condition acting on the netting and on the characteristics of the netting (mesh size and twine thickness).

We recommend that the combination of NETVISION and FISHSELECT is integrated into future studies dealing with technical regulations of towed gear because:

- Together the methods can be used to quantify and compare the size selective potential of different netting including those legally used today.
- Together the methods can be used to improve the understanding of the influence of the netting characteristic on the selection process and thereby contribute to a use of more optimal netting designs in towed fishing gear.

18.9 Simulation-based study of precision and accuracy for methods to assess size selective properties of codends (Poster)

Bent Herrmann,

DTU Aqua, Technical University of Denmark

Abstract

Two different methods, the covered codend and the paired gear method, are often used to experimentally assess the size selective properties of different gear designs. But how efficient are these methods compared to each other? Especially how many fish is it necessary to catch and measure to obtain results with a given precision with the two methods? Do the results tend to be biased or not when the number of fish included in the assessment is decreased? This is investigated for a single scenario using a simulation-based approach.

A special facility in the FISHSELECT software tool enables production of virtual retention data of a similar structure as would be obtained in an experimental fishing process using a twin trawl design where the test codend also has a small mesh size cover codend. For each length class the number of fish in three different compartments: test codend, cover codend and control codend was obtained. To estimate the size-selective properties of the test codend two different methods were applied: covered codend (using data in test and cover) and paired gear (using data in test and control). Data for single hauls were analyzed according to the procedures described in ICES report 215. First a baseline haul containing 10000 fish was simulated containing more than 250 fish in each length class thus minimizing binomial effects that dominates when length classes only contain a small number of fish each as would be the case with very limited catch or heavy subsampling. With the FISHSELECT software tool the baseline haul was used to produce subsamples from each compartment. For each subsample rate 500 repeated samples were drawn from the full sample. The simulations were performed for cod in a 100 mm mesh size diamond mesh codend to produce realistic selection results. 2 x sd was applied to estimate the 95% confidence bands for L50 and SR. Equal fraction subsampling was performed, that is, sub. rate 90% means that 10% (100 - 90) of the fish in the test, cover and control were each randomly selected and included in the estimation of L50 and SR in the individual "hauls".

Because the obtained results are only based on one simulation scenario results can be different for other scenarios. Definitive conclusions will require a more comprehensive study to be carried out. Likewise uncertainties in the relative sampling rates between cover and test are not included. But the following observations can be made:

- To obtain the same precision for L50 and SR the covered codend method requires much fewer fish to be caught and measured than the paired method.
- The covered method produces unbiased mean results for L50, while mean SR tends to be biased slightly downwards for small amounts of fish.
- For the paired method mean SR tends to be increasingly biased downwards when estimates are based on fewer fish.
- The P-value alone is a poor indicator for the quality of the estimates of L50 and SR since it (as expected) tends to increase as the data gets weaker (estimates based on fewer fish). Contrary does the R2-value tends to decrease as data gets weaker.

19 National Reports

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

19.1 Belgium

Institute for Agricultural and Fisheries Research

EU-project: "Development of fishing Gears with Reduced Effects on the Environment" (DEGREE) (Contract SSP8-CT-2004–022576)

This projects aims at the investigation of ways of reducing the environmental impact of beam trawl fisheries (reduction of discards of non-commercial fish and invertebrate species and undersized commercial fish species) and the possible solutions to technical drawbacks for voluntary implementation in the Belgian beam trawl fleet.

Contact : Jochen Depestele (Jochen.depestele@ilvo.vlaanderen.be)

FIOV-project: "Alternative beam trawl"

This projects aims at the investigation of reducing the environmental impact of beam trawl fisheries (reduction of discards of non-commercial fish and invertebrate species and undersized commercial fish species) and reduction of fuel consumption. Several technical modifications are combined in the beam trawl such as a benthos release panel, more selective codends, large meshes in the top panel, lighter chains and roller gear. A voluntary experimental phase and a voluntary uptake by the industry is envisaged. Already an industry working group has been established with trials on board commercial vessels. Contact: Hans Polet (hans.polet@ilvo.vlaanderen.be)

National project: "Evaluation of the ecosystem effects of Trammel net and Beam trawl fisheries at the Belgian Continental Shelf" (WAKO) [Work package within the project "Innovation Centre Sustainable and Ecological Fisheries" (project° VIS/02/B/05/DIV)]

This project aims at the investigation of the ecosystem effects of trammel net fisheries for sole and beam trawl fisheries for flatfish at the Belgian Continental Shelf. Existing data from several Belgian institutes and a literature review have been conducted to investigate the possibilities for an integrated evaluation of fishing impacts of different fishing methods. Three ecosystem components were under consideration: benthic invertebrates, seabirds and marine mammals. Contact: Jochen Depestele (Jochen.depestele@ilvo.vlaanderen.be)

National Project "Trammel- and gill net fishing, traps and pots" (project° VIS/07/B/01/DIV)

This project aims at the testing of various static gear, traps and pots in order to determine the possibilities of multi-purpose, alternative fishing methods. The fishermen need to be able to diversify throughout the year to target various species at optimum times of the year. Protecting spawning periods, reduction of bycatch and selectivity are important. By means of a broad range of various static gears, fisherman will be able to be flexible for the whole year and change fisheries depending on market demand. By means of exploring these fishing methods, we can offer an alternative for beam trawl fishing and attract new investors, which is essential for the basis of a whole new versatile and profitable fishing fleet.

Additional funding for five years has been requested to extend this project and have sought other external partners regarding further development. Contact: Dirk Verhaeghe (dirk.verhaeghe@ilvo.vlaanderen.be).

Project alternative fisheries (projectn°VIS/02/B/07/DIVb)

Contact : Kris Van Craeynest (kris.vancraeynest@ilvo.vlaanderen.be).

National Project: "The impact of fishing gear on fish quality" (traditional versus alternative beam trawl) – (project° VIS/07/B/02/DIV)

This project aims to verify if sole and whiting caught with an alternative beam trawl (at least equipped with a T-90 net or benthos release panel) are of a better quality than these caught with a conventional beam trawl. The basis of comparing will be the "Quality Index method", PH- and Total volatile base analysis and the "Injury Index Method" under development.

There is a growing opposition against beam trawl fishing so every bit of upgrading and improvement of this fishing method needs to be verified before switching over to alternative methods. The consumer market is demanding improved fish quality linked to sustainable fisheries where upgrading efforts have been already carried out.

Additional funding for five years has been requested to extend this project and have sought other external partners regarding further development. Contact: Dirk Verhaeghe (dirk.verhaeghe@ilvo.vlaanderen.be).

National Project: "Development and demonstration of a species-selective electro-shrimp trawl for the brown shrimp fishery with the focus on the reduction of discards and the environmental impact" ["PULSKOR" (project number VIS/05JE/01/DIV)]

The discarding practices associated with the brown shrimp fishery have been regarded as a problem for many years. The poor selectivity of the small mesh nets used produces very high amounts of unwanted bycatch. Consequently the implementation of adequate selectivity enhancing measures should result in both ecological and commercial improvements.

This national project was set up to investigate the potential of electric pulses as a means to develop a species-selective electro-shrimp trawl. This new type of fishing gear focuses on the reduction of unwanted bycatch, the reduction/elimination of bottom contact and the improvement of catch-quality.

Contact: Bart Verschueren (bart.verschueren@ilvo.vlaanderen.be)

National Project: Evaluation of climate change impacts and adaptation responses for marine activities (CLIMAR)

The North Sea Ecosystem is characterized by *high productivity* and highly diversified habitats but also by an *intensive use*. As a consequence the *vulnerability* of the ecological, social and economic community formed by the North Sea is high (in terms of risk on damage) for climate change. This calls for a sustainable approach when addressing climate change issues in our North Sea.

Research and modelling will be carried out to differentiate the *primary impacts* of climate change from the natural evolution at the North Sea scale. These primary impacts include sea level rise, increased storminess, possible increased rainfall, erosion, temperature changes, salinity, etc. Then *secondary impacts* of climate change both on the ecological system of the North Sea as well as on social-economic activities will be assessed. Two *extensive case-studies* (coastal flooding, fisheries sector) have high ex-

trapolation potential towards the global North Sea environment. Adaptive measures will be formulated both for the ecosystem as well as for the other marine activities. Based on in-depth application for the two above mentioned case-studies, an evaluation tool will be developed to assess the impact of these measures according to the principles of sustainable development. Using parallel integrated assessment and *policy & legal evaluation*, recommendations will be formulated towards North Sea future policy. ILVO-Fisheries will be responsible for the development of the impacts of climate changes on the fisheries sector, the development/evaluation/extrapolation of different scenario↕s and adaptation measures for the Belgian fleet, and the formulation of a series of recommendations.

Contact: Els Vanderperren (els.vanderperren@ilvo.vlaanderen.be)

National Project:"Outrigger II"

The ILVO-institute was asked by the "Belgian foundation for sustainable fishery development" to analyse and study the outrigger fishing method as a feasible and economical alternative for the beam trawl fishery.

Although the results of the "Outrigger I" project were very promising, it should be taken into account that the fishing method by means of otter boards is quite complex with respect to rigging and preparation involved and demands quite a lot of expertise from the skipper and crew in order to be made profitable.

In order to inform the Belgian beam trawl fleet accordingly about the "outrigger-system" and to offer the possibility to switch over to this gear either depending, a follow-up project "Outrigger II- introducing outrigging with otter boards fishing in the beam trawl fleet with the main objective to reduce fuel consumption".

Contact: Els Vanderperren (els.vanderperren@ilvo.vlaanderen.be)

19.2 Canada

Fisheries and Marine Institute of Memorial University of Newfoundland

Longlining through the Ice:

Winter longlining for Greenland halibut (turbot) is continuing in the Baffin Island Region of the Canadian Arctic. Gear developments and operational techniques are being refined and taught to the Inuit. Catch rates are now commercially viable but developments in handling, processing, and export are still ongoing.

Contact: Philip Walsh (Philip.Walsh@mi.mun.ca).

Low Profile Trawl for Northern Shrimp:

Earlier results using a multi-level trawl revealed strong variation in the vertical density distribution of shrimp in the mouth of conventional trawls used in Newfoundland and Labrador waters. The results lead to the subsequent design and flume tank testing of new low-profile wide-opening trawl designs for both the inshore and offshore fleets. A full-scale prototype has been constructed for the inshore region and will be tested this summer.

Contact: Harold DeLouche (Harold.DeLouche@mi.mun.ca).

Seabed Friendly Shrimp Trawls:

Design and testing is currently underway on several modifications for offshore shrimp trawls to reduce their downward footprint on the seabed. Several models are being tested in the flume tank and sea trials are expected later this year.

Contact: Harold DeLouche (Harold.DeLouche@mi.mun.ca).

Cod potting:

Thirty pots were given to 6 harvesters to use during their commercial operations in 2007. These harvesters fished from Sept to Nov with as much as 4050 lbs harvested in nine pots. On November 23, 2007 a demonstration was held in Petley, Newfoundland where individuals could come and look at pots during fishing operations. Government groups, fishing company representatives and harvesters attended. Pots will remain with harvesters for the 2008 season with continued demonstrations. A professionally produced promotional video is currently in development.

Contact: Philip Walsh (Philip.Walsh@mi.mun.ca).

Escape Mechanisms in Snow Crab Traps:

Based on the results of earlier experiments, escape mechanisms were introduced into the commercial snow crab fishery on an experimental basis in 2005, 2006, and 2007. Catch data continues to show that installing mechanisms around the bottom of the trap results in reduced numbers of under-sized crab being caught and discarded. The program has been expanded and a total of 36 harvesters in 25 communities will evaluate during the 2008 season. A professionally produced promotional video is currently in development.

Contact: Paul Winger (Paul.Winger@mi.mun.ca).

Plastic Barriers in Snow Crab Traps:

The objective of this study was to examine the feasibility of using plastic barriers (i.e., collars) to reduce the incidental capture of white snow crab in the summer commercial fishery in Crab Fishing Area (CFA) 19 located in the southwestern Gulf of St. Lawrence. Secondary objectives included an examination of the reduction of soft shell and sub-legal hard snow crab. Catches in traps fitted with 12, 18, and 24 cm high collars were compared along with catches in non-collared traditional and small mesh (control) traps. It was concluded that plastic collars are not a suitable barrier to soft or white shell snow crab; however they did prove to be effective at reducing the incidental capture of undersized snow crab.

Contact: Wade Hiscock (Wade.Hiscock@mi.mun.ca)

Fisheries and Oceans Canada

Neutrally Buoyant Rope:

Experimental rope with a specific gravity close to that of water was monitored for its ability to avoid turtle and other marine animal entanglements during the 2007 whelk pot fishery in NAFO Subdivision 3Ps. The rope was also examined for overall fishing effectiveness. During this year's project, no turtle or large marine mammals were entangled, nor sighted by the observer, in the area of the St. Pierre Bank. The sample set was relatively small considering there were three observed fishing trips on one vessel from August 12 – September 10, 2007. Catch rate differences were not significant and the rope handled as well as the harvester's regular polypropylene rope.

Contact: Judy Dwyer (Judy.Dwyer@dfo-mpo.gc.ca).

19.3 Denmark

Activities in 2007 have mainly been embedded in nationally coordinated projects, with particular focus on selectivity in commercial trawls.

A national project; SELTRA was funded by DFFE in collaboration with the Danish Fishermen's Association to further improve selectivity of bottom trawl fisheries. The project runs in 2006–2008 and gear from *Nephrops* and whitefish fisheries are investigated.

In 2007 several designs of species selective *Nephrops* trawls and codends including T90 were tested in flume tank and during sea trials. Furthermore will, the properties of a T90 cod-end be tested in flume tank using stereo vision technique. The projected will be completed in 2008.

DIFRES participates in the EU project; DEGREE which aims at reducing the environmental impact of benthic fisheries. In 2007, pilot studies of a modified oyster dredge were carried out in collaboration with the fishing industry. Further studies on the selectivity of the dredge and its impact on the benthos will be investigated in 2008.

In order to achieve a better understanding of the selectivity process determined by the relationship between fish morphology and mesh configuration, a multidisciplinary project (FISHSELECT) was initiated in 2006. It involves investigation of fish morphology, testing of different mesh shapes and sizes in relation to different fish species, and simulation of gear selectivity. Major activity in 2007 was data collection for: cod, haddock, plaice, sole, lemon sole, turbot and nephrops. Concurrently with the data collection was the methodology and tools improved and extended. The nationally funded project was completed in 2007. International collaboration with the University of Tromsø (Norway) was initiated.

19.4 Faroe Islands

Kristian Zachariassen (krizac@frs.fo) and Bjarti Thomsen (bjartit@frs.fo) Faroese Fisheries Laboratory P. O. Box 3051, FO-110 Tórshavn, Faroe Islands.

Impact of scallop dredging

Investigations of the impact of scallop dredging on benthic communities began in 2005. The investigation is carried out on a scallop area that has been closed for scallop dredging except for the years 1990–91. The size of the area is ca.100 km2 and is situated north of the Islands. Samples by grab, triangular dredge and commercial dredge as well as video have been taken all around the area. After sampling the area will be open for commercial scallop dredging for about three years. After this period the area will be investigated again and samples before and after dredging will be compared. There has also been some experimental dredging carried out to see the direct effect of dredging. The first result will be accessible by mid-2009.

Groundgear development

Experiments to reduce the impact on the bottom from trawl groundgears have been carried out in recent years mainly using underwater video observations. This work is now integrated in the EU project 'DEGREE'. Experiments with a combined plate gear with rolling bobbins have been carried out on Norwegian research and commercial

vessels in 2007. The final concept will be tested on the final DEGREE cruise onboard on F/V "G. O. Sars" in October 2008.

Pelagic trawl research

A three-year project has been initiated to study fish behaviour in pelagic trawls in relation to water flow and geometry. This project will be undertaken in close cooperation with Icelandic and Norwegian institutes. The main aim of this project is to optimize trawl design with regard to water flow and fish behaviour. Trials have been completed in 2007 and 2008, where flow inside large blue whiting trawls was measured using ADCP technology. Preliminary results show that in trawls with long and heavy codends there is a reduction of water speed just in front of the codend.

Size sorting grid for shrimps

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

A full scale version of the grid system was first tested in the flume tank in St. John´s in April 2006. The first experiments with the size sorting grids were carried out in Canadian waters in June 2006. These tests identified problems with clogging of shrimps in font of the grid.

A new version of the grid system was tested in Greenland waters in December 2006. These experiments showed a big reduction of small shrimps in the catch, from 160 shrimp per kilo to 130 per kilo. The grid tested had a bar distance of 10mm, which was too wide, as too many medium size shrimps were lost.

This same system with a bar distance of 7 mm was tried in Greenland waters at the end of April 2007. These tests showed that it was possible to sort out more than 50% of small shrimps with this size sorting grid. Further experiments will be carried out to try to make the sorting grid better to handle. Other bar spacing's will also be tested.

Effect of colour of gillnets for monkfish

In 2005 and 2006 experiments were made to see how the colour of gillnets affected the fishing efficiency of gillnets for monkfish. A fleet of 200 gillnets with 5 different colours were tested. The fleets were sampled 21 and 31 times in 2005 and 2006 respectively. The fishing time was approximately 3 days each test at depths around 200m. The colour of nets seems to have no effect on the fishing efficiency. In 2007 coloured lines were tested and again the results showed no difference in the catch of monkfish.

Cod and Greenland halibut tagging

Since 1997, more than 26,500 cod have been tagged on various locations on the Faroe Plateau. More than 7,900 cod have been recaptured, and stomach contents from more than 1,800 of these fish have been collected. Analysis of this material provides valuable understanding of the migration patterns and feeding behaviour of cod on the Faroe plateau. Some of these results were reported to the ICES 2003 Symposium in Bergen. A smaller scale tagging experiment on Greenland halibut and halibut was initiated in 2002. Totally 399 Greenland halibut and 95 Halibut have been tagged and of these 24 and 13 respectively have been recaptured.

Effect of fishery on coral areas

Coral reefs in the Faroese area have been mapped using information from interviews with fishermen and by underwater video observations. Underwater video recordings will continue in 2008 and more detailed mapping will be undertaken. This information will be used in the discussion with stakeholders on preserving coral reefs. Three different coral areas are now closed for trawl fishery to prevent damage to corals by trawls.

Development of static gear

Research into the development of fish pots was initiated in 2005 with the aim to increase the efficiency and establish pots as a real alternative fishing gear for traditional species (cod, haddock and saithe). Fish behaviour in relation to different design of pots has been studied using underwater video observation. This work will continue in coming years. In 2008 experiments will be conducted with low frequency vibration for attraction of fish.

19.5 France

Ifremer

Nephrops selectivity (AGLIA 2006–2007)

The objective of this project was to provide a technological assessment and analyse the data collected from sea trips onboard commercial boats in order to improve *Nephrops* trawl selectivity in the Bay of Biscay.

Run in collaboration with the AGLIA and commercial fishermen, the project aims at testing in three types of selective devices meant to reduce undersize *Nephrops* catches (<9 cm) in commercial conditions: (i) square mesh panel fitted in the bottom part of the extension; (ii) cylindrical bar Nephrops grid (13 mm bar spacing); (iii) 80 mm netting (to be compared with the 70 mm standard legal size).

Results achieved with square mesh panel fitted in the bottom part of the extension

Despite the low abundance indexes, the following results were achieved: (i) the escapement rate remains quite significant (around 30%), though there is a high variability from one boat to the other; (ii) the commercial losses seem to be better controlled with a reduced mesh size, though this remains to be confirmed as far as small low-powered vessels are concerned. With regards to this device, the results on escapements and commercial losses will be confirmed only after an extensive repetition of the tests.

Results achieved with *Nephrops* grid

Almost no commercial size *Nephrops* escape through the bars of the grid. The average escapement rate of undersize *Nephrops* (<9 cm) ranges is around 35%.

Results achieved with 80 mm codends

The tests at sea were completed from three different fishing boats. The escapement rates seem stable from one boat to the other (around 30%).

The main goal is that by the end of 2008 one of the selective devices be adopted commercially.

Technology creep effects for Mediterranean bottom trawl fishery

Within the scope of CAFÉ project (6th EU framework program) this study aims to examine the relationship between capacity and effort and hence fishing mortality for Mediterranean demersal trawling fishery targeting hake as case study. Various technical characteristics and their evolution of the trawling were collected over the last 10 years and matched to CPUE by GLM analysis. The initial conclusion of this study shows the relationship of bollard pull measurement and door characteristics as correcting factors of the overall fishing capacity.

Experimentations on separator panel

Within the frame of the international project MEDICIS several studies have been carried out on hake (*Merluccius merluccius*) behaviour in the water column. For this purpose the effect of a horizontal separator panel fixed on a Mediterranean high opening bottom trawl was tested in sea trials. Differences in species composition have been observed but must be validated by multivariate analysis.

Shrimp fisheries

CHAMAD project in Madagascar

On request of the Malagasy Aquaculture and Shrimp Fisheries Syndicate, Ifremer have conducted various studies investigating ways to reduce fuel consumption and improved selectivity, assess impact, and provide training courses. Thus, in 2007, the fisheries technology team trained the Malagasy Fisheries Commission officers in the use of turtle excluder devices (TED) and bycatch reducing (BRD) devices. They also took part in a TED validation trip onboard a Malagasy shrimp trawler.

Workshop on TED in Gabon

On demand of NOAA, the laboratory took part in a working group, hosted in Gabon in September 2007, on introducing TED (Turtle Excluder Device) techniques in shrimp trawl fisheries. This gave rise to many fruitful exchanges with the local commercial fishermen and the Civil Service officers. On this occasion, the results of tests conducted in other parts of the world (USA, Nigeria, Madagascar, and French Guyana) were presented to the attendees. The meeting was followed by a demonstration of the correct installation of TEDs onboard trawlers. Finally, some practical work enabled the attendees to master the use of the selective device.

Workshop on brown shrimp fishery selectivity in French estuaries

In October 2007, Ifremer fisheries technology laboratory invited some thirty fishermen currently fishing for brown shrimp. The technologists demonstrated scale models of several selective trawls that fishermen already use. They appreciated very much the fact of visualizing the gear shown in the flume tank and the possibility of discussing selectivity improvements. The aim was to define and validate the various models that will be tested at sea so as to assess their selective performances, more particularly in terms of fish bycatch escapement.

ITIS-SQUAL: Pots, traps, and improvement of quality

Motivated by the need for competitiveness, in Brittany a project started on 1st May 2007 (duration 3 years). It aims to develop fish pots and *Nephrops* trap fishing techniques, and on improving the quality of the catches compared to trawl caught fish and *Nephrops*. In June 2007, a workshop organised at Ifremer (Lorient) flume tank was attended by fifteen fishermen and tests were conducted on various current traps and

pots with a presentation on the state of the art about these fishing devices. The objective was to define the first specifications of traps and pots adapted for use in the Bay of Biscay. Novel concepts of fish pots are currently being developed in partnership with the company Le Drezen and will be tested at sea in 2008 and 2009.

Regarding *Nephrops* traps, preliminary trials have been carried out in the south of the Bay of Biscay with Scottish type creels, at depth ranging between 100 and 600 m; the yields (kg per trap) are comparable to those obtained in Scotland. Collapsible prototypes are being developed in partnership with Le Drezen.

Experimentation on fish pots in the Mediterranean Sea

To provide Mediterranean small scale fisheries with less impacting techniques than static or towed nets, the implementation of fish pot technique has been studied by Ifremer since the 90's. The actions completed up to now have mainly consisted in simple technology transfer to the fishermen as was done for Norwegian lobster and deepwater shrimp traps. Since 2005, Norwegian collapsible pots have been tested for fish on the continental slope between 100 and 600 m. Several technical modifications have been tested so that they can be adapted to the fleet characteristics (vessels less than 15 m LOA) and fishing conditions (depth, hard bottom, current). Problems were experienced with target fish behaviour, pot stability, choice of material type and netting colour, scavengers, competition. Last year, an experiment began in cooperation with fishermen organisations with 3 types of fish pots to target *Sparus aurata* in lagoons and coastal waters.

DynamiT software

Several licences of the software were sold during the last six months of 2007: five to North Africa, one to the Netherlands and, very soon, one to IMARES Institute, one to Spain, and finally three licences were placed at the disposal of representatives of fisheries local committees so that they maybe able to carry out the project on energy savings, managed by Ifremer.

Necessity project – Integrating selective devices in DynamiT simulation tool

As part of the EU Necessity project, new functionalities were added to DynamiT software. It is now possible to simulate the mechanical behaviour of a selective grid along with the various netting panels supporting the grid, which constitute the selective device. It is also possible to simulate square mesh panels and separating panels. Particular attention was paid to the ergonomic aspects of the application. Thus, for instance the user can assess the angular positioning of the grid as a function of the design of the device.

EU-DEGREE – Assessing the bearing stress of trawl doors on the seabed

The aims of the project are (i) to develop new fishing gears and techniques having less impact on benthic habitats; (ii) to assess the possibilities of reducing the physical impact along with the negative effects on the benthos; (iii) to assess the socio-economic impact of the modifications versus other alternative management steps.

Ifremer is involved in the development of novel bottom trawl components generating no or hardly any impact on the benthic habitats (doors, groundropes); these developments require flume tank tests, numerical simulations and tests at sea.

At the beginning of 2007, several techniques were tested in Ifremer flume tank in Boulogne sur Mer, to assess the reaction force generated by trawl doors on the sea-

bed. A first series of data was collected from the tests conducted on three types of doors studied according to several angles of attack. The results achieved have been used to validate a theoretical model designed to calculate the reaction force generated on the seabed by the doors, according to the fishing conditions. The theoretical model was validated at sea last summer.

Energy savings

Regarding the coordination of the French Governments plan of action in terms of energy savings, and in order to comply with the French Fisheries Prospects Scheme, Ifremer fisheries technology lab is in charge of the coordination of national projects on fuel savings, in conjunction with the industrialists and commercial fishermen.

A symposium on the subject was hosted in Lorient, in October 2007, on the occasion of Itech'Mer Annual Fishing fair. Organised by an Ifremer technologists, the symposium dealt with all the different issues on this topic. Some solutions were put forward, mainly regarding the design of fishing boats (shape, length, displacement, propeller), the engine (alternative fuel), and fishing gears (trawls, nets). The economic aspects of the problem were also approached, and the information collected from the fishermen was distributed.

Furthermore, a project was started in cooperation with the Brittany fisheries regional committee : two representatives, supervised by Ifremer fisheries technology lab, have started a fuel efficiency project which consists of simulating with DynamiT tool some practical cases of trawl optimisation so as to provide solutions towards energy saving. The results were validated at sea and more tests will be carried out in 2008.

19.6 Germany

Institute of Baltic Sea Fishery

Alter Hafen Süd 2, 18069 Rostock (http://www.vti.bund.de/en/institutes/osf/)

Contact: Jens Floeter, Bernd Mieske, Harald Wienbeck, Christopher Zimmermann

NB: The Institute for Fishing Technology and Fishery Economics (IFF), Federal Research Centre for Fisheries, Hamburg was formally dissolved in 31 December 2007. The IFF was re-organized into five departments, which are working in the areas of environmental effects of fishing gear, fishing technology, hydroacoustic methods, as well as fisheries economics. The group working on environmental effects of fishing gear and fishing technology is now part of the Institute of Baltic Sea Fishery, Rostock. The other groups are now part of the Institute of Sea Fisheries, Hamburg. The remaining three federal fishery institutes are now affiliated to the new Johann Heinrich von Thünen-Institut, Federal Research Institute for Rural Areas, Forestry and Fisheries (vTI, http://www.vti.bund.de).

Selectivity of flatfish trawls in the North Sea

Contact: Harald Wienbeck (harald.wienbeck@vti.bund.de)

The present fishing effort regulation for bottom trawls in the North Sea (EU 40/2008) reduces the fishing effort with bigger codend mesh sizes (> 100 mm mesh opening) to 86 fishing days per year. The aim of this technical measure is the protection of the weak cod stock usually harvested with this mesh opening. With the smaller mesh sizes (70 to 90 mm mesh opening) a fishery targeting flatfish is allowed with 184 fishing days per year. This regulation has lead to a shift towards smaller mesh sizes in North Sea commercial fisheries. This is backed by the fact that currently the fishery

for cod is not economically feasible and that therefore fishermen are now concentrating on flatfish (with the prescribed smaller mesh opening). As a consequence this has lead to high discard rates of all fish species on the fishing grounds, which is detrimental to stocks. A commercial fishing trip on board a German vessel was conducted and demonstrated the high discard rates for the target species.

In the framework of the selectivity investigations carried out reductions in discards were found when using codend meshes with larger mesh opening. Whereas in the small mesh reference codend with 80 mm mesh opening 47% of the total catch of plaice had to be classified as undersized bycatch, in the experimental codends with 120 mm mesh opening only 7% and with 130 mm mesh opening only 3% was discarded. On the other hand however, the increased codend mesh sizes gave subsequent high escape of marketable plaice. By weight these losses equated to 18% with 120 mm codend mesh opening and 28% with 130 mm codend mesh opening.

Catch efficiency of experimental trawls in the Baltic

Contact: Bernd Mieske (bernd.mieske@vti.bund.de)

Experiments with a topless trawl (reduced upper layer) were conducted to design a flounder trawl, which minimized the catch of cod. Comparisons between stern trawlers and side trawlers revealed differences in selectivity, but generally, a reduction in cod catch around 85% was achieved with the topless trawl. However, this was also accompanied with a loss of the target species (flounder) when fishing with the stern trawler, while the opposite was true for the side trawler. Further modifying the design to improve its performance is currently underway with the help of newly available sensors.

Catch efficiency of set net and cod pots for Baltic Cod

Contact: Bodo Dolk (dolk@fischumwelt.de) and Jens Floeter (jens.floeter@vti.bund.de)

In the Baltic Sea coastal areas of Germany bycatch of birds and mammals in gillnet fisheries for cod is seen as a problem. Therefore, a series of small scale feasibility studies were conducted with the intention to, if possible, fully or partly replace the gillnet fishery with cod pots:

2003–2004: "Investigating the catchability of fish traps in the area of the artificial reef 'Großriff Nienhagen'...." joint project by Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern, Germany, and Fisch und Umwelt M-V e.V.

In the Baltic Sea coastal area, 6 "Stucki-traps" and one prototype cod pot (double chamber, 30mm, 10mm mesh opening) were deployed. The Stucki trap was deployed without bait while the trap was baited with either sandeel or herring. The cod pot caught almost exclusively cod while the Stucki traps, caught six additional fish species including eel, as intended. There seemed to be a negative correlation between cod and eel catches within a Stucki trap. Setting the pots close to the bottom caused problems with algae and jelly bycatch, and therefore investigating catchability with pelagic pots is planned for the future.

2005–2006: "Increasing the fisheries value of coastal areas…". Joint project by Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern and Fisch und Umwelt M-V e.V.

Stucki traps and 8 cod pots of 7 different designs, incl. pots from the Norwegian REFA Froystad Group, were deployed for 8 months and mark-recapture experiments were conducted. Cod catches from the pots in the period May-August were higher than later in the year. Eel was the main species caught by the Stucki traps. In total around 20 cod pots were deployed in single and also as strings. This small scale experiment (total cod catch < 500kg) with a limited number of cod pots confirmed the results of the previous project. Additionally, good mesh selection properties were demonstrated. Defining the optimal deployment depth, optimal baiting strategy – especially during the summer with high water temperatures - , and pot design remain.

2006: In August, the Federal Research Centre for Fisheries conducted a research cruise with RV Clupea to compare the cod catches of gillnets and cod pots. 50 gill nets (2000 m) and 12 pots (Norwegian type) were compared. In total the pots caught 15kg cod; the nets caught 712kg cod, i.e., a factor of ~ 50.

2007–2008: Joined project by Bundesamt für Naturschutz and Fisch und Umwelt M-V e.V.

Five commercial fishermen were equipped with a limited number of cod pots, which were deployed as strings. The first results confirmed higher catches in summer than in winter, but at generally too low levels to be economically feasible. There is a joint initiative between vTI, BfN and Fisch & Umwelt e.V. for a larger scale project, which aims at a more active involvement of commercial fishermen, increasing the number of pots and enhancing their catch efficiency in cooperative trials.

Discard ban / Landing obligation - Pilot Study

Contact: Dr. Christopher Zimmermann (christopher.zimmermann@vti.bund.de)

In 2008 a pilot study to investigate the feasibility of a complete landing obligation for all species and its advantages and disadvantages for fishery, science and management on a medium-term began. The project has started with the North Sea fisheries and the Baltic Sea fisheries will be included in due course.

The main objectives of this project are to give a reduction (or as far as possible prevention) of discards in the commercial fisheries. This will result in the better utilisation of resources and the reduction of uncertainties in estimates of fishing mortality, which in turns improves the quality of the scientific stock assessment. The other objective is to strengthen the responsibility given to fishers as a step towards co-management. The final objective is a simplification of existing rules, which results in a reduction of work for control and enforcement inspection authorities. The stability of rules is aimed for (> 2years, compared to 1 year as typical at present), which would result in better long-term planning opportunities for fishermen.

This is very much seen as an alternative solution to effort management. For selected fleets, the outlined management approach might be better (to implement, to control, to communicate) than present management systems or effort management systems increasingly implemented in the EU. Therefore, it can result in an increase of fairness in the competition between fishermen. Additionally, this concept will be beneficial for those fisheries, which have already reduced capacities significantly during the last years in accordance with the EU-strategy (e.g. Germany and Denmark).

The Key elements of this study are:

i) Landing obligations – All caught marine animals, including undersized fish and non-target species (with exception of jellyfish) have to be retained onboard and landed. If TAC-species are caught, all of these are counted against the TAC (undersized and marketable).

ii) Management – The regulation of fishery will be performed (at the final stage of the project) solely based on a) TAC-and quota measures and b) the setup of permanent and time-restricted protection areas for spawning aggregations. Both measures are comparatively simple to control.

iii) Suspension of technical measures – In return, most of the implemented technical measures and the days at sea regulation will be suspended. As a matter of fact, technical measures are increasingly complex, difficult to control and expensive to be implemented by fishermen. A multi-annual stability of regulations is aimed at.

iv) Scientific Programme – The study is monitored by scientists, who investigate biological (onboard and market sampling), as well as socio-economic aspects.

v) Possible extension: It may be necessary to counteract a fishery which begins to target juvenile fish (if this develops) and at the same time increase the incentive to reduce illegal (in this study) discards. While minimum landing size will be omitted by all means, a minimum marketing size could be introduced, where individuals below a given length are not allowed to be sold for human consumption and have to be disposed via carcass-processing plant (cost-covering, but not profitable).

Approach

This study is built with two parts, which should be implemented simultaneously but with different fisheries/participants: The first part is an intermediate step toward a change of management strategy. A fishery with proven low discard rates will land all discards within this study. This will demonstrate that for some fisheries a landing obligation is applicable with a minimum of legislative and technical effort. The introduction of a discard ban for such "clean" fisheries has been submitted to the EU. Project partner for this part of the study is "Kutterfischzentrale Cuxhaven" and its saithe-fishery in the North Sea. The second part includes the introduction of a landing obligation for mixed fisheries with known discard-problems and simultaneously a suspension of a number of rules, as mentioned above. This goes far beyond the concept of part one. Industry partner for this sub study will be the cod fishery of "EG Burg/Fehmarn" in the Western Baltic and the cod and flatfish fisheries of the "Kutterfischzentrale Cuxhaven" in the North Sea.

Working hypothesis

If more individual responsibility is given to fishermen, it is possible to implement a sustainable fisheries management with fewer basic rules. In particular, a multitude of technical measures is dispensable. It is also felt by the German authorities that a landing obligation/discard ban is technical feasible; acceptable for the fishing industry; easier to control; and can be communicated to consumers as a way of demonstrating good practice. The combination of a) the suspension of detailed technical regulations and b) the introduction of a landing obligation will result in (after an implementation phase): sustainable usage of fish resources; increased individual responsibility and financial advantages for fishermen; and an increase of quality and quantity of data used for stock assessments

Underwater observation systems

Contact: Harald Wienbeck (harald.wienbeck@vti.bund.de)

The surface towed intelligent powered vehicle (STIPS II) with wireless transmission of video and control signals is currently being revised to enhance its robustness and observation capabilities. An initiative to re-animate an older 3D manoeuvrable towed ROV System is underway. This ROV System would allow the observation of net geometry and fish behaviour along the entire trawl.

Development of a long range pinger test device

Contact: Harald Wienbeck (harald.wienbeck@vti.bund.de)

Council Regulation (EC) No 812/2004 requires the mandatory use of acoustic deterrent devices (pingers) to deter small cetaceans from bottom-set gillnet or entangling nets. However, the regulation does not provide detailed guidance on how the governmental enforcement bodies should control the correct usage and functioning of these pingers.

The German authorities wanted to have a pinger control device that allows assessing, whether a set net is correctly fitted with pingers and whether these are functioning. Subsequently, there was the need to enable this control without the fishermen being at place and retrieving the nets.

The device should allow:

- to test functionality of pingers at sea
- to count the numbers of pingers fitted to a set net
- to measure the distances between individual pingers fitted to a set net (with additional help from GPS).

An initial Europe-wide survey of potential pinger test devices was not successful with respect to the identified requirements. Manufacturers of similar devices such as bat detectors were not interested in investing for device with a small market.

The prototype

A Danish company (ETEC - Torben Roenne, Industrivaenget 8a, DK3300 Frederiksvaerk, Denmark) agreed to enhance and further develop an existing control device in cooperation with the Federal Research Institute for Rural Areas, Forestry and Fisheries (vTI), Institute for Baltic Sea Fisheries.

The prototype PG1101 Ping Go (ETEC) was equipped with a Hydrophone TC4033 (RESON), a Hydrophone - protection cage and earphones. Tests with different, cheaper, hydrophones did not give satisfactory results with respect to the detection distance. It was thus further equipped with optical indicators (LEDs) for the detected frequency of the signal and its field intensity.

The device was thus designed to display the detected pinger signal visually when the signal was clearly identified. If the signal was too weak then detection was possible via headphones.

The aim was to reach a detection distance of 400m because this would enable to hear 2 digital pingers simultaneously when they are correctly deployed (200m distance between them).

The prototype PG1101 Ping Go has 3 modes of operation:

1) The "Click" position is an envelope detector which monitors the high frequencies and converts them into something that is audible.

2) The "Mixer" position is a detector that functions somewhat like the other but it also contains some information about the frequency of the test signal.

3) The position "Audio" is a listening position just to hear what is going on in the water. It may also be useful for detecting analogue pinger signals of around 10kHz.

Test setup:

The prototype of the new device was tested in 2007 / 2008 on three cruises (1. Danish with Havörnen, and 2. German with Seeadler, Figures. 1 and 2). The tests were conducted with 3 pinger types.

Pingers were deployed on buoys and their functionality was tested from the vessels Havörnen and Seeadler as well as from dinghies. Distances between the ships and the buoys were measured by radar and GPS. Maximum detection distance was 900m for analogue pinger types (Fumunda, Airmar) and 400 m for the digital AquaMark 100. These detection distances were obtained from dinghies with engines turned off and some distance away from the mother ships.

From the Danish inspection vessel Havörnen it was possible to detect the pingers when only the auxiliary engine was running, but the detection distance was lower. The same results were obtained with the German RV Solea while in harbour, however, it was not possible to detect the pingers from onboard the German inspection vessel Seeadler.

The optical indicators (LEDs) for the detected frequency of the signal functioned up to a distance of 50m away from the pinger. When the noise level was too high or the distance was larger than 50m, the detection was only possible via the headphones.

The field intensity indicators did not yet function in a satisfactory way, however they are not required for the purpose of pinger control. Best results were obtained when using the operation modus "Mixer".

The tested device is a prototype and final modifications are still needed. This refers especially to the waterproof design and the simplification of switches and visual indications, and fine tuning the detection technique. A final version is envisaged to be available in June 2008.

19.7 Iceland

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

Species selective demersal trawling

A separator trawl was tested in October 2007 for separating cod and haddock. A 64 m stern trawler with 4000 hp main engine was used for the experiment. The vessels own trawl was modified for the experiments. The trawl belly was cut 10.5 m behind the bosom section of the fishing line and a divided trawl belly connected. The width of the foremost part of the separator panel was 2/3 of the bottom panel. Cod, haddock and saithe were measured, and other commercial species counted. An analysis was made, investigating the vertical separation by fish length, depth, area (inshore, offshore), diurnal variations (night, day, twilight) and mesh size in the separator panel.

Another survey is ongoing at the same time as this FTFB meeting on the research vessel Árni Friðriksson. The plan is to film the trawl underwater and then make replicate tows to measure how effective the cod and haddock separation in those two codends and if there is any length based difference or different fish species composition.

Species selective Nephrops trawling

Last year a trial with grid in a *Nephrops* trawl was conducted. This grid, similar to the Nordmøre grid used in shrimp fisheries, was designed to separate *Nephrops* and fish in separate codends. A steel grid with 50 and 80 mm bar spacing's and a horizontal separation panel were tested to separate fish from *Nephrops* in a demersal trawl. Two codends were connected to the grid and panel. Almost all the *Nephrops* catch entered the lower codend and most of the fish in the upper one. Fish separation varied among species and fish sizes. The results show that a significant separation could be achieved. There are also indications that by using a *Nephrops* grids in combination with bigger mesh sizes in the fish codend and in the trawl belly, marketable fish could be retained, while most undersized fish can be released. More trials are planed this year on commercial fishing vessel.

Pelagic trawling in capelin fisheries

Information on trawl geometry and capelin behaviour was observed with underwater cameras in a survey in 2007. In order to estimate the catching efficiency of this type of pelagic trawl used in the capelin fishery, an evaluation of mean volume density for capelin (in number per cubic metre) assumed entering the trawl, was compared with recorded catch from the commercial fleet. Results showed low catching efficiency of the capelin trawl. A new design of pelagic trawl for capelin fisheries is planned to be tested later this year.

See in more detail (http://www.ices.dk/products/CMdocs/CM-2007/Q/Q1207.pdf).

Sorting grids in blue whiting fishery

Development of a sorting grid system for blue whiting fishery is continuing. In last years survey underwater filming was carried out to estimate how effective the sorting grid was for releasing saithe and cod without lose of target species. The results were clear, of the four grids tested none were effective but from the results a new design of grids has already been made and will be tested and filmed in May this year.

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

Published results on the effects of hook and bait sizes on size selectivity of gadoid fish have been inconclusive, probably partly due to a number of confounding effects. To date, results from Icelandic waters are non-existent. A designed experiment to measure relative selectivity of cod and haddock for different hook and bait sizes will be conducted in 2008. Several trips will be conducted throughout the year.

Development of pot fishery in Iceland

Within the last few years a trials has been carried out with large traps. They have been used near coast inside fjords and bays, in relation to sea farming of cod and haddock. Ina few of the trials, the small pots used for catching cod as well been done. There is a growing interest in Iceland in this fishing method both in relation to fish farming and commercial fisheries on a larger scale. An application for funding to test traps and pots on a larger scale is being formulated and if funding is secured will begin later in 2008.

19.8 Ireland

Dominic Rihan, Bord Iascaigh Mhara, Ireland, rihan@bim.ie

EU Degree Project

BIM carried out two series of flume tank trials with model doors to identify the characteristics which potentially allow the doors to be operated with lower seabed reaction forces. As it was not possible to make the doors lighter, reduced weight and hence reduced reaction force was simulated by (i) increasing the towing speed, and (ii) reducing the warp/depth ratio. Many different model doors were tested with suitable trawls attached. This identified which doors worked well at different angles of attack. All doors were tested when lifting off the seabed as this was considered to be a more likely event of doors worked lighter on the seabed in practical fishing conditions.

A standard vee door was then tested in the flume tank, adjusting the warp and bridle attachment points to correct poor behaviour when light on the seabed. This "re-balancing" using adjustments to the warp and bridle attachment points could be used to correct other doors if necessary. Re-balancing involves altering the warp and bridle attachments points in such a way that the desired angle of attack is maintained but the centre of gravity of the door is not inside or outside the force lines of the warp and bridle.

A series of three sea trials was carried out to examine these practical rigging problems, and assess how the application of basic gear technology and training can be used to help fishermen work existing doors better. These trials were carried out from the ports of Greencastle in NW Donegal and also Castletownbere in South-west Cork and tested standard vee and Bison doors.

A project workshop was held in the flume tank in Hirtshals, Denmark in early March, at which a demonstration of the "good" and "bad" door behaviour identified in the earlier flume tank and sea trials was given to the project participants.

EU DEEPCLEAN project

BIM is currently involved in an EU funded study called DEEPCLEAN with the Marine Institute, Galway, Ireland, CEFAS, Lowestoft, UK and Sea Fish Industry Authority, Hull, UK, which has the aim of recovering lost or abandoned nets in deepwater gillnet fisheries > 200m and evaluating the effects of such "ghost fishing" by these lost nets on these fisheries. In September BIM and CEFAS carried out a preliminary analysis of whether it would be possible to fit an underwater camera system to the net retrieval system being deployed. These trials were carried out in Norway and were successful in that the camera could be mounted and orientated correctly but no filming was carried out due to technical difficulties with the camera. A follow-up to these trials is planned for May 2008 off the south west coast of Ireland on the Irish vessel "India Rose". Following this survey a further 4 x 20 day retrieval campaigns will be undertaken, covering Rockall, North, West and South Porcupine, Rosemary Bank and areas to the west of Shetland. These surveys will be carried out over the June-September 2008.

Environmentally Friendly Fishing Gears

Several sets of selectivity trials were undertaken during 2007/2008 as follows:

1) Trials to assess the effect of reducing the number of meshes in the codend circumference of standard *nephrops* trawls were carried out in August/September 2008. Two sets of catch comparison trials were completed on board the Rossaveal based twin-rig vessel "Maria Magdalene III", comparing a standard 80mm x 6mm PE codend with 120 meshes in the circumference against an 80mm x 6mm PE codend with 100 meshes and 80 meshes respectively. The results showed reducing meshes round reducing discards of whiting and haddock but a reduction in marketable *nephrops* catches although there was a lot of inter haul variation making analysis problematical.

2) Preliminary work with a flexible grid placed into the extension section of a standard scraper trawl to release juvenile monkfish was completed in January 2008. The grid used was designed by IFREMER in France. This work was carried out on the Greencastle based single rig vessel "Catherine-R" during a monkfish tagging survey being undertaken by the Irish Marine Institute. Due to bad weather only a small number of tows were completed but the results indicated that the grid did sort small monkfish < 34mm length. No handling difficulties on board the vessel were observed with this grid. Further work is planned for later in 2008.

3) A project investigating the potential for incorporating flexible grids systems into the codends of trawls for release of mackerel and horse mackerel began in 2007, following approaches by industry. Extensive underwater observations of two different grid designs was collected, allowing fine-tuning of the grids, as well as providing an insight into fish behaviour and reaction to the grids. High levels of escapement were observed although no assessment of escapement mortality has been carried out as early attempts using collecting bags placed over the grids were largely unsuccessful. This work is continuing.

4) Trials to generate selectivity data for a range of codends used in the Rockall fishery began in April 2008. The selectivity of a standard 100mm x double 4mm PE codend will be compared to a 110mm x 4mm double codend; a 100mm x 4mm double codend with a 120mm square mesh panel fitted 4–7m from the codend; and a Russian style codend with 135mm x single 6mm codend with a 70mm x 4mm PE liner. This work is continuing and no results as yet are available.

Environmental Management Systems

Working closely with Seafood Services Australia, BIM completed a pilot project in 2007 looking at the implementation of such a Seafood Environmental Management System (EMS) in a number of pilot fisheries. These pilots involved individual fishermen and 4 fishermen's co-operatives and following on from the work completed in 2007, an EMS manual has been produced and a target of implementing EMS systems on 25 vessels has been set. Industry mentors have also been identified to assist fishermen work through the process. This work is being closely linked to looking at certification/accreditation schemes currently being considered nationally.

Fuel Efficiency

As part of an EU project called "Energy Saving in Fisheries" (ESIF), which aims to investigate potential technical and operational methods in addressing the need for reducing energy consumption and associated costs in European fisheries, BIM in con-

junction with Engineer and Marine Surveyor Noel O'Regan of Promara Ltd have been looking at a design for a "Green Trawler". A draft specification together with a General Arrangement drawing describing a concept fishing vessel equipped for fishing with twin-rigged trawls, single rig or as a pair trawler has been produced. This concept vessel is designed to incorporate the highest level of efficiency available in a practical form for use in the Irish fishing fleet. This concept, however, does not necessarily follow the design restrictions currently imposed by rules and regulations both nationally and at EU level but strictly on design principles to maximise fuel efficiency.

New Fisheries

Two new fisheries were investigated during 2007/2008 as follows:

1) Exploratory fishing trials for deepwater rose shrimp () were completed in August 2007 on board the Clogherhead vessel "Endurance". Extensive areas off the west and south-west coasts of Ireland were explored but little or no shrimp were caught.

2) Under a joint BIM and CEFAS project an assessment of the potential for developing a fishery for hagfish in Irish and UK waters. The conclusion of this study was that given the biology and stock structure in Irish and UK waters it was unlikely a sustainable fishery could be developed.

Waste Management Project

In the latter part of 2007 and early 2008 following on from work carried out in 2006, the Marine Technical Section set up a net recycling site in Tramore, Co. Waterford. A net baling station has been installed at this site and over 20 tonnes of waste monofilament gillnets, as well as salmon nets taken back from fishermen as part of the Salmon Hardship Scheme have been successfully baled and transported to a Recycling firm, Petlon UK. Samples of PE netting have also been sent to Petlon for assessment as to whether this material can also be recycled into plastic products.

Gear marking

BIM recently have recently begun an EU funded project that aims to assess the current EU gear marking and identification regulations benchmark these against regulations in other countries and propose alternative designs that are practical, safe, cost effective but also identifiable. A review of current regulations has been completed and an inventory of available components for ear marking buoys has been made. Alternative technologies such as the use of RFID tags have been researched and its application to gear marking will be assessed in due course. This project is due to be completed by October 2008.

Norman Graham, Marine Institute, Ireland, norman.graham@marine.ie

Monkfish Assessment and Tagging Programme

As a follow-up to work carried out in 2006 a follow-up monkfish assessment and tagging survey was completed in 2007. Two vessels were involved and allocated 14 days charter each, these were the "*Marliona"* (SO 975), a 32.5m (LOA), 1243 Kw trawler owned and Skippered by Cyril Harkin and the "*Catherine R*" (SO 956), a 30m (LOA), 741 Kw trawler owned and Skippered by Cara Rawdon. This fishery independent survey is unique in that rather than providing a relative index of monkfish populations, it provides an estimate of total abundance with the objective of ascertaining

how the stock is biologically distributed. In addition to estimating the biomass, monkfish have also been tagged in 2006 and 2007. This tagging exercise aims to gather more detailed information on migration and diurnal behaviour.

Celtic Sea Cod Recruitment Survey

This project seeks to develop a collaborative Industry/Science herring and cod recruitment survey for the Celtic Sea stocks and to obtain data on migration patterns and stock fidelity of cod through tagging experiments. Suitable areas and times in which to measure the strength of incoming year class so that a recruitment index can be built up over time were identified through discussion with industry. In addition a new survey trawl was developed in collaboration with commercial net manufacturers and BIM for the purposes of the survey. The trawl was designed with characteristics that maximised the capture of cod and other demersal species but still adhered to the recommendations SGSTS. Under the auspices of this proposal the survey design has been developed and the trawl and associated hardware tested during winter/spring 2008. Surveys are planned to commence later in 208 subject to funding being made available. In addition cod captured using short duration hauls have been tagged with ribbon tags (~8000 fish) and a limited number (120) with electronic data storage tags (DSTs) and tagged with high reward ribbon tags. Tagging was conducted in a number of key areas, including the current Celtic Sea closed area, targeting both adult and juvenile fish. This stratified approach will provide information on migration and fidelity patterns of both juvenile (pre-fishery recruits) and adult fish as well as help scientific evaluation of the current Celtic Sea area closures.

19.9 Netherlands

Wageningen IMARES (contact: bob.vanmarlen@wur.nl; tel. +31 317 48 71 81)

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

The project is finished and the final reports are being collated. A suite of discard reduction devices were developed for the European *Nephrops* trawl fisheries. Acoustic deterrents were developed for cetaceans in pelagic trawling as well as excluder devices showing potential to scare off the animals or release them from a trawl, but escape rates were still rather low and the conclusions were not definite, and therefore follow-up research is recommended.

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

Additional experiments were proposed after questions were raised by ICES in 2006 concerning the use of electric pulses on species not caught that may come into contact with the gear. Measurements were conducted on the generated stimulus in the facilities of the producing company Verburg-Holland Ltd., and onboard the beam trawler that fished commercially with the system MFV "Lub Senior" (UK153) to make sure that the electrical stimulus of a pulse simulator to be used in the tank experiments is a good match for the stimulus of the UK153 pulse trawl system *in situ* at sea. Tank experiments were then carried out at IMARES on cat sharks (*Scyliorhinus canicula*) using this pulse simulator to appraise the survival, physical condition and behaviour of these animals under stimulation. Further experiments are planned on cod (*Gadus morhua* L.) and invertebrates. A more formal guidance structure from ICES than the

present 'ad hoc' topic and expert groups is needed and will be requested. The Dutch fishing industry has plans to outfit a total of five vessels with pulse trawls and winches likely beginning in September 2008 under derogation from the present ban on using electricity in fishing of the EU (EC Reg. No 850/98 of 30 March 1988). This involves substantial investments by the industry, which will partly be subsidized by the Dutch government. Further implementation in the Dutch fleet depends on lifting the EU ban, emphasizing the importance of a positive verdict from the scientific community. Further work was also done on several other topics in the project, among which adjusting the MAFCONS-model to calculate the effects of new gear components on benthic invertebrates and relate their mortality with physical interactions on various types of sediment.

EU-Project Energy Saving in Fisheries (ESIF)

A new project began in 2007 looking at potential energy savings in various segments of the European fisheries, with participants from Denmark, Netherlands, Belgium, France, United Kingdom, Ireland and Italy. This project aims at investigating potential technical and operational methods to address the need to reduce energy consumption and associated costs in European fisheries. The study started with an inventory of potential technical solutions and ongoing projects in the participating nations. The economic performance of a number of selected fleet segments, using data collected under the EU Data Collection Regulation (DCR), was analysed with emphasis on the role of energy for individual fleet segments, a break-even analysis relating to fuel price, factors determining energy efficiency, the economic potential for technological improvement, and scenarios for future outlook, particularly related to possible development in the costs of fuel oil. Examples are given on a national basis of research on reducing the drag of towed fishing gears, potential changes in gear design, components and fish stimulation, as well as replacement by alternative gear types, including static gears. In addition fishing vessel design and operation topics will be addressed. The study will continue with an economic analysis of the merits of these technical and operational changes.

National projects

A short study was conducted on the statistical problems associated with measuring mesh sizes, and presented to an industry workshop. This work was done in relation to the development of the OMEGA-mesh gauge.

A project began in conjunction with industry on discard reducing techniques for beam trawls. Three weeks of comparative fishing were carried out on FRV "Tridens" in October-November 2007 using T90 and/or square mesh benthos release panels. A major finding is that releasing benthic invertebrates can be achieved, but the penalty is in many cases that marketable fish, particularly sole, are also lost to some extent. The optimum solution is thought to be a panel that releases a fair amount of benthos with only a relatively small loss in catch of target species and thus fishermen's income. Such losses might be compensated by an increase in days at sea as a bonus for fishing more environmentally friendlier. The experiments will be continued in May-June 2008.

A number of new national projects were proposed by groups of fishermen in the Call of March 2008 of the Dutch Fisheries Innovation Platform in which IMARES (together with ILVO Ostend Belgium) plays a scientific guiding role. These proposals involve the development of hydro-mechanical stimulation in beam trawling for flatfish, improving the catch rate on sole in fishing with outrigger trawls replacing beam trawls,

and the optimization of a hydro-dynamically shaped beam to replace the conventional cylindrical ones in beam trawling in order to reduce gear drag and fuel consumption. These projects, if granted, are expected to start after the summer of 2008.

19.10 Norway

Institute of Marine Research, Bergen

Unaccounted mortality of mackerel crowded and slipped in purse seine fisheries

Full scale survival experiments carried out in the North Sea in Aug/Sept 2006 and 07, have for the first time revealed that the unaccounted mortality of mackerel *(Scomber scombrus)* that have been exposed to crowding and slipping from a purse seine, may be huge. In five parallel experiments, where mackerel was crowded until the fish showed a panic reaction for 10–15 min, the mortality was monitored and compared to that of an untreated control group. The mortality of the crowded fish was significantly higher than of the control groups. From 80 to 100% of the crowded fish died within 2 to 6 days, while the mortality of the control groups varied between 0 and 46%. The experiments show that the mackerel is extremely sensitive to handling and stress, and that the unaccounted mortality due to crowding/slipping in the purse seine fisheries may be high.

Contact: Aud Vold Soldal; aud.vold.soldal@imr.no

Fish Welfare in Capture Based Aquaculture

In capture based aquaculture, wild fish are being held in net pens in order to supply fresh fish with high quality throughout the year and thereby increase the value of the catch, given a set boat quota. Welfare issues in CBA arise when handling stress and adaptation costs to new environments are added to the capture stress, and the duration of impact will increase dramatically contra traditional fishing. In spring 2007 fishing trials focusing on effect of swimbladder puncture on mortality, behaviour and physiology have been conducted. Behaviour of cod (resting and acclimatization time) in transport tanks and net pens has, for the first time, been quantified by use of electronic data storage tags. Pressure tests of vacuum pumps onboard fishing vessels used to move live fish from tanks to net pens revealed (coupled with data on swimbladder healing) pressure reductions way in excess to re-puncture cod swimbladder. Preliminary data suggests that functionality of a punctured swimbladder is rapidly restored, and that swimbladder puncture alone does not lead to long-term detrimental chronic stress.

Contact: Odd-Børre Humborstad; Oddb@imr.no

Effect of gangion floats on bait loss and catch rates in longlining

Bait loss in bottom set longline by predation of scavengers such as bottom lice (amphipods and isopods), crabs, hagfishes etc is a problem in the coastal fishery for cod and haddock in northern Norway. By floating gangions 70 cm off the bottom, comparative fishing trials showed a slight increase in cod catches, decrease in haddock catches and reduction of flatfish and elasmobranch bycatch. Results may be explained by less bait loss for floated longlines, higher visibility of floated baits, and species specific differences in feeding strategies.

Contact: Odd-Børre Humborstad; Oddb@imr.no

Reduce bycatch of king crab in the gillnet fisheries for lumpsucker

Trials with gillnets for lumpsucker which were equipped with a 70 cm high, fine meshed panel at the lower part have been carried out. Compared to a standard gillnets the bycatch of king crab were significantly reduced while the catch of lumpsucker only reduced by about 10%.

Contact: Dag Furevik; dag.furevik@imr.no

A new demersal survey trawl

IMR is working on a project with the objective to develop a new demersal survey trawl. This two panel trawl is equipped with short bridles (15 m) and self-spreading ground gear. Comparisons in the Barents Sea between the standard sampling trawl and the new trawl indicates that the new trawl has lower efficiency for juvenile cod and haddock, while the opposite was obtained for large cod.

Contact: arill.engas@imr.no

Development of midwater trawls for gadoids in the Barents Sea

Midwater trawling targeting gadoid fish has been banned in the Barents Sea since the late 1970's due to high catch rates of juvenile fish. Due to increased concern about bottom impact from demersal bottom trawling, research is carried out to verify if midwater trawling techniques can be an economical and sustainable method for catching gadoids. Low catch rates have been obtained with the midwater trawl compared to dermersal trawl carried out in the same area, mainly due to the difference in distribution.

Contact: terje.joergensen@imr.no

The University of Tromsø, The Norwegian College of Fishery Science

Comparisons between traditional and mechanized de-hooking systems in coastal longline fisheries

Experiments show that it is possible to use a simple device to de-hook fish without using the traditional gaff. Landed fish are hence without gaffmarks and quality and outcome is improved. There are minor differences in efficiency between traditional and the new technique, i.e. retention of fish with the new hauling system (known as "automatic de-hooking unit"). Fishermen claim that it is a great advantage during hauling with reduced labour as no gaff is needed. Instead they can spend more time in preserving fish quality. The results are reported in different presentations, reports (in Norwegian) and via fisheries magazines. Further experiments with the automatic de-hooking unit will be carried out during summer 2008 on live fish landings from the coastal longline fleet, targeting cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*).

Improved retention of fish in the Norwegian mechanized longline (autoline) fisheries.

During 2006 and 2007 a system comprising a hauling well in the side of the vessel was tested. The vessel used is one of the most modern Norwegian longliners, the 51 m M/V "Loran". De-hooking is made inside the well and the traditional gaff is removed during hauling. The idea behind the technology is to reduce incidental loss of fish (outside the boat), to improve quality on landed fish (no gaffmarks) and to improve the comfort and safety for crew during hauling. In extreme weather conditions the vessel can continue hauling the line with the traditional hauling hatch closed.

During our experiments the focus was retention of fish, i.e. efficiency and reduction of incidental loss of fish (and possible reduction in unaccounted mortality).

M/V "Loran" is currently the only vessel with this technology, which is a somewhat simpler technical solution to the "moonpool" used on the M/V "Geir". The results are reported in different presentations, reports (in Norwegian) and via fisheries magazines, including World fishing.

Results from two periods (autumn 06 and spring 07) show an increase in catch of 2 to 4% for cod (*Gadus morhua*), 6 to 10% for haddock (*Melanogrammus aeglefinus*) and 8 to 14% for Greenland halibut *(Reinhardtius hippoglossoides*) with the new hauling technique. The results are accepted for publication.

Further experiments will be carried out during 2008 aiming at comparing a traditional vessel to the vessel with new hauling method with focus on efficiency, fish handling/quality and working conditions/safety for the crew during hauling.

Project Title: Size selectivity patterns in the North-east Arctic Cod and Haddock fishery with sorting grids of 55, 60, 70 and 80mm

Sorting grids are compulsory for trawlers fishing for cod (*Gadus morhua* L.) and haddock (*Melanogrammus aeglefinus*, L.) in Norwegian waters at the Barents Sea. Four different sorting grids were tested onboard R/V Jan Mayen (64 m) during February-March 2007. The aim of the study was to determine the changes in selectivity parameters when increasing bar spacing from the compulsory 55 mm to 60, 70 and 80 mm. In all cases, the codend used was a standard 135 mm codend. This study shows different exploitation patterns on cod and haddock populations. The conclusions of the paper are useful in order to help determining the optimal exploitation pattern for a certain cod or haddock stock.

The results indicated that for haddock there is little variation in the selectivity parameters when increasing bar spacing from 55 to 60 or 70 mm for haddock (2.7 cm in the l_{50} while the *SR* is fairly constant around 5 cm). For cod, no differences were found between the 55 and the 60 mm grids or the 70 and 80 mm grids, but the first two differed from the latter. The mean l_{50} increases from 56.08 to 73.33 cm and the mean *SR* from 7.46 to 14.28 cm when the bar spacing is increased from 55 to 80 mm. The selection curves move to the right and tend to lose sharpness, and the 95% confidence areas increase gradually as the bar distance of the grid is widened. The relationship between the l_{50} and grid bar spacing, based on this and previous studies, was determined to be linear for both cod and haddock. The results are in a review process, Fisheries Research.

Further experiments on the importance of fish morphology on fish escape are planned for 2008. In addition, the implications of using covered codend or paired gear sampling methods for selectivity study purposes will be investigated.

SINTEF

Energy friendly Shrimp trawling

The development and testing of a new energy friendly trawl for fishing of shrimps has been continued in the period during 2007–2008. A full scale trawl was constructed and tested in a triple rig arrangement onboard a commercial trawler in the Barents Sea. The fishing efficiency of the trawl showed to be poor with about 65–70% of the catchability of the standard trawls towed by the vessel. Observations using small mesh collecting bags showed that the shrimps escaped through the side panels

and the larger meshers in the upper panel. An alternative design with more small mesh in the upper panel has been constructed to solve this problem. More full scale tests will be made to test this new design. The project has been funded by the Fisheriea and Aquaculture research fund.

Model based surveillance of trawl systems

The submerged parts of the trawl systems can not be directly observed, and the available measurements are often few and unreliable. To address this issue, SINTEF Fisheries and Aquaculture are developing a state estimator based on a mathematical model of the system. The mathematical model is used in a simulation running in parallel to the real system. The simulation is thus able to improve existing measurements in terms of both precision and update rate, as well as to provide information which is not, or can not be, measured. The provided information may include any position and velocity in the trawl system, such as trawl door orientation, wing spread and wing positions, as well as e.g. information about the bottom pressure and symmetry of the trawl. The model is improved and adapted to the actual system by using the available measurements. This project is part of a project run by Rolls-Royce Marine, where the goal is to develop a control system for trawl winches which can take the additional available information into account. Offshore Simulation Centre, Alesund is also part of the project, responsible for the 3D visualization of the trawl system. Contact: Karl-Johan Reite; karl.j.reite@sintef.no

Harvesting zooplankton by use of air bubbles

In recent years there has been increased interest in exploitation of marine zooplankton like copepods and krill. Trawls with very small meshes have a high towing resistance and problems with by-catch, and may not be suited for industrial harvesting of such resources. Addressing this technical challenge is the goal of our project, where we study the use of air bubbles to lift Calanus to the sea surface to be skimmed by an oil spill recovery type skimmer, or to concentrate Calanus closer to the surface to be collected by a trawl with reduced opening area. The air bubbles are released by a sparger system towed at 40 m depth or less. The 'lifting' can be achieved by two different mechanisms, namely flotation and upwelling. Flotation means that air bubbles attach to the Calanus body and lift it by buoyancy. Upwelling means that a lot of bubbles are generated to induce an upward water transport, bringing everything that naturally follows the water with it towards the surface. The project has included laboratory studies of pure bubble hydrodynamics as well as high speed video capturing and analysis of interaction between bubbles and live Calanus. So far the upwelling mechanism appears most promising, although attachment and flotation of individual Calanus has also been observed, and will be tested at sea in the summer of 2008.

Contact: Svein Helge Gjøsund; Svein.H.Gjosund@sintef.no

Triple trawls with asymmetric fastening of centre weights

Trawl systems with three nets are commonly used for prawn fisheries, and a widely used configuration has four main wires connected to two trawl doors and two centre weights, respectively. The centre weights are constructed with rollers to reduce towing resistance. Asymmetric fastening of the main wires onto the weights has been proposed to change the yaw angles and provide extra spreading forces on the weights. The intention is to achieve a wider trawl system and increase the fishing efficiency. Full-scale tests were performed with a commercial trawler at a water depth

of approx. 260 metres, with symmetric and asymmetric fastening of the main wires. Several forces and distances were measured, and statistically significant results showed that asymmetry reduced the total distance between the trawl doors by 2-6 metres. The total distance between the trawl doors was about 180 metres. Contrary to the intention, asymmetric fastening of the centre weights reduced the total width of the trawl system.

Contact: Vegar Johansen; vegar.johansen@sintef.no

Optimization of bottom trawl gear with respect to energy consumption

Fundamental research has been performed to achieve more knowledge on hydrodynamic properties of net panels and rockhopper bottom gear, and improved mathematical descriptions of the hydrodynamic loadings will be developed based on the experiments performed in the flume tank. Flume tank experiments with a trawl net were carried out as well, and response forces were measured as a function of the trawl opening's width and height. The hydrodynamic loading models will be verified by comparing such experiments to numerical simulations with these new loading models. A new computer tool for simulating net structures is being developed, and will be used for this comparison. Model scale experiments with trawl door bottom impact have also been performed, and these will form the basis for the development of new structure-seabed interaction models. In order to make such research results available for daily operation of bottom trawls, a computer tool has been developed for studying the effect of changes in the rigging of the gear. The latest models and mathematical descriptions are included in the tool, enabling the fisher-men to investigate how changes in important parameters like weights, floaters, door sizes, net mesh sizes etc. influence on the geometry and towing resistance. This computer tool may help the fishing fleet to optimize the equipment to their current operation conditions. The project is funded by the Norwegian Research Council and The Norwegian Fishery and Aquaculture Industry Fund.

Contact: Vegar Johansen; vegar.johansen@sintef.no

19.11 Spain

Institute: AZTI Tecnalia

Esteban PUENTE (epuente@suk.azti.es)

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

Field study to assess some mitigation measures to reduce bycatch of marine turtles in surface longline fisheries (project Ref. No. FISH/2005/28A)

This project worked with fishermen to test hook and bait types in European surface longline fisheries targeting swordfish in the Atlantic, eastern and western Mediterranean with the aim of assessing whether they reduce turtle bycatch. The trials were conducted in collaboration with the fishing industry in the following fisheries:

- Greek longline fishery in the eastern Mediterranean,
- Spanish longline fishery in the western Mediterranean,
- Spanish distant water longline fishery in the south-east Atlantic Ocean,

Two longlines were set each day, one with squid bait and one with mackerel bait, and each with alternating magazines of J hooks, 0º offset 16/0 circle hooks and 10º offset 18/0 circle hooks. A total of 124 turtles were caught in the trials — 9 leatherback turtles and 115 loggerhead turtles. More loggerhead turtles were caught in the Atlantic and western Mediterranean (36 and 77 respectively) than in the eastern Mediterranean (2). Turtle bycatch was significantly affected by bait type. Turtles were consistently caught more frequently on squid bait than on mackerel bait, and 82% of all loggerhead turtles were caught with squid. There was no significant difference in turtle bycatch rates between circle hooks and J hooks, although there was an indication that 18/0 circle hooks were less likely to be swallowed than J hooks or 16/0 circle hooks and, in the western Mediterranean, that turtle catch rate on circle hooks was slightly lower than on J hooks. Swordfish catch rates were not significantly affected by bait type in any region. However, hook type did have an influence in the western Mediterranean, with significantly higher catch rates of swordfish on J hooks compared to circle hooks. The size of swordfish caught was not affected by hook type, but bait type did have an effect in the western Mediterranean, where larger swordfish were caught on squid bait compared to mackerel bait. Effects of hook and bait on other species caught during the trials as secondary target species or bycatch were also monitored. Bluefin tuna catches were significantly lower on mackerel compared to squid bait in the western Mediterranean.

Nephrops and Cetacean Species Selection Information and Technology (NECESSITY) EC contract 501605

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

Development and testing of a semi- automated rod for the pole and line tuna fishery (AZTI project ATM2006CAÑA_CIM).

The pole and line artisanal tuna fishery with live bait requires a large crew as it is essentially a manual fishing method manually. The aim of this project is to develop an

automated rod prototype which can substantially reduce the manpower needed for the fishing operation, as well as to minimize operational risks associated with hooks and physical over-effort (back injuries). A first prototype has been designed, built and tested in the commercial fishery during the summer tuna fishing in 2005. As a result of the fishing trials with the prototype, several technical improvements have been identified and defined in terms of technical specifications. Two more improved prototypes were built in 2006 based on the reviewed technical specifications. They have been tested in the commercial tuna fishery in 2007 with success both in terms of reduction of manpower for similar catching performance to the classic pole and line manual operation and of increased safety during fishing operation.

Analysis of the acoustic spectrograms of tuna fishing vessels (AZTI project ATM2006RUIDO)

Vessel noise is an important factor to be taken into account in the fishing performance of artisanal tuna fishing vessels using trolling lines as well as pole and line with live bait. This is to minimise fish avoidance to vessel as much as possible during fishing. The objectives of the study are: to establish a standard procedure for the measurement of noise radiated by commercial vessels using hydro-acoustic equipments; to define the noise pattern of different categories of vessels; to define the noise characteristics that have an influence on fishing performance according to sound and vibration sensitivity of tuna. Different measurement operations of commercial fishing vessels were carried out along 2005, 2006 and 2007, building a database of noise recordings of the fleet. Noise recordings are processed to obtain sound pressure levels and frequency spectral composition. The project is carried out in consultation with technical staff that checks acoustically the fishing vessels every year by studying their air radiated noise. The long term goal of the study is to be able to establish the underwater noise pattern of those mechanical deficiencies in the vessels detected by aerial noise recording.

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 the fuel efficiency in fishing vessels. In order to characterize accurately the pattern of fuel usage onboard, a complex consumption measuring system has been 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 speed among others. The information given by each sensor will be recorded every second in a computer. This will allow calculating how much the fishing vessel consumes in each part of the fishing operation. The installation of the first measuring system is being carried out and the same will be done in other three vessels during the summer. As soon as the system is installed, analysis of the data files will be carried out so that possible improvements of the consumption pattern might be identified.

Design and trial of a new trawl net to reduce fuel vessel consumption in the bottom trawl fishery targeting multi-species in ICES VIIIabd

Thinner and robust netting materials are available in the market for the construction of fishing nets that can reduce the drag of the trawl and hence improve the energy consumption of fishing vessels. A modified design of a commercial bottom trawl net has been designed and built with the half upper part of the trawl replaced by high tenacity polyethylene netting except in the codend. Preliminary trials at sea have

been carried out in 2006 to establish the working method for the assessment of the hydrodynamic performance of the trawl system, its catching efficiency and the level of fuel consumption of the towing vessel during fishing. The preliminary trials point out that there is room for fuel consumption optimisation while maintaining similar catch rates for the target species. Further improvements in trawl design and trawl fishing system have been carried out in 2007 and modelled prior to trials at sea. Experimental fishing trials are scheduled in 2008 to evaluate net geometry, catching performance, fuel efficiency and operation on deck.

Viability study on the potential to improve fuel efficiency in fishing vessels of the application of renewable sources of energy (solar & eolian)

The trend to increasing fuel prices is one of the most serious threats that the fishing sector has to face in the short term. This research project aims at studying the potential of the use of renewable sources of energy (solar: photovoltaic plates; eolian: wind vane layouts; sail assistance) to reduce fuel consumption on fishing vessels. The pilot study focus on a trolling line type vessel, as these vessels have long running hours over the course of the tuna season. The electric power generation of possible solar plate and wind vane layouts has been calculated. Studies are being carried out to determinate the maximum sail area and describe the necessary changes so that adequate stability is kept. Apart from estimating (or measuring in case of installing sails in a prototype) the fuel saving achieved by the use of sails as an auxiliary power source, the roll reducing effect of the sails will also be studied.

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 driving 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 attending to the hull design and the fishing operation. A sample of several fishing vessels, representatives of each group, all the possible modifications on the hull are being studied and designs of new propellers are being looked at. Although many of the modifications studied will not be executed during the course of this project, their improvement in fuel efficiency will be estimated based on naval engineering methods. Conclusions will be reached about the potential of hull/propellers changes in the rest of the fleet after estimating (or measuring in those vessels where modifications will be carried out) the improvements in terms of fuel efficiency achieved with each modification.

19.12 Scotland

Fisheries Research Services

Dave Reid (reiddg@marlab.ac.uk) for the FTFB team at FRS

Selectivity and other work in relation to Scottish Industry Science Partnership and Scottish Government

FRS are running an ongoing programme linked to industry summaries in the table below.

Funding	General Description	Conservation Driver	Area	Vessel Type	Survey Date
SISP (06/08)	Selectivity of North Sea *Nephrops* gear using 100–120mm square mesh panels. Aim - identify mesh size for SMP positioned in the taper which will provide a compromise between allowing sufficient juvenile cod, haddock and whiting to escape while retaining viable quantities of marketable fish and Nephrops. Method - Selectivity of up to 3 configurations of SMP in two different codends made from netting of 80mm and 90mm single twine. SMP at end of tapered portion of net within the legal maximum distance from the end of the codend.	Reduce whitefish (cod, haddock and whiting) discards in mixed *Nephrops*/whitefish fisheries.	North Sea	Twin-rig vessel	14–28 April 2008

Funding	General Description	Conservation Driver	Area	Vessel Type	Survey Date
SISP (07/08)	Effect on selectivity of different mesh sizes and positions of square mesh panel for vessels of large and small horsepower Aim - improve selectivity for juvenile fish in Nephrops gears. Anecdotal evidence- smaller low powered vessels more selective than higher power vessels. Method - Large SMP for range of different mesh sizes (>140mm) tested on a larger powered (>500hp) Nephrops twin trawl vessel. Positioning the panels at the end of the trawl's tapered section. Also tested on lower powered vessel to assess effectiveness at reducing discards but still maintaining Nephrops catches.	Reduce discards of juvenile fish in gears used to target *Nephrops*	West Coast	1. >500hp *Nephrops* twin-rig vessel 2. l50–250 hp single trawl vessel	3–12 June 2008
SISP (08/08)	Selectivity of *Nephrops* gear using square mesh panels on small vessels on North Sea inshore grounds. Aim - identify the mesh size for an SMP positioned in the taper which will eliminate discards of cod, haddock and whiting while retaining viable quantities of Nephrops Method - measure selectivity of up to 3 configurations of SMP with an 80mm codend on a low-powered twin-rig trawler. Method -	Reduce whitefish (cod, haddock and whiting) discards in mixed *Nephrops*/whitefish fisheries	North Sea (Inshore)	Low-powered twin-rig vessel	Early August 2008
SISP (09/08)	Trial to reduce cod bycatch by modification of a commercial whitefish trawl to incorporate large meshes in the lower wings and belly sheet Aim - To modify an existing whitefish trawl by inserting very large diamond mesh netting panels into the belly sheet and lower wings to allow an escape route for juvenile cod but still retaining other commercially important ground fish species.	Reduce mortality on cod, and particularly juvenile cod	North Sea	Whitefish twin-rig vessel	23 June – 4 July 2008

Funding	General Description	Conservation Driver	Area	Vessel Type	Survey Date
SISP 0?/07	West of 4 – Windsock Aim - to evaluate the effects of windsock closure on catch rates within and without the closed area Method – The study will use a charter vessel which has worked the windsock and adjacent area prior to closure and has diary records of this. The survey will then resample these tows to establish catch rate changes	Evaluation of closure effect	NW of Scotland	Whitefish single trawl vessel	10–19 March 2008
SISP 0?/07	GOV twinning. Aim – to investigate the potential for twin trawling the GOV with a similar sized commercial net. To carry out trials to illustrate the relative catch rates of the two nets Method – 10 days trials to establish technical feasibility of twinning the two nets, followed by 10 days of tows on IBTS and other stations	Confidence in FRS survey trawl especially for cod	North Sea	>1000hp Whitefish twin-rig vessel	19 May-1 June 2008
SGMD (SLA)	*Nephrops* size selectivity using grids, meshes round or square mesh belly panels. Aim – Evaluate a range of proposed gear modifications to allow escape of undersized Nephrops Method – Standard twin trawl selectivity with small mesh cod end on control and gear modification on the test net	Improve selectivity for *Nephrops*	North Sea	>500hp *Nephrops* twin-rig vessel	Early December 2008

Funding	General Description	Conservation Driver	Area	Vessel Type	Survey Date
SGMD (SLA)	Selectivity of whitefish mixed fisheries, particularly cod selectivity Aim – to evaluate the use of a flexible sorting grid combined with the horizontal separator panel. The horizontal panel has been shown to be effective in separating cod (plus anglers and flats) below the panel from haddock and whiting above. The grid is planned to allow retention of large fish from the lower part of the net while allowing smaller and younger fish to escape. Method – A flexible grid will be installed in the lower part of the net. Orientation of the grid and the behaviour of the fish at the grid will be monitored by TV camera.	Reduce discards of cod in gears used to target whitefish	North Sea	>1000hp Whitefish twin-rig vessel	Mid February 2009

Catchability in Survey trawls

FRS has just completed a 3 year project on the catchability of commercial fish in the GOV & angler fish survey trawls. The core work was on quantifying herding and ground gear escapes in the angler trawl. Additional work was centred on the GOV and involved developments of the Levy et al intercalibration design and on ground gear escapes. The work is reported in papers below.

Jones, E.G., Jones, M., Greig, T., Campbell, M. and Reid, D. G. Quantification of entrance position and catch rate of fish in a survey trawl in relation to season and time of day using multi-beam sonar and video cameras. Presented at ICES Symposium on "Fishing gear in the 21st Century", November 2006, Boston, USA.

Kynoch, R.J., Peach, K. & Reid, D.G. To assess the effect of a GOV (Chalut 36/47) rigged with a modified rockhopper ground gear on gear geometry and survey trawl catches using the alternate haul method Presented at ICES Symposium on "Fishing gear in the 21st Century", November 2006, Boston, USA.

Reid, D. G., Bova, D.J., Peach, K., Jones, E.G., Kynoch, R.J. & Fernandes, P.G. Angler fish catchability for swept area abundance estimates in a new survey trawl. Presented at ICES Symposium on "Fishing gear in the 21st Century", November 2006, Boston, USA.

Reid, D. G., Kynoch, R. J., Penny, I., & Peach, K. (2007). Estimation of catch efficiency in a new angler fish survey trawl. Presented at ICES Annual Science Conference, Helsinki, Finland, September 2007. ICES CM2007/Q:22.

Fernandes, P. G., Armstrong, F., Burns, F., Copland, P., Davis, C., Graham, N., Harlay, X., O'Cuaig, M., Penny, I., Pout, A. C., & Clarke, E. D. (2007). Progress in estimating the absolute abundance of anglerfish on the European northern shelf from a trawl survey. Presented at ICES Annual Science Conference, Helsinki, Finland, September 2007. ICES CM 2007/K:12.

Benthic impact of trawl components

This is an ongoing project linked to EU project DEGREE on modelling and filed trials to allow the evaluation of benthic impact in terms of physical impact, biological impact and resuspension of sediments

Capacity, Effort and Mortality

As part of the ongoing EU project FRS are working on fine scale movements and fishing behaviour in the Scottish pelagic fleet, and on modelling the links between capacity, effort and mortality. Final report is programmed for February 2009.

Other publications from the group in 2007/08 are listed below:

Bez, N., Reid, D.G., Bouleau, M., Beare, D.J., Neville, S., Vérin, Y., Godø, O.R. and Gerritsen, H. (2007) Acoustic data collected during and between bottom trawl stations: consistency and common trends. Can. J. Fish & Aquat. Sci. 64, 166–180.

Bullough, L., Riley, D., Napier, I. R., Fryer, R. J., Ferro, R. S. T., & Kynoch, R. J., 2007. A yearlong trial of a square mesh panel in a commercial demersal trawl. Fisheries Research 83 (2007):105–112.

Ferro, R.S.T., Jones, E.G., Kynoch, R. J., Fryer, R.J. & Buckett, B.E. (2007) Separating species using a horizontal panel in the Scottish North Sea whitefish trawl fishery. ICES Journal of Marine Science; 64: 1543 - 1550.

Fonteyne, R., Buglioni, G., Leonori, I. and O'Neill, F.G., (2007). Review of mesh measurement methodologies. Fisheries Research, 85, 279 – 284.

Fonteyne, R., Buglioni, G., Leonori, I., O'Neill, F.G. and Fryer, R.J., (2007). Laboratory and field trials of OMEGA, a new objective mesh gauge. Fisheries Research, 85, 197 – 201.

Graham, N., Ferro, R.S.T., Karp, W.A. and MacMullen, P. (2007).Fishing practice, gear design, and the ecosystem approach—three case studies demonstrating the effect of management strategy on gear selectivity and discards. ICES Journal of Marine Science: 64: 744–750;

Herrmann, B., Frandsen, R., Holst, R, O'Neill F.G. (2007). Simulation-based investigation of the paired-gear method in cod-end selection studies. Fisheries Research, 83, 175 – 184.

Ingolfsson, O´. A., Soldal, A. V., Huse, I., and Breen, M. 2007. Escape mortality of cod, saithe, and haddock in a Barents Sea trawl fishery. – ICES Journal of Marine Science, 64: 1836–1844.

O'Neill, F.G., (in press). Source models of flow through and around screens and gauzes. Ocean Engineering.

O'Neill, F.G. and Herrmann, B., (On line). PRESEMO – a predictive model of cod-end selectivity– a tool for fisheries managers. ICES J. Mar. Sci.,64: 1558 - 1568.

Reid, D.G., Allen, V.J., Bova, D.J., Jones, E.G., Kynoch, R.J., Peach, K.J., Fernandes, P.G. & Turrell, W.R. 2007. Angler fish catchability for swept area abundance estimates in a new survey trawl. ICES J. Mar. Sci., 64: 1503 - 1511.

Reid, D.G., Annala, J. Rosen, S., Pol, M., Cadrin, S.X., and Walsh, S.J. 2007. Survey sampling tools: Challenges, Themes and Questions. ICES J. Mar. Sci.; 64: 1607 - 1609.

Sala, A., O'Neill, F.G., Buglioni, G., Lucchetti, A., Palumbo, V. and Fryer, R.J. 2007. Experimental method for quantifying the resistance to opening of netting panels. ICES J. Mar. Sci., 64: 1573 - 1578.

Anderson, J.T., Holliday, D.V., Kloser, R., Reid, D.G. and Simard, Y. (in press). Acoustic Seabed Classification: Current Practice and Future Directions. ICES J Mar Sci.

Madsen, N., Skeide, R., Breen, M. Krag, M, L., Huse, I., Soldal, A.V. (In press). Selectivity in a trawl codend during haul-back operation—An overlooked phenomenon. Fisheries Research xxx (2007) xxx-xxx

O'Neill, F.G. and Neilson, R.D., (in press). A dynamic model of the deformation of a diamond mesh cod-end of a trawl net. ASME Journal of Applied Mechanics.

O'Neill, F.G., Kynoch, R.J. and Fryer, R.J., (in press). Square mesh panels in North Sea demersal trawls: separate estimates of panel and cod-end selectivity. Fisheries Research.

19.13 USA

Massachusetts Division of Marine Fisheries - Conservation Engineering Program

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

Further Testing of Cod-Avoiding Trawl Net Designs

Two flatfish trawl nets designed to reduce catch of Atlantic cod, the Ribas and Topless nets, were compared against a standard flatfish net onboard a commercial fishing vessel working around the clock. The Ribas net uses large mesh panels in its top section; the Topless net has the top section from the wings back to the belly removed. The Topless net significantly reduced catches of Atlantic cod and sub-legal-sized yellowtail flounder; the Ribas net showed no differences. Significant diurnal differences in the Topless net's catching efficiency for Atlantic cod *Gadus morhua*, sub-legal yellowtail *Limanda ferruginea*, American plaice, and winter flounder were found. Our results imply that light levels affect the behaviour and reaction of these species to trawl nets. A manuscript titled, "Diurnal Variation within the Species Selective 'Topless' Trawl Net" was submitted to the Journal of Ocean Technology.

Development of the Five Point Haddock Trawl

Continued investigation of this semi-pelagic cod-avoiding haddock *Melanogrammus aeglefinus* trawl focused on determining the stability of the net. Imaging of the net with a Towed Underwater Vehicle and underwater cameras and net mensuration in April 2008 demonstrated stability at varying speeds and over diverse bottom types. Viewing of the footrope is planned for the future.

Experimental Haddock Demersal Longline Fishery in Coastal Massachusetts

Norbait© 700E, clams, and herring were tested for catch of haddock and Atlantic cod using longlines in a cod conservation zone during April and May 2007. Trials on a commercial fishing vessel demonstrated that Norbait had lower catches of cod than either natural bait, and the lowest ratio of cod to legal-sized haddock (0.38). Interactions of bait type, area of set, and trip confounded the effects of bait on catch. A manuscript was submitted for the 2007 Haddock Symposium volume of Fisheries Research.

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

We fished three different (tied-down) gillnet mesh sizes for monkfish (10, 12, 14-inch; (254, 305, 356 mm) in collaboration with a commercial fisherman to determine selectivity curves, and to measure differences in monkfish length and/or weight. Final field trips are currently being completed; preliminary data show increasing monkfish length with increasing mesh size.

Factors Affecting Trap Hauler Design and Tuning

Minor changes to lobster gear hauling equipment can affect the length of service life of non-buoyant (sinking) groundline used to reduce risk if cetacean entanglement in fixed fishing gear. Using a rope-wear simulator equipped with an offshore lobster trap hauler, the effect on rope damage of sheave profile and angle, the depth at which the rope rides, sheave and knife material, and knife shape are under investigation.

Future Work

Primary work planned for 2008–2009 includes filming and development of a rigid grid to exclude spiny dogfish (*Squalus acanthias*) in a small-mesh whiting (*Merluccius bilinearis)* fishery and seasonal comparison of Newfoundland and Norwegian cod pot designs.

NOAA Fisheries Northeast Fisheries Science Center - Cooperative Marine Education and Research Program, Virginia Institute of Marine Science

The repulsive and feeding deterrent effects of an electropositive alloy (palladium neodymium mishmetal) on juvenile sandbar sharks (*Carcharhinus plumbeus*)

Richard W. Brill (rbrill@vims.edu), Peter Bushnell, Leonie Smith, Coley Speaks, and John Wang

This study was undertaken to measure changes in the behaviours of captive juvenile sandbar sharks (*Carcharhinus plumbeus*) in the presence of an electropositive alloy (palladium neodymium mishmetal). Our ultimate objective is to determine if electropositive alloys might be used to reduce shark bycatch in the pelagic longline fisheries. Palladium neodymium mishmetal clearly altered the swimming patterns of individual animals and temporarily deterred feeding in groups of sharks. Individual sharks would generally not approach ingots closer than 60 cm, nor attack pieces of cut bait suspended within approximately 30 cm. The latter effect was, however, relatively short lived perhaps due to social facilitation of feeding. Palladium neodymium mishmetal clearly exhibits the potential to repel sharks from longline gear, although optimal size and shape, distance to baited hooks, etc. remain to be determined. Behavioural assays with captive juvenile sandbar sharks clearly provide an effective stratagem for testing and optimizing the use of electropositive alloys as a shark bycatch reduction method.

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

Cliff Goudey (cgoudey@mit.edu)

Reduced Impact Scallop Dredge

CFER has developed and tested a new scallop dredge design that eliminates the normal cutting bar, using hydrodynamics to encourage the lifting and capture of scallops. The Hydro dredge design was developed under a $25,000 seed grant from the Northeast Consortium (a funder of cooperative research in New England). The design is based on tow-tank testing of the effectiveness of various hydrodynamic devices at raising scallops off the bottom. A prototype 2.1-m dredge was constructed and observed in-situ and evaluated in fishing trials on Stellwagen Bank. Follow-on research has occurred in collaboration with the University of Wales, Bangor and the Dept. of Agriculture, Fisheries and Forestry on the Isle of Man. Testing of the new dredge occurred out of the fishing port of Douglas both in April and August of 2007 in a commercial fishery for the great scallop (*P. maximus*). In these tests the Hy-

drodredge was less efficient at catching these scallops compared with the toothed Newhaven dredges. However, the new dredge was found to be significantly less damaging to the catch. In addition, the Hydrodredge was found to be especially effective on queenies (*A. opercularis*), a scallop that, like the giant sea scallop (*P. magellanicus*), the New England species for which the design was originally intended, does not burrow in the seabed.

Work in the US has ceased until additional funding for development and further testing can be secured. With CFER cooperation, a 4.6 meter Hydrodredge has been built by a fishing company in Canada and it will be tested in April 2008 in the Canadian fishery. Hydrodredge technology is also being evaluated in The Netherlands in collaboration with Machinefabriek TCD/Visserijcoöperatie Urk and IMARES. A four-meter Holland beam trawl has been fitted with wheels and cups to evaluate their effectiveness on flatfish.

Acoustic control of trawl door altitude

A system designed to eliminate the seabed impacts of trawl doors is under development with support from the MIT Sea Grant College Program. The system will control the height of the trawl door using altitude measurements of a door-mounted sonar. Based on a setting established before the tow, the doors will descend to a specified height and then "terrain follow." The technology will allow the exploitation of low-swimming pelagic species and higher-swimming demersal species. It will operate independently as long as the trawl-wire scope and towing speed are kept within a prescribed range. Therefore, the system will be useful to smaller vessels without the complexity and cost of acoustic-link sensors or an auto-trawl system.

Tank tests of half-scale models were conducted in April 2008 at the St. John's flume tank. Excellent performance of the system was revealed, both on high-aspect midwater doors and low-aspect bottom doors. The acoustic sensor, microprocessor controller, and DC motor actuators have been completed, but further development is on hold. Our next steps are to implement the prototype system on a pair of 2.25 sq. m. slotted trawl doors and demonstrate its functionality in the New England groundfishery.

Whale-safe fishing gear

CFER continues its efforts to introduce the Whale-Safe Buoy into fixed gear fisheries to reduce the entanglements of marine mammals and endangered species and the loss of gear from buoy-line weak links. By including a stem beneath the buoy with gradual taper and stiffness, the gear is readily shed from whales at low tension in the line, discouraging an encounter from progressing into an entanglement. Release loads are typically less than 10% of the buoy line weak-link requirements under the Atlantic Large Whale Take Reduction Plan. This is not only beneficial to whales, but also reduces gear loss from weak-link failures. Work will continue on this innovative buoy as funding allows.

Energy Efficient, Novel Fishing Systems

CFER has formalized a program to explore opportunities to improve the energy efficiency of commercial fishing through the development of innovative methods and technology. These initiatives range from waste-heat refrigeration, to passive midwater fish traps, to fish attraction and control using light and acoustics, to the recapture of acoustically trained fish released from hatcheries. CFER seeks collaborators to broaden the scope of each of these programs.

University of Rhode Island – Rhode Island Sea Grant

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

Bycatch Reduction in the Directed Haddock Bottom Trawl Fishery

After successful field testing (significant reduction of cod, yellowtail flounder, winter flounder, witch flounder, and American plaice, as well as other species such as monkfish and skate – with no reduction in haddock), the "Eliminator" trawl was submitted to the World Wildlife Fund 2007 Smart Gear Competition and won the grand prize. Underwater videoing of the net is being conducted, funded using a portion of the Smart Gear prize. In addition, a grant was received through the NOAA Northeast Fisheries Science Center (NEFSC) to investigate a smaller version of the Eliminator, designed to fit fishing vessels with horsepower between 250 and 550. Sea sampling will begin in 2008.

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

This project is entering its fifth year of funding by the Mid-Atlantic Research Set-Aside (RSA). It is designed to collect scup from hard bottom sites in Southern New England, which are un-sampled by current state and federal finfish trawl surveys. Two commercial vessels are conducting the fieldwork and the University of Rhode Island Rhode Island Sea Grant (URI RISG) is leading the data analysis and report preparation. Staff from the RI Department of Environmental Management Division of Fish and Wildlife (RIDEM DFW) and the Massachusetts Division of Marine Fisheries (MADMF) are collaborating on the project. The age distributions of the catch will be statistically compared to each of the other collection sites, to finfish trawl data collected by the National Marine Fisheries Service (NMFS) and the RIDEM DFW.

Development of a Behavioural Assay to Estimate Discard Mortality of Summer Flounder and Winter Flounder

Funding was received through RISG to conduct research to develop and validate a Reflex Action Mortality Predictor (RAMP) and visual marker index for predicting delayed discard mortality of summer and winter flounder. The goals of the project include: (1) Identify specific behavioural reflex actions and visual markers of summer and winter flounder for use as indicators in a RAMP assay/index, and (2) validate the accuracy of the RAMP and visual marker index for predicting delayed mortality of trawl caught flounder. Research is expected to begin in the fall of 2008.

Fisheries Gear Research Database

The program developed and maintains a searchable database of fisheries research and outreach projects, completed and ongoing, funded over the last thirty years by various funding agencies: http://www.uri.edu/seagrant/fisheriesgear/. This valuable tool covers information on fisheries related projects in monitoring, bycatch, gear type, biology, essential fish habitat, cooperative research, and data collection. Searches can be conducted on one category or multiple categories to view project details, reports, and related websites.

Interactions between Sea Turtles and Vertical Lines in Fixed Gear Fisheries

A workshop was held to discuss interactions between sea turtles and the vertical lines of fixed gear fisheries with NMFS support. The main objectives of the workshop were: (1) to gain a common understanding of sea turtle interactions with the vertical

lines of fixed gear fisheries, including the nature of the entanglements; (2) to explore potential options for reducing the bycatch of sea turtles in vertical lines; and (3) to explore ways to improve disentanglement response and reporting.

Emerging Strategies for Improving Fisheries Management

A workshop on "Emerging Strategies for Improving Fisheries Management" was held with support from the Walker Foundation. This workshop was intended to build upon the successful 2005 fisheries workshop held in California and the important initiatives that emerged among the participants of that conference. The goal of the workshop was to advance the cause of fisheries self-governance by assembling both commercial and recreational fishermen to discuss case studies of successful management, research, and marketing. The workshop had an Atlantic Ocean focus, but drew upon select examples from other North American, Icelandic, and Norwegian case studies. Further information can be found at the Walker Foundation website.

Sector Allocation as a Management Tool

The focus of this regional workshop was to provide education and information on sector allocation as a management tool, and exploring how this method might be applied to New England's quota-managed fisheries. The workshop was intended to answer questions on how sectors function, and to discuss the pros and cons of this approach. Presenters included commercial fishermen, fisheries managers, government agency spokespersons, and members of the private sector and academic institutions. The workshop was held in January 2008 and materials (including proceedings – when completed) are available on the website: http://seagrant.gso.uri.edu/fisheries/sector_allocation/index.html.

Menhaden Science and Policy Symposium

A workshop on "Menhaden Science and Policy" was conducted in November 2007, co-sponsored by RISG and the RIDEM DFW. The objectives of the meeting were to provide background information on the state of science of menhaden and to gather information for effective management of the resource. Topics discussed included menhaden life history, history of the menhaden fishery, current coast-wide stock assessment, current stock assessment for Narragansett Bay, and the ecological value of menhaden. Following the presentations, a panel of menhaden resource stakeholders discussed resource allocation. Proceedings are available on the website: http://seagrant.gso.uri.edu/fisheries/menhaden/index.html.

Gulf of Maine Research Institute – Portland, Maine

Shelly M.L. Tallack (stallack@gmri.org)

Can Rare Earth Metals Deter Spiny Dogfish? A Feasibility Study on the use of Mischmetal to Reduce Dogfish Catches in Hook Gear in the Gulf Of Maine

Spiny dogfish, *Squalus acanthias*, are considered to be unacceptably abundant by many inshore fishermen (commercial and recreational) during the summer and fall in the Gulf of Maine. Finding a practical and economic dogfish deterrent for application in various fishing gears is of strong interest. Industry-science collaboration afforded six research trips during September 2007. Triangular slices of a cerium/lanthanide alloy ('Mischmetal') were incorporated into baited hook gears (longlines and rod and reel gear) and the catches were compared for 'treatment' (Mischmetal present) versus 'control' (mischmetal absent). Some reduction in dogfish catch was recorded for rod

and reel (~2%) and longline (~9–25%), but these results were not statistically significant. One complicating factor was the high rate of Mischmetal dissolution, which led to the rapid disintegration of the Mischmetal slices. In situ video footage verified that dogfish feeding behaviour is persistent on bait, regardless of Mischmetal presence. This footage also showed that bait pursuit by one dogfish would escalate to frenzied feeding by multiple dogfish, with or without Mischmetal. Overall, there is little evidence to suggest that Mischmetal has the potential to reduce dogfish catches in either commercial or recreational gear types in the Gulf of Maine.

New England Aquarium – Boston, Massachusetts

John W. Mandelman, Ph.D. (jmandelman@neaq.org)

The Shifting Baseline of Threshold Feeding Responses to Electropositive Metal Deterrents in Two Species of Dogfish

Due to the potential repercussions for fisheries, the use of electropositive rare earth metals to deter sharks from interacting with baited fishing gears is undergoing extensive investigation across multiple species. This lab-based study aimed to assess the behavioural responses to rare-earth metal variants in a squaloid, the spiny dogfish (*Squalus acanthias*), and a triakid, the smooth dogfish (*Mustelus canis*), two species commonly captured as bycatch in western North Atlantic commercial and recreational fishing operations. In species-specific trials, tank-acclimated animals were exposed to squid-baited hook-gear setups. Either a lanthanide/cerium alloy ("mischmetal") or rare-earth magnet (neodymium-iron-boride), and corresponding chemically inert stainless steel decoys were deployed just above (mock) hooks to "protect" associated baits. In total, 89 videotaped trials were conducted, in which the response behaviour (e.g. approaches, flinches, general avoidances, complete disregard, bites) of dogfish around the baits/metals was carefully monitored. A nested repeated measures design was utilized where animals were changed out weekly to reduce the potential for learned behaviour, and to enhance the overall sample of experimental animals. Relative to decoys, spiny dogfish were significantly more averse (e.g. > rate of avoidances and flinches; lower bite rate) to alloys, and smooth dogfish to magnets, when trials followed same-day routine feedings. However, bait selectivity in both species progressively declined in trials following 2- and 4-day periods of food deprivation, whereby the repellents no longer had any effect. Animal density (either three or 15 animals per tank trial) had no effect on selectivity regardless of hunger level. Results suggest that once a threshold hunger level is surpassed, neither metal variant appears to effectively repel these two dogfish species. The significant interspecific variation in response to the two metals when satiated indicates possible divergences in sensory processing of the metallic repellents and associated behaviours between the two species.

University of New Hampshire

Pingguo He (pingguo.he@unh.edu)

Species Separation in Groundfish Trawls

A project to test a rope separator haddock trawl was completed. A raised footrope haddock trawl was designed and tested at sea. The trawl rigging with its fishing lines 1 m off seabed seemed most suitable for reducing cod catch (by 63%) while maintaining haddock catch (9% reduction), when compared with regular rock hopper groundgear with fishing lines 0.15 m off the seabed. A project to reduce small monkfish in a monkfish trawl is being planned. The design incorporates various grid de-

signs to separate the monkfish by sizes, and to reduce small groundfish species. An international haddock symposium was organized and held in 25–26 October, 2007 in Portsmouth, New Hampshire, USA. Selected papers are being reviewed for publication in a special volume in Fisheries Research.

Bycatch Reduction in Groundfish Gillnets

Demersal gillnets of various vertical heights, different hanging ratios and twine sizes were tested to compare species composition of their catch to evaluate whether a lower vertical nets with slack hanging and finer twine can be used to harvest flounders and reduce catch of cod.

Bycatch Reduction in Shrimp Trawls

A project to design and test a topless shrimp trawl to reduce pelagic species bycatch was completed with success. The topless trawl was able to reduce herring and other pelagic species without loss of shrimp. The design has since been used by a local fisherman for commercial use and reported good results. Another shrimp trawl project to modify the Nordmore grid was also completed. Three designs of modified grid systems were tested. A size-sorting grid installed in from of the main Nordmore grid was able to reduce small shrimps by 30 to 40 count/kg when shrimps caught by a net with a regular grid were about 130 to 160 count/kg. A combined rope grid and size sorting grid was able to reduce both small shrimps and finfish bycatch. Further work on the size-sorting grid and modified Nordmore grid is being planned to optimize the design for maximum reduction of small shrimps and finfish.

Reducing Seabed Impact of Trawling

A preliminary project to design and test a wheeled groundgear to reduce seabed impact in the whiting fishery has been completed. Further work is being planned to improve the design including flume tank testing and sea trials.

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

Laboratory investigation of rare earth metal and magnetic deterrents with spiny dogfish and Pacific halibut

Michael W. Davis (michael.w.davis@noaa.gov), Allan W. Stoner (al.stoner@noaa.gov), Steve M. Kaimmer (stevek@iphc.washington.edu)

Spiny dogfish (*Squalus acanthias*) comprise a significant unwanted bycatch on demersal longlines set for halibut and cod in shelf waters of the east and west coasts of North America. In this laboratory study, attacks on baits were tested in the presence of 2 different rare-earth materials (neodymium-iron-boride magnets and cerium mischmetal) believed to deter elasmobranch catch. Experiments were made with spiny dogfish and with Pacific halibut (*Hippoglossus stenolepis*) in pairwise tests of the rare-earth materials and inert metal controls. Dogfish attacked and consumed baits tested with cerium mischmetal at a lower frequency than controls. Times to attack the baits were significantly higher in the presence of mischmetal, as were numbers of approaches before first attack. The time differential between mischmetal and control treatments and the number of baits consumed converged with increasing food deprivation (1 hr, 2 d, 4 d), but treatment differences were always significant. Cerium mischmetal appeared to be irritating to dogfish and may disrupt their bait detection and orientation abilities. Magnets also appeared to irritate dogfish but provided no protection for baits in feeding trials. Pacific halibut showed no reaction whatsoever to

the rare-earth magnets or cerium mischmetal. Mischmetal, therefore, may be useful in reducing spiny dogfish bycatch in the halibut fishery. Disadvantages in using mischmetal in commercial operations are expense, hazardous nature, and relatively rapid hydrolysis in seawater.

Assessing probability of discard mortality in two Alaska crab species using reflex impairment

Allan W. Stoner (al.stoner@noaa.gov), Craig S. Rose, J. Eric Munk, Carwyn F. Hammond, Michael W. Davis

Delayed mortality associated with discards of both crabs and fishes has ordinarily been observed through tag and recovery studies or prolonged holding in deck tanks, and there is need for a more efficient assessment method. Six reflexes were identified in *Chionoecetes bairdi* (Tanner crab) and *C. opilio* (snow crab) that combine to provide a useful index of crab condition and close relation to subsequent mortality. Crabs collected with bottom trawls in the Bering Sea were evaluated for reflex impairment and injuries, and held to track mortality. Logistic regression revealed that reflex impairment provided the most parsimonious predictor of delayed mortality in *C. opilio* (91% correct predictions). For *C. bairdi*, reflex impairment along with injury score resulted in 82.7% correct predictions of mortality, and reflex impairment alone resulted in 79.5% correct predictions. The relationships were independent of crab gender, size, and shell condition, and predicted mortality in crabs with no obvious external damage. Reflex Action Mortality Predictors (RAMP) provides substantial improvement over earlier mortality predictors and will help to increase the scope and replication of fishing and handling experiments. The approach should be equally valuable for a wide range of crustaceans.

International Pacific Halibut Commission - Seattle, Washington

Effect of hook size and hook spacing on the setline catch of Pacific halibut

Bruce Leaman and Steve Kaimmer (stevek@iphc.washington.edu)

The 2007 experiment continued a 2005 experiment where fishing hook spacing's from 3.5 to 18 ft (1.1 – 5.5 m) and hook sizes from 13/0 to 16/0 were fished to estimate the effects of these combinations on the weights and sizes of Pacific halibut on setlines. Results generally show increasing catch rate by weight with increasing spacing, although higher fish densities diminish this effect. Hook size had little effect on the catch of larger fish but smaller hooks caught smaller fish. The data are currently undergoing more detailed analysis.

Determining the hooking success of Pacific halibut on circle hooks on setline gear

Steve Kaimmer (stevek@iphc.washington.edu) and Steve Wischniowski

In 2007 we used a DIDSON sonar to observe hook attacks and hooking success of Pacific halibut at 100 fm (183 m) water off Kodiak Island in Alaska. The 2007 effort observed attacks on 16/0 circle hooks. In ten days, we observed 133 hook attacks resulting in 45 captured fish. Fish lengths ranged from 53 to 141 cm. The data collected describe a hooking success curve that is very close to that predicted by our ongoing stock assessment model, suggesting that the gear selectivity in this area is entirely a function of fish size and hooking success. In 2008, we intend to collect more observations with large fish on the 16/0 hooks, as well as a set of observations using the smaller 13/0 hooks which are common in the Pacific cod (*Gadus macrocephalus*) fisheries in the area.

Reducing the bycatch of spiny dogfish by using mischmetal on commercial setline gear

Steve Kaimmer (stevek@iphc.washington.edu) and Allan Stoner (al.stoner@noaa.gov)

This was a cooperative project between the IPHC and NOAA Fisheries Alaska Fisheries Science Center, Fisheries Behavioural Ecology Program, Newport, Oregon. Following a successful laboratory experiment, we fished halibut setline gear near Homer, Alaska comparing hooks with and without pieces of mischmetal, an ionically-active alloy of lanthanide metals, attached to the hooks. We did achieve a statistically significant 20% reduction in the catch of dogfish (*Squalus acanthias*) on the mischmetal gear. There was no associated increase in the catch of halibut. Rapid dissolution in seawater and the expense of the mischmetal would limit broad application of its use as a shark deterrent.

Assessing the effect of swivels on the setline catches of Pacific halibut and bycatch species in British Columbia

Steve Kaimmer (stevek@iphc.washington.edu)

Most vessels using snap-in gear to fish for halibut in British Columbia and southeastern Alaska have swivels attached to their gear, either near the snap or on the hook. During 2008, we will assess the effects of swivels on the catches of halibut and bycatch, particularly rockfish. Based on fishermen's accounts, we expect to catch more halibut, and perhaps much more rockfish, on the swivel equipped gear. It is believed that on gear without swivels, many fish spiral during the retrieval process, twisting and weakening the gangion, or wrapping up so tightly that continued spiralling results in the fish coming off the hook.

Oregon Department of Fish and Wildlife - Marine Resources Program

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

Bob Hannah (bob.w.hannah@state.or.us), Troy Buell

We expanded our study of how increasing the height of angled baits above the bottom using long leaders (4.6 m) inserted between the lowermost bait and the terminal weight (long-leader gear) altered the species and size composition of the recreational catch off the Oregon coast. Specifically, we expanded the study reported on last year to include separate sub-studies of the effectiveness of long-leaders when angling with only small lures or flies or with large whole bait, and conducted additional work to examine gear interaction effects. Side-by-side fishing with long-leader and control gear showed a strong reduction in the catch of demersal rockfishes, including yelloweye rockfish, with long-leader gear, with negligible effects on catch rates of target species (Pacific halibut or black rockfish). Replicate drifts over the same habitat, with and without the control gear, showed that when fishing only small lures or flies for black rockfish the bycatch reduction effect was robust to which gear was presented first. However, when fishing with large whole baits for Pacific halibut, the bycatch reduction seen for yelloweye rockfish disappeared when long-leader gear was presented first. This suggests that there is a potential to use long-leader gear to reduce the bycatch of demersal rockfish in recreational fisheries, but only in fisheries that can be successfully prosecuted with small lures and flies only, not large whole baits.

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

Bob Hannah (bob.w.hannah@state.or.us), Nancy Gove (NMFS Northwest Fishery Science Center)

We analyzed NMFS Northwest Fishery Science Center observer program data to evaluate the effectiveness of selective flatfish trawls (required nearshore since 2005) at reducing canary rockfish bycatch in the nearshore groundfish trawl fishery off Oregon and Washington. The data showed that some vessels were using selective flatfish trawls effectively while some were not and the fishery as a whole had exceeded the canary rockfish bycatch rates projected from research studies and a large-scale fishery test. Analyses aimed at determining if the nets being fished had excessive rise were inconclusive, however anecdotal comments from fishers and net shops indicated that nets with excessive rise were being fished by some vessels. A recommendation to change the legal definition of selective flatfish trawls to better restrict overall rise was forwarded to the Pacific Fishery Management Council.

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

Bob Hannah (bob.w.hannah@state.or.us), Steve Jones

We tested a rigid-grate BRD in the Oregon shrimp trawl fishery that incorporated a lower section designed to allow the escapement of undersize shrimp and an upper section that allows shrimp to pass into the codend but excludes all large and medium-sized fish. The grate did increase the average size of shrimp in the codend, and excluded fish well but also caused significant shrimp loss above that expected from just the escape of very small shrimp. Underwater video showed that the narrowly spaced sorting grid was causing excessive water flow towards the fish escape hole. This research showed that rigid-grate BRDs that also size-sort shrimp are possible but that a different design is needed.

ROV survey of soft-bottom habitats affected by shrimp trawling

Bob Hannah (bob.w.hannah@state.or.us), Steve Jones, and William Miller

We conducted an extensive ROV survey of mud-bottom habitats in four areas near Nehalem Bank to study the impacts of shrimp trawls on macro-invertebrate populations. The four study sites have quite disparate trawling histories and two of the sites are within the Nehalem Bank no-trawl zone established in 2006. The study has two main goals; determine if differences in macro-invertebrate populations correspond with differences in trawling history as shown in logbook data and to establish a baseline macro-invertebrate survey that can be used to examine long-term changes in macro-invertebrate populations going forward as two of the areas continue to be trawled and two remain closed. Field work was completed in 2007.

20 New Business

20.1 Date and Venue for 2009 WGFTFB Meeting

The **ICES–FAO Working Group on Fishing Technology and Fish Behaviour** [WGFTFB] (Chair: Dominic Rihan, Ireland) will meet in Ancona, Italy from 18-22 May 2009

20.2 Proposals for 2009/2010 ASC – Theme Sessions

It is proposed to hold a theme session at the ICES ASC with following objectives:

1. Case studies on directed elasmobranch fisheries documenting catch levels over time or changes in fishing patterns
2. Research with technical mitigation measures used to reduce the bycatch of elsamobranch species; and
3. Studies using other management strategies including spatial or temporal closures, bycatch limits to protect elsamobranch species.

Conveners: Dominic Rihan (BIM, Ireland) and Chair of WGEF (TBC)

Scientific Justification

Fisheries for elasmobranchs are common throughout the world (Bonfil 1994). The life histories of many of these species make them highly vulnerable to human exploitation or unintended mortality and therefore the incidental bycatch associated with commercial fishing operations, leading in most cases to mortality, is an issue of global concern. Historically, some of these fisheries have shown rapid declines in abundance, presumably linked to long gestation periods. It is fair to say that to date most available mitigation techniques used to reduce charismatic species bycatch have been directed at reducing the bycatch of marine mammals. Elasmobranchs including large sharks and species such as manta ray are at risk due to conflicts with fishing operations but to date have received limited bycatch mitigation attention. Nonetheless in the course of research into mitigation devices for release of marine mammals, reduction in elsamobranch bycatch have been observed e.g. Mauritanian pelagic fisheries. A comprehensive review of such work has not been carried out. In addition, high local abundances of small coastal sharks and dogfish species, particularly Squalus acanthias, can impede commercial fisheries for other fishes, as large opportunistic catches are quite common. Little or no research has been carried out into ways of reducing these catches yet there is increasing pressure from managers to do so.

20.3 ICES and other Symposia

ICES Symposium on the Ecosystem Approach with Fisheries Acoustics and Complementary Technologies will be held at the Institute of Marine Research in Bergen, Norway, 16–20 June 2008. Co-Conveners: Egil Ona (Norway), Rudy Kloser (Australia), and David Demer (USA).

An ICES Symposium on the Collection and Interpretation of Fishery Dependent Data will be held during the summer 2010, in Galway, Ireland. Convenors: N. Graham (Ireland), K. Nedreaas (Norway), and W. Karp (USA).

20.4 Any Other Business

From an FAO perspective, one of the objectives for FAO participation in WGFTFB is to bring the collective expertise in fishing technology in developed countries within reach of those in developing countries. To this end, FAO welcomes the opportunity for WGFTFB to meet outside of the traditional ICES countries and therefore would like the ICES Secretariat and FTC to carefully consider the offer made by SEAFDEC to host WGFTFB in Thailand in 2010. FAO FIIT fully supports this initiative as it would ensure the continued participation of those developing countries

Annex 1: List of participants

Name	Address	Phone/Fax	Email
Abdelhak Lahnin	Regional Centre of INRH, BP 5221 Agadir, Morocco	Tel: +21228822985 Fax: +21228827415	abdelahmin2000@yahoo.fr
Adnan Tokac	Ege University, Fisheries Faculty, Izmir, 35100, Turkey	Tel: +90 532 6216580 Fax: +90 232 3747450	adnan.tokac@ege.edu.tr
Alain Frechet	Maurice Lamontagne Institute, ~ 850 Route de la mer, Mont-Joli, G5H 3Z4, Canada	Tel: +418 7750628 Fax: +418 7750679	Alain.Frechet@DFO-MPO.GC.CA
Alessandro Lucchetti	CNR-ISMAR, Largo fiera della pesca, Ancona, 60125, Italy	Tel: +39 071 2078828 Fax: +39 071 55313	a.lucchetti@ismar.cnr.it
Altan Lok	Ege University Fisheries Faculty, Bornova, Izmir, 35100, Turkiye	Tel: +90 232 3434000 Fax: +90 232 3747450	altan.lok@ege.edu.tr
Andres Seefoo	INAPESCA Mexico	Tel: +523143323750	Y-aseefoo@yahoo.com
Andy Revill	Cefas, Pakefield Road, Lowestoft, NR33 0HT, UK	Tel: +44 1502 524 531 Fax: +44 1502 526 531	andrew.revill@cefas.co.uk
Antonio Porras	Institute of Fishery and Aquaculture, Costa Rica	Tel: +50622481196 Fax: +50622481585	porrasantonio@hotmail.com
Benoit Vincent	IFREMER, 8 rue F Toullec, Lorient, 56100, France	Tel : +33297873804 Fax: +33 2 97873839	benoit.vincent@ifremer.fr
Bent Herrmann	DIFRES, North Sea Centre, Box 101, Hirtshals, 9850, Denmark	Tel: +45 3396 3200 Fax: +45 3396 3260	bhe@difres.dk
Bill Karp	Alaska Fisheries Science Center (NOAA), 7600 Sand Point Way NE, Seattle, 98115, USA	Tel: +1 206 526 4000	Bill.karp@NOAA.GOV
Bjarti Thomsen	Faroese Fisheries Laboratory, Noatun 1, P O Box 3051, Tórshavn, Faroe Islands	Tel: +298 353900 Fax: +298 353901	bjartit@frs.fo
Bob van Marlen	IMARES, Haringkade 1, Ijmuiden, 1976 CP, Netherlands	Tel: +31 317487181 Fax: +31 317487326	bob.vanmarlen@wur.nl
Bundit Chokesanguan	SEAFDEC, Suksawadee Rd., Phrasamutchedi, Samut Prakan, 10290, Thailand	Tel: +66 2 4256100 Fax: +66 2 4256110	bundit@seafdec.org

Name	Address	Phone/Fax	Email
Christopher Glass	University of New Hampshire, 39 College Road, Durham NH, 03824, USA	Tel: +1 603 862 0122 Fax: +1 603 862 7006	chris.glass@unh.edu
Daniel Valentinsson	Institute of Marine Research, P.O. Box 4, Lysekil, S-453 21, Sweden	Tel: +4652318747 Fax: +4652313977	Daniel.Valentinsson@fiskeriverket.se
Dave Reid	FRS Marine Lab 375 Victoria Road, AB9 11DB, Aberdeen, Scotland	Tel: +44 1224 876544 Tel Direct: +44 1224 295363 Fax: +44 1224 295511	reiddg@marlab.ac.uk
Dirk Verheagele	ILVO Ankerstraat 1 8400 Ostende, Belgium	Tel: +32496388127	dirk.verhaegle@ilvo.vlaanderen.be
Dominic Rihan	BIM, Crofton Road, Dun Laoghaire, Co. Dublin, Ireland	Tel: +353 12144104 Fax: +353 12300564	rihan@bim.ie
Fabio Grati	CNR-ISMAR, Largo fiera della pesca, Ancona, 60125, Italy	Tel: +39 071 2078846	f.grati@ismar.cnr.it
Francois Theret	European Commission, J 79 02/79, Brussels, 1049, Belgium	Tel: +32 2 298 03 28 Fax: +32 2 299 48 02	Francois.Theret@ec.europa.eu
Frank Chopin	FAO Rome	Tel: +3906 57055257	Francis.chopin@fao.org
Frodi B. Shuvadal	Faroese Fisheries Laboratory, Noatun 1, P O Box 3051, Tórshavn, Faroe Islands	Tel: +298 353900 Fax: +298 353950	frodis@frs.fo
Gerard Bavouzet	IFREMER, 8 rue Francois Toullec, Lorient, France	Tel: +33 2 97 873830 Fax: +33 2 97873838	gerard.bavouzet@ifremer.fr
Gianni Fabi	CNR-ISMAR, Largo fiera della pesca, Ancona, 60125, Italy	Tel: +39 071 2078825 Fax: +39 071 55313	g.fabi@ismar.cnr.it
Håkan Vesterberg	Swedish Board of Fisheries	Tel: +46317430333 Fax: +46317430444	hakan.vesterberg@fiskeriverket.se
Hans Polet	ILVO-FISHERY Ankerstraat 1 8400 Ostende, Belgium	Tel: +3259569837	hans.polet@ilvo.vlaanderen.be
Harldur Einarsson	Marine Research Institute of Iceland, Skúlagata 4, 101, Reykjavík, Iceland	Tel: +354 5752000 Fax: +354 5752001	haraldur@hafro.is

Name	Address	Phone/Fax	Email
Huseyin Ozbilgin	Mersin University Fisheries Faculty, Yenisehir Campus, 33169, Mersin, Turkey	Tel: +90 532 7061977 Fax: +90 324 3413025	ozbilginh@yahoo.com
Irene Huse	Institute of Marine Research, Nordnesgt 33, N-5817, Bergen Norway	Tel: +47 55236808 Fax: +47 55236830	irene.huse@imr.no
Jacques Sacchi	IFREMER, Jean Monnet, Sete, 34200, France	Tel: +33 4 99 57 32 08	jacques.sacchi@ifremer.fr
James C. Ogbonna	Fisheries Dept. Nigeria	Tel: +234806 5775322	Jamescogbonna@yahoo.com
Janne Fogelgren	FAO, Rome	Tel: +390657052377	Janne.fogelgren@fao.org
Jens Floeter	VTI-OSF AG Fischerieitechnik, Palmelie 9, D-22767 Hamburg, Germany	Tel: +44 (0) 40 38905185	jens.floeter@vti.bund.de
Jochen Depestele	ILVO-Fisheries, Ankerstraat 1, Oostende, B-8400, Belgium.	Tel: +32 59 56 98 38 Fax: +32 59 33 06 29	jochen.depestele@ilvo.vlaanderen.be
Johan Lovgren	Institute of Marine Research, P.O. Box 4, S-453 21 Lysekil, Sweden	Tel: +4652318779 Fax: +4652313977	Johan.lovgren@fiskeriverket.se
Jonathan O. Dickson	Bureou of Fisheries and Aquatic Resources, PCA Annex Bldg, 4th Floor Eliptical Road, Diliman, 1100 Quezon City, Philippines	Tel: +6329294296	jod_bfar@yahoo.com
Jose Alio	Instituto Nacional de Investigaciones Agricola Edif. INIA, Ave. Carupano, Caiguire, Cumana,Venezuela	Tel: +58 293 4317557 Fax: +58 293 4325385	jalio@inia.gob.ve
Ken Arkley	Sea Fish Industry Authority, Seafish House, St. Andrews Quay, Kingston upon Hull, HU3 4QE, UK	Tel: +44 1482 327837 Fax: +44 1482 223310	k_arkley@seafish.co.uk
Kris Van Craeynest	ILVO-FISHERIES Ankerstraat 1 8400 Ostende, Belgium	Tel: +3259569826	kris.vancraeynest@ilvo.vlaanderen.be

Name	Address	Phone/Fax	Email
Kristian Zachariassen	Faroese Fisheries Laboratory, Noatun 1, P O Box 3051, Tórshavn, Faroe Islands	Tel: +298 353900 Fax: +298 353901	Krizac@frs.fo
Ludvik Krag	DIFRES,~ North Sea Centre, Box 101, Hirtshals, 9850, Denmark	Tel: +45 3396 3200 Fax: +45 3396 3260	lak@difres.dk
Luis Marcano	Instituto Nacional de Investigaciones Agriculas, Cumana, Venezuela	Tel: +58 2934510723	lmarcano@inia.gob.ve
Mario Rueda	Marine and Coastal Research Institute (INVEMAR), Santa Marta Cerro Ponta Betin, Colombia	Tel: +(57) 5–4211380	mrueda@invmar.org.co
Michael Pol	Mass. Division of Marine Fisheries, 1213 Purchase St, New Bedford, MA, 02740, USA	Tel: +11 508 9902860 Fax:+11 508 9900449	mike.pol@state.ma.us
Mike Breen	Fisheries Research Services, 375 Victoria Road, Aberdeen, AB11 9DB, Scotland	Tel: +44 1224 295474 Fax: +44 1224 295511	breenm@marlab.ac.uk
Oumarue Njifonjou	IRAD/SRHOL PMB 77 Limbe, Cameroon	Tel: +27377619149	njifonjo@caramail.com
Øystein Patursson	Aquaculture Research Station of the Faroes, Faroe Islands	Tel: +298 474756 Fax: +298 474748	oystein@fiskaaling.fo
Pascal Larnaud	IFREMER, 8 rue F Toullec, Lorient, 56100, France	Tel : +33 297873841 Fax: +33 297873838	pascal.larnaud@ifremer.fr
Paul Winger	Marine Institute, 155 Ridge Rd., St. Johns, A1C5R3, Canada	Tel: +1 709 7780430 Fax: +1 709 7780661	Paul.Winger@mi.mun.ca
Peter Munro	Alaska Fisheries Science Center (NOAA), 7600 Sand Point Way NE, Seattle, 98115, USA	Tel: +1 206 526 4292 Fax: +1 206 526 6723	peter.munro@noaa.gov
Philip MacMullen	Seafish, Saint Andrew's Dock, Hull, HU3 4QE, England	Tel: +44 1482 327837 Fax: +44 1482 223310	p_macmullen@seafish.co.uk
Philip Walsh	Marine Institute, 155 Ridge Rd., St. Johns, A1C5R3, Canada	Tel: +1 709 7780430 Fax: +1 709 7780661	philip.walsh@mi.mun.ca

NAME	ADDRESS	PHONE/FAX	EMAIL
Pingguo He	University of New Hampshire, 137 Morse Hall, Durham, NH, 03824, USA	Tel: +1 603 8623154 Fax: +1 603 8620243	Pingguo.He@unh.edu
Rogvi K. Rouritsen	FRS, Tórshavn, Faroe Islands	Tel: +298353900	rogvi@mfrs.fo
Sofie Vandemaele	ILVO-FISHERY Ankerstraat 1 8400 Ostende, Belgium	Tel: +3259569883	sofie.vandemaele @ilvo.vlaanderen.be
Svein Løkkeborg	Institute of Marine Research, Nordnesgaten 50, N-5817Bergen, Norway	Tel : +47 55236826 Fax : +47 55236830	svein.lokkeborg@imr.no
Sven Gunnar Lunneryl	Swedish Board of Fisheries	Tel: +4631609231 Fax: +46317430444	sven.gunnar.lunneryl @fiskeriverket.se
Tom Catchpole	CEFAS, Pakefield Road, Lowestoft, NR33 0HT, UK	Tel: +44 1502 524 531 Fax: +44 1502 526 531	Thomas.Catchpole@cefas.co.uk
Waldemar Moderhak	Sea Fisheries Institute in Gdynia, ul.Kollataja 1, Gdynia, 81–332, Poland	Tel: +48 58 7356258 Fax: +48 58 7356110	moderhak@mir.gdynia.pl

Annex 2: Agenda

21 April 08:30 – 09:00 Registration
09:00 – 09:15 Opening Address
09:15 – 09:30 Housekeeping Issues & Meeting Arrangements (Chair)
09:30 – 10:30 WGFTFB Advice & Requests during 2006/2007 (Chair)
10:30 – 10:50 Coffee Break
10:50 – 11:30 ICES Draft Science Plan & New Advisory Structure (B Karp)
11:30 – 12:00 Report from WGQAF (P.MacMullen)
12:00 – 12:15 Update on Gear Classification Topic (Chair/F.Chopin)
12:15 – 12:30 WWF Smart Gear Competition (A. Revill)
1300 – 14:00 Lunch Break
14:10 – 14:15 ToR a) Species Separation in demersal trawls (P He & M Pol)
14:15– 14:30 Summary of Haddock Symposium 2007 as it relates to species separation (M. Pol)
14:30– 14:45 Can Yellowtail Flounder be harvested without bycatch of cod and haddock on Georges Bank? Real-time spatio-temporal fishing strategies (C. Glass).
14:45– 15:00 UK trials with the eliminator trawl and a new simple method for catch comparison analysis (A. Revill)
15:15 – 15:30 Questions & Discussions
15:30 – 16:00 Coffee Break
16:00 – 16:10 ToR b) on Advise to Assessment WG's (D Reid)
16:10 – 16:20 ToR c) on Static Gear Selectivity Manual (A Revill)
16:20 –16:30 Size selectivity of basket traps for the gastropod Nassarius mutabilis in the Adriatic Sea (G. Fabi)
16:30 –16:55 ToR d) on Mitigation Measures for portected species (A Lucchetti)
16:55– 17:10 Turtle Excluder Device Experiments In The Central Adriatic Sea (A. Lucchetti)
17:10 – 17:25 ToR d) Presentation 2 (TBA)
17:25 – 17:40 ToR f)Shrimp Trawl Efficiency (Chair)
17:40 – 18:00 ToR g) WGECO OSPAR QSR report (J Despestele)

22 April 09:00 – 09:10 Housekeeping (Chair)
09:10 – 10:30 FAO Shrimp Project Update (F Chopin)
10:30 – 10:45 Coffee Break
10:45 – 10:50 Introduction to Open Session (Chair)
10:50 – 11:05 Nordic Pelagic Project (F. Skúvadal)
11:05 – 11:25 Direct observations of large mesh capelin trawls; evaluation of mesh escapement and gear efficiency (H. Einarsson)
11:25– 11:45 Design and test of a topless shrimp trawl to reduce pelagic fish bycatch in the Gulf of Maine pink shrimp fishery (P. He)
11:45– 12:00 FISHSELECT - a tool for predicting basic selective properties for nettings (B. Hermann)
12:00– 12:20 Technical and selective properties of T90 meshes codend-extension made of different netting stiffness (W. Moderhak)
12:20– 12:40 Fuel Saving Initiatives in the French Fishing Industry (B. Vincent)
12:40– 13:00 Modeling flow through and around nets using computational fluid dynamics (Øystein Patursson)

12:40 – 13:30 Lunch Break
13:30 – 15:30 Topic Group meetings
15:30 – 15:50 Coffee Break
15:50 – 17:30 Topic Group Meetings

23 April 09:00 – 17:00 Topic Group Meetings

24 April 09:00 – 09.10 Housekeeping (Chair)
09:10 – 10:20 Topic Group Meetings
10:20– 10:50 Coffee
10:50 – 13:00 Topic Group Meetings
13:00 – 14:00 Lunch Break
14:00 – 14:30 Presentation of report, conclusions & recommendations on Species Separation
14:30 – 15:20 Presentation of report, conclusions & recommendations on Fisheries Advice
15:20 – 15:50 Coffee Break
15:50 – 16:30 Presentation of report, conclusions & recommendations on Static Gear
16:30 – 17:30 Presentation of report, conclusions & recommendations on Mitigation Methods

25 April 09:00 – 09:15 Housekeeping (Chair)
09:15 – 09:35 Report on SGPOT (B. Thomson & M.Pol)
09:35 – 10:20 Presentation of report, conclusions & recommendations on Shrimp Trawls
10:20 – 11:00 Presentation of report, conclusions & recommendations on WGECO request
11:00 – 11:15 Coffee Break
11:15 – 12:00 Report from WGQAF (P MacMullen)
12:00 – 12:30 TORs for 2009 (Chair)
12:30 – 12:40 Suggestions for ASC theme session topics 2009 (Chair)
12:40 – 12:50 Date and venue for WGFTFB 2009 meeting (Chair)
12:50 – 13:00 AOB and concluding remarks (Chair)
13:00 – 14:00 Lunch& Close Meeting

Annex 3: Recommendations

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

RECOMMENDATION	FOR FOLLOW UP BY:
1. WGFTFB recommends the publication of an ICES Cooperative Research Report on Species Separartion based on the work carried out by the Topic Group.	FTC, ICES Publications Committee
2. The topic group will continue to collate this information on an annual basis, based on the issues related above and subject to further revision of the questionnaire and better quantification of the information where possible.	ACOM, AMAWGC, GFCM Assessment Chairs to note.
3. WGFTFB should continue to receive feedback from the different Expert Group's and AWAWGC, to assess the usefulness of the information supplied and also target specific areas that are identified of particular importance to individual assessment WG's. WGFTFB are committed to assisting in the provision of information to the new Benchmark workshops planned for winter 2008/2009.	ACOM, AMAWGC, GFCM Assessment Chairs to note.
4. WGFTFB will expand the provision of information to other relevant groups such as GFCM in the Mediterranean.	ACOM, AMAWGC, GFCM Assessment Chairs to note.
5. WGFTFB recommend that the Topic Group work to the timetable outlined to drafte the gillnet selectivity manual. This will be presented to WGFTFB at the 2009 meeting.	FTC, FAO, ICES Publication committee to note
6. WGFTFB recommend that the Compendium of Mitigation Methods deployed to minimise bycatch of protected species developed by SGBYC and expanded on by WGFTFB should continued to be updated as information on work being undertaken globally becomes available.	FTC, FAO-GFCM, SGBYC, WGMME, WGECO to note
7. WGFTFB recommend that GFCM encourage Mediterranean States instigate data collection programmes to provide a better understanding of the bycatch issues in Mediterranean fisheries, particularly in non-EU countries.	FTC, FAO-GFCM, SGBYC, WGMME, WGECO to note
8. WGFTFB recommend that research in the Mediterranean on mitigation technologies be carried out under commercial conditions and include consideration of socio-economic effects of introducing such technologies.	FTC, FAO-GFCM, SGBYC, WGMME, WGECO to note
9. WGFTFB recommend as a matter of priority that GFCM instigate further development and testing of Turtle Excluder Devices in trawl fisheries in the Central Adriatic, Tunisia and the North-east Mediterranean given the level of turtle bycatch in these areas.	FTC, FAO-GFCM, SGBYC, WGECO to note
10. WGFTFB recommend that GFCM instigate research and pilot projects to ascertain whether simple modifications to longline gears such as the use of circle hooks, different bait types and setting depths used extensively in other parts of the world e.g. US and Hawaii to reduce turtle bycatch are appropriate in the Mediterranean.	FTC, FAO-GFCM, SGBYC, WGECO to note
11. WGFTFB recommends the issue of shrimp trawl efficiency be addressed to SGGEM as a case study for consideration	SGGEM, NIPAG, STACREC, FTC, ACOM
12. WGFTFB recommends further analysis of the Icelandic or other suitable datasets by SGGEM.	SGGEM, NIPAG, STACREC, FTC, ACOM

RECOMMENDATION	FOR FOLLOW UP BY:
13. WGFTFB recommends that SGGEM should consider whether horizontal wingend spread can be used as an effort parameter for this fishery.	SGGEM, NIPAG, STACREC, FTC, ACOM
WGFTFB recommends that WGECO use the findings of the case studies presented in the context of the OSPAR QSR 2010.	FTC, WGECO, ACOM
WGFTFB recommends that the case studies presented by WGFTFB be used to assist in the development of a framework that can be used to assess the efficacy of gear-based technical measures introduced to reduce the environmental impact of fishing.	FTC, WGECO, ACOM
WGFTFB recommend that definitions and terms associated with catch, bycatch and discards be collated and assessed and the drafting of a new definition(s) of terms used to describe the various catch components be considered.	FTC, WGQAF, WGECO, ACOM

Annex 4: WGFTFB terms of reference for the next meeting

The **ICES-FAO Working Group on Fishing Technology and Fish Behaviour** [WGFTFB] (Chair: Dominic Rihan, Ireland) will meet in Ancona, Italy from 18 – 22 May 2009 to address the following ToRs:

a) Incorporation of Fishing Technology Issues/Expertise into Management Advice. Based on the questionnaire exercise carried out in 2005/2006, 2006/2007 and 2007/2008.

Conveners: Dave Reid (FRS, Scotland); Norman Graham (Marine Institute, Ireland); and Dominic Rihan(BIM, Ireland)

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

i) Identify all seine net fisheries globally and describe the gears being used in terms of net design, rope material and construction, as well as areas being worked.

ii) Critically assess these fisheries, identifying the positive aspects in terms of reduced fuel consumption, high fish quality and low bottom impact as well as the negative aspects with respect to gear selectivity and technological creep.

iii) Evaluate methods for determining selectivity in these gears to allow comparison with conventional towed gears e.g. otter trawls

iv) Make recommendation for research/monitoring work to substantiate (or otherwise) claims for environmental friendliness, discarding, unaccounted fishing mortality.

Conveners: Ken Arkley (SFIA, UK); Rob Kynoch (FRS, Scotland); and Harldur Einarsson (MRI, Iceland)

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

- To review and appraise the current selectivity characteristics of the gears used in the Area VII Nephrops trawl fisheries and Beam trawl fisheries for flatfish in ICES areas IV and VIId; and

i) To propose potential gear modifications that could contribute to the future technical conservation measures needed to achieve the targets proposed by the European Commission, while also taking into account fish survival from such gear modifications.

Conveners: Dominic Rihan (BIM, Ireland); Andy Revill (CEFAS, UK) and Hans Polet (ILVO, Belgium)

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

- Review progress with better developing scientific collaboration of WGFTFB with GFCM on fishing technology issues in the Mediterranean; and specifically
- Review new research with 40mm square-mesh codends introduced recently into EU legislation for the Mediterranean;
- Assess the efficacy of this measure in terms of improved selectivity and fish survival;
- Identify whether from a technical perspective that the regulation needs to be amended i.e. twine material, meshes in the circumference.

Conveners: Jacques Sacchi (IFREMER, France); Antonello Sala (CNR-ISMAR, Italy) and Huseyin Ozbilgin (Mersin University, Turkey)

WGFTFB will report by 16 June 2009 to the attention of the Fisheries Technology Committee.

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the effectiveness of technical measures to change size selectivity and fishing mortality rates. Consequently these activities are considered to have a very high priority

Scientific justification and relation to action plan:	Action Item 3.16, 3.17, 3.18, 5.8, 5.11, 5.16, 6.3 (a) Action Item 3.2, 3.13, 4.11.3, 4.13, 5.11 (b) Action Item 3.16, 3.18, 4.13, 5.8, 5.12 (c) Action Item 3.2, 3.5, 3.16,3.17,4.13, 5.8 (d)

Term of Reference a)

Fisheries management bodies are often dependant on catch per unit 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. The topic group 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 2008 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. The topic group recommends 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 2008/2009. Feedback on the content and value of this years report will be sought from the Assessment working groups and through AMAWGC and will be used to improve the survey in 2009. 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)

Seining, either fly-dragging or anchor seining are considered to be "environmentally friendly" fishing methods with a number of positive benefits. Traditionally the gear used tends to be of much lighter construction and as there are no trawl doors or warps has less impact on the seabed than trawling. The use of such light gear also means the method is very fuel efficient. Another positive aspect of the method is that fish are only caught in the very last part of the capture process, and therefore are not in the codend of the net very long leading to high catch quality of fish compared to trawled fish.

In the early 1990s, in countries such as Scotland and Ireland the number of vessels seining declined as vessels switched to twin-rig trawling, targeting species such as monkfish and *nephrops,* taking advantage of relatively low fuel prices. In recent years, however, as fuel prices have steadily increased attention once again has shifted to this method and there has been a switch back to this method in some countries e.g. Scotland and Ireland and interest in developing the technique in other EU countries, notably France and Netherlands and further a field in countries such as the Philippines and South Africa.

While there is no doubting the positive benefits of seining as indicated, concerns have been expressed that there are negative aspects associated with the method that should be addressed, given the increased interest and adoption by fishermen globally. For instance in Scotland and Ireland there is evidence of high discarding and high-grading as seine netters aim to maximise returns. Also as the pressure on grounds increase and seiners are forced into areas of harder ground, there is evidence of technological creep in seine net design with much heavier seine ropes and heavy hopper footropes now commonly used. There are similarly concerns in some quarters in the adoption of seine net techniques by French and Dutch vessels given these vessels are often targeting non-quota species such as red mullet for which there is little or no scientific assessment.

Scientific justification and relation to action plan:	**Term of Reference c)** In 2008 the European Commission will focus on mitigation of discards associated with a number of key fisheries in community waters. Part of this process is to identify candidate technical measures suitable for these fisheries which will achieve measurable targeted reductions. The target discard levels are to be fishery specific and will be reduced over a specified period so as to achieve a Maximum Allowed Bycatch Limit (MABL). In the recent non-paper "On the implementation of the policy to reduce unwanted bycatch and eliminate discards in European fisheries" the commission has identified two key fisheries, these are: Bottom trawl fisheries in ICES area VII targeting *Nephrops* and; Beam trawling for flatfish in ICES areas IV and VIId Proposed MABL targets for fishery (i) are to be based on a baseline estimate of 50% (by weight) and 60% (by number) and are reduced over a period of five years to be no more than 10% (by weight) and 15% (by number) of the total catch (MABL). During year 1 and 2, the rates are to be reduced by 50% year on year, while overall reductions of 60, 70 and 80% compared to the baseline level will be expected in years 3, 4 and 5. For fishery (ii) the baseline level is assumed to be70 and 80% by weight and number respectively. The final target after 6 years is set at no more than 15 and 20% with reductions during the 3rd, 4th, 5th and 6th years of at least, 50%, 60%, 70% and 80% of the original baseline levels. Clearly these represent significant reductions and stiff targets in overall discard fisheries. However, in order to achieve these, modifications to the current range of technical conservations measures are required. **Term of Reference d)** At the 2007 WGFTFB meeting a recommendation was made for better collaboration between WGFTFB and GFCM on gear technology issues. It would be opportune to determine if progress has been made on this objective in 2009. In this context it woul also seem an opportune time to consider the new 40mm square mesh codend regulations introduced into the Mediterranean. Mediterranean demersal trawl fisheries traditionally operate using small diamond-shape meshes in the codend, which tend to retain almost all animals. Furthermore, the use of such small mesh sizes leads to a bycatch which is of low commercial value and often almost entirely discarded. 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 it is appropriate to provide for increases in mesh sizes for trawl nets used for fishing for certain species of marine organisms and for the mandatory use of square-meshed netting. Furthermore, the (EC) 1967/2006 establishes in Annex II point 7 that technical specifications limiting the maximum dimensions of some parts of the trawl nets along with the maximum number of nets in multi-rig trawl nets. Establishing the maximum dimension and number of fishing gears per vessels represent a way to control and limit the fishing effort. The effect and efficiacy of these measures should be assessed.
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 50–70 scientists and invited experts.
Secretariat facilities:	None.
Financial:	None required. Having overlaps with other meetings of expert groups of FTC increases efficiency and reduces travel costs.

Linkages to advisory committees:	The questions of bycatch reduction, fisheries information and survey standardization are of direct interest to 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 and also the EU Regional Advisory Councils.

Annex 5: Study Groups

It is recommended that a **Study Group on Turned 90° Codend Selectivity, focusing on Baltic Cod Selectivity** [SGTCOD] Chairs: Bent Hermann, DIFRES, Denmark and Waldemar Moderhak MIR, Poland) be established and meet in --- to address the following ToRs:

a) To evaluate the effect of turning diamond netting by 90° (T90) on codend selectivity.

b) To improve knowledge on the size selection processes in T90 codends compared to T0 codends (normal direction of diamond netting).

c) To attempt to quantify the magnitudes of the effects of different factors (construction, generic netting properties, stock specific morphology, catch composition)

d) To develop a guide on T90 codend constructions with respect to size selection properties and optimal construction; and

e) To review available data on fish survival and in particular cod escaping from T90 codends.

SGTCOD will report by xxxx for the attention of the Fisheries Technology Committee.

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the effectiveness of technical measures to change size selectivity and fishing mortality rates. Consequently these activities are considered to have a very high priority
Scientific justification and relation to action plan:	Action Item 3.16, 3.17, 3.18, 5.8, 5.11, 5.16, 6.3 The use of T90 codends is legal in the Baltic Sea cod fishery and there is an increasing global interest in using T90 for towed fishing gears. The basic mechanisms governing T90 performance are, however, not well understood or quantified. In order to address this it is proposed to set up a Study Group specifically to look at all issues relating to the use of T90 netting as a means of improving selectivity. The objectives will be reached by combining field experiments (size selectivity experiments), laboratory experiments with nettings (loading by different forces comparing mesh openness), laboratory experiments with fish morphology specific on Baltic cod (FISHSELECT) and theoretical approach (structural mechanic for bending of mesh bars under load and computer simulations). A case study on Baltic cod will be conducted. We expect that the benefit of T90 on size selectivity will depend on the netting panel construction (twine thickness, twine stiffness, single/double twine, ratio between mesh sizes (mesh bar)/twine thickness). Therefore all T90 experiments should be evaluated against a baseline of experiments with similar diamond mesh codends (T0) made of the same netting and having the same number of meshes around. For the comparison of results from sea trials regarding the performance of T90 it is important that the trawl designs in front of the codends (T0 and T90) are identical. It is also important that the experimental design take into account potential confounding effects like vessel size. The level of unaccounted mortality of cod escaping through T90 codends will also be considered specifically for the Baltic.

Resource requirements:	The research programmes, which provide the main input to this group, are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants:	The Study Group is likely to attract 10–15 participants from Baltic countries and a further 5 experts in the field.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	ACOM
Linkages to other committees or groups:	There is a very close working relationship with all the groups of the Fisheries Technology Committee. It is also very relevant to the Working Group on Ecosystem Effects of Fisheries and Baltic Fisheries Committee
Linkages to other organizations:	The work of this group is closely aligned with the EU and Baltic Sea Regional Advisory Council.

Annex 6: Proposed Term of Reference JFTAB

It is proposed a **Joint Workshop of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour** [WGFTFB] **and the Working Group on Fisheries Acoustics Science and Technology** [WGFAST] will be held in Ancona, Italy on 20 May 2009 - Co-Chairs: Paul Winger (Marine Institute, Canada), Emma Jones (NIWA, New Zealand) and Julia Parish (University of Washington, USA) to address the following ToRs:

a) To explore the decisions (i.e. bahvioural trade-off's) made by fish and crustaceans during natural behaviour, vessel avoidance, and in response to fishing gear and other platforms.

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the effectiveness of technical measures to change size selectivity and fishing mortality rates. Consequently these activities are considered to have a very high priority
Scientific justification and relation to action plan:	Action Item 3.16, 3.17, 3.18, 5.8, 5.11, 5.16, 6.3 The second ICES Symposium on fish behaviour, entitled "*Fish Behaviour in Exploited Ecosystems*" was recently held in Bergen, June 2003. Scientific research was presented across 5 key theme sessions, culminating in 27 peer-reviewed papers (Fernö *et al*. 2004) with *Discussion Sessions* recorded by Bjordal and Gerlotto (2004), Huse (2004), Glass and Gunn (2004), Walsh *et al*. (2004), and Thiele and Fernö (2004). One of the dominant conclusions from several of the theme sessions was the need to challenge our traditional approaches to the study of fish behaviour. No one would argue that the field hasn't grown rapidly, nor that our observational techniques haven't improved remarkably. They have. But what is clear, is that there continues to be too much observation and description of animal behaviour without an attempt to understand *why fish do what they do* (Bjordal and Gerlotto 2004; Glass and Gunn 2004; Walsh *et al.*, 2004). This joint session presents a forum for discussion on new approaches and interpretation of animal behaviour. We invite presentations and posters that emphasize the functional explanations behind behavioural expression, whether it be natural behaviour, vessel-induced behaviour, or animal behaviour in relation to fishing gear. We want to explore the costs and benefits associated with the decisions that animals make and how we can predict the probable (or optimal) decision under different conditions? For example, what are the behavioural trade-offs that fish make in response to an attractive odour plume when simultaneously engaged in spawning, or by contrast, what is the optimal avoidance distance to an approaching trawler when actively engaged in feeding?
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 Joint Session is likely to attract 50–100 participants from WGFTFB, WGFAST and invited experts.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	ACOM

Linkages to other committees or groups:	There is a very close working relationship with all the groups of the Fisheries Technology Committee and the joint sessionw ill continue to consolidate these links.
Linkages to other organizations:	None

Annex 7: Outline of CRR Report on Species Separation

1. Introduction

2. Review of recent literature on fish behaviour and species separation (Pingguo He)

This section will review relevant information on fish behaviour and species separation methods which may be potentially useful for application in separation of groundfish species. Actual application and design of species separation devices and strategies will be elaborated in Section 3.

Spatial and temporal differences in behaviour and distribution

Swimming ability

Fish reaction to gear components

Recent research on species separation in demersal trawls

3. Fish behaviour and strategies for avoiding and separating species in demersal trawls

3.1 Fish behaviour and species separation species using spatial and temporal separation (Dave Reid/Chris Glass)

- Principles
- Strategies
- Effectiveness
- Avoid encounter with unwanted species
- Employ spatial and temporal distribution characteristics to fish for target species and to avoid bycatch species
- Use real time voluntary or non-voluntary bycatch reporting network to avoid area of bycatch concentration
- Use remote identification of species using acoustics, video or other sensors
- Conduct test tows
- Use specialized or alternate gear
- Vessel noise characteristics

3.2 Fish behaviour and species separation between the doors, bridles and the mouth of the trawl (Emma Jones and Paul Winger)

- Principles
- Strategies
- Effectiveness
- Trawl Doors – Colour and sand cloud, bottom contact – sand cloud
- Trawl door design
- Quasi / Semi-pelagic fishing
- Non-herding trawls
- Altering sweep lengths and angles
- Modifying Wings of the net
- Counter-herding devices

Others to consider may include:

- Guide undesired species out of the trawl path
- Alter warp-depth ratios
- Reduce herding efficiency for unwanted species through
- Reduce towing speed
- Electrical stimulus
- Alter sand cloud with semi-pelagic doors
- Alter noise of doors, floats, etc.
- Alter visual stimuli of components of trawl mouth
- Modify contact of sweeps and bridles with spacers
- Avoid herding by increasing swept area using multiple rigs instead of sweeps with single rig.
- Use of tickler chains

3.3 Fish behaviour and Species separation at the mouth of the trawl (Mike Pol /Ludvig Krag /Bob van Marlen)

- Principles
- Strategies
- Modifications to the top of the trawl net
- Modifications to the net overhang
- Modifications to top panels (large mesh top panels)
- Cut back headline (topless) trawls
- Modify headline height
- Modifications to the headline of the trawl
- Modifications to the net mouth
- Modifications to the bottom of the net
- Modify height of fishing line
- Modify type or construction of ground gear
- Increase spaces between discs or bobbins
- Drop-out panels
- Other modifications
- Alternative stimulation

3.4 Fish behaviour and species separation in the extension and codend (Haraldur Einarsson/Ken Arkley)

- Principles of separations within the codend and how it compares with the rest of the gear.
- Biological factors influencing species separations.
- Separations process is possibly throughout all capture process.
- Clarifications of extension (influence of separations).
- Uncounted mortality.
- Behaviour of stressed fish.

Rigid Devices & Sorting Devices

- Grids, Sort-X (Norway), Sort-V (Norway – Iceland)

- TEDs, J-TEDs (FAO), Eurogrid, Flatfish grid (Faeroese Flexigrid)
- Yellow flounder grid
- Flexible arrangements
- Latitudinal ropes
- Horizontal panels
- Use of horizontal and inclined separator panels or ropes
- Inclined panels, Ireland's grid panel.
- Escape windows
- Provide exit openings/funnels
- Use square mesh windows
- Provide escape openings (e.g. Fish eye, radial escape panel)
- Use square mesh windows (e.g. BACOMA window)
- Different mesh in side panels in four-panel net
- Longitudinal ropes
- Visual stimuli: dark tunnels
- Codend design
- Drop out panel location and colours in bottom of trawl (Milliken)
- Alternative mesh configurations (e.g. hexagonal meshes)
- Alternative mesh colours and characteristics
- Alter taper of net construction
- Alternative meshes including T-90 and hexagonal meshes
- Alternative mesh configurations such as composite codends (square and diamond, etc)
- Surface characteristics and construction of mesh materials
- Additional consideration for improvement
- Remote observation and release of catch
- Manipulation of water flow

4. Conclusions, future work and recommendations

- Conclusions
- Knowledge gaps
- Recommendations

5. References

Annex 8: WGFTFB Information for other ICES Expert Groups – Questionnaire sent to WGFTFB members

Incorporation of Fishing Technology Issues/Expertise into Management Advice

Rationale:

Over the past few years, the nature of the advice ICES has been requested to provide by the client commissions e.g. Norway, EU, and NAFO etc has changed considerably.

ICES is now asked to provide advice that is more holistic in nature, including information on the influence and effects of human activities on the marine ecosystem.

From the fishing technology perspective this includes information on how fishermen are responding and adapting to changes in regulatory frameworks e.g. the introduction of effort control; technological creep; fleet adaptations to other issues e.g. fuel prices etc.

In response to this WGFTFB initiated a ToR in 2005 to collect data and information that was appropriate for fisheries and ecosystem based advice, co-sponsored by Dominic Rihan (Ireland), Dave Reid (Scotland) and Norman Graham (Ireland).

In 2006, the FAO-ICES WGFTFB was formally requested by the Advisory Committee on Fisheries Management (ACFM) to provide such information and to submit this to the appropriate assessment working group.

This type of information is becoming more and more important at both international and national levels. It demonstrates that the community of gear technologists have an important role to play in this and that our expertise is considered to be highly valued.

Please note that this is intended for WGFTFB members from countries that receive their stock/fisheries advice from ICES.

It would be greatly appreciated if you, in collaboration with whoever necessary, fill out the questionnaire.

Thank you for your time and effort

Norman, Dave and Dominic

Introduction

This contains a series of questions relating to recent changes within the fleets in you particular country that you may have observed. It also gives you the opportunity to raise any issues that you think are important but are not currently recognised.

If at all possible, please try to quantify your statements or state how the information has been derived e.g. common knowledge, personal observations, discussions with industry etc.

a. *Changes in Fleet Dynamics between **2006 and 2008***

Have there been any major shifts between mesh categories (e.g. from 100mm+ to 70 – 90mm) and in which ICES area has this occurred?

What are the principal driving factors for this change? (e.g. effort allocation, and fuel costs).

Is there a geographical shift in activity (e.g. between IV to VI – give the subdivision if possible)?

Within a particular mesh/gear category, has there been any shift in target species (e.g. from demersal gadoids to anglerfish; sardine to tuna etc)

Has there been any removal of effort through decommissioning schemes, of so which fleets have been affected and has the decommissioning affected older or newer vessels or a combination of both?

What proportion of the fleet has opted for decommissioning (express as a percentage of the total fleet)?

b. Technology Creep

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

Have there been any significant changes in gear usage in specific fisheries, if so what are the changes (e.g. switch from twin to single rig trawling, beam trawl to seine net).

In which fishery has this occurred and in what ICES areas?

Have any other technical changes occurred in particular fleets that will have resulted in changes in catching efficiency (e.g. changes in fishing pattern, new gears or navigational equipment) has the change in catchability been quantified?

c. Technical Conservation Measures

Other important information could include what is the level of uptake if voluntary, has the selectivity of these been determined and if so how does it compare with the earlier estimates, are there any other wider benefits e.g. reduced fuel costs, ecosystem benefits etc.

Have any new TCM's been introduced into specific fisheries? If so what are the measures and which fleets and/or areas are affected?

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

Can the changes in selectivity (size or species) be quantified relative to 'standard' gears; if so what are the changes (e.g. shift in L50, % reduction in bycatch)

What proportion of the fleet has opted to use new TCMs (0 -5; 5 highest)

Please specify regulation (national or otherwise) and fishery.

d. Ecosystem Effects

Are there any fisheries where there are known impacts on non-target species including birds and marine mammals, ghost fishing etc?

Are there any mitigation measures in place and how effective have they been?

e. Development of New Fisheries

Briefly describe any new fisheries developed?

Have these new fisheries removed effort from others, and if so can you provide an estimate (in terms of numbers of vessels) of how many?

Please return both files prior to the WGFTFB meeting by email to Norman Graham (norman.graham@marine.ie) and use a country code identifier in the file name e.g. Norway.doc. Your information will then be collated during the WGFTFB meeting into a common format.

ANNEX 8a: FTFB Report to WGSSDS & WGHMM

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the Southern Shelf Assessment Area including the Celtic Sea and hake, monkfish and megrim stocks.

It should be noted that the information contained in this report does not cover fully all fleets engaged in Southern Shelf fisheries; information was obtained from Ireland, Belgium, Spain (Basque Country) and France.

Changes in Fleet Dynamics between 2007 and 2008

- Effort associated with French purse seine vessels targeting anchovy and bluefin tuna has transferred to targeting red mullet, squid and whiting with Danish Seines in the Bay of Biscay. A similar trend has been observed in Ireland, with a switch from demersal trawling for monkfish and megrim to Danish Seining for roundfish. It is estimated that this has increased the Irish Seine net activity from 5 to 10 vessels in the space of one year (France: Implications: shift in target species and gear type).
- French vessels targeting *Nephrops* are now reverting back to the use of a single trawl rig to reduce fuel consumption (France: Implications: Reduced LPUE; changes in bycatch species and length composition [Breen *et al*, 1996]).
- Effort in the pelagic pair trawl fisheries for sea bass, tuna and anchovy has reduced and transferred to megrim and monkfish using demersal trawl in VIIIa and VIIIb (France and Spain: Implications: Changes in effort and gear type).
- Economic losses associated with French quota reductions of traditional species such as cod, whiting and plaice in VIId and IVc have been partially compensated for by increased catches of red mullet, sea bass and squid (France: Implications: Increased landings of non-quota and non-assessed species).
- French trawlers targeting whiting which traditionally operate in VIId have switched effort into IVb due to reduced catch rates in VIId and to reduce fuel consumption by decreasing the number of individual trips but increasing duration. (France: Implications: Switch in effort between assessment areas possible issues for raising metrics).
- During 2007/2008 5% of the Belgian beam trawl fleet was removed through decommissioning.
- During 2008 Ireland introduced a further decommissioning scheme which aims to remove 11,140GT from the fleet register. This is targeted at vessels over 10 years and >18m. To date applications represent ~45% of the total target, which is expected to be over subscribed. The majority of applica-

tions emanate from East and west coast ports from vessels which traditionally target *Nephrops* with uptake from the South East also. No applications have so far been received from vessels from the South West which traditionally target whitefish. It is expected that much of the actual effort removed from the decommissioning scheme may be partially negated through the introduction of ~21 modern second hand vessels (mostly ex-French) into the fleet. These have either replaced existing older, less efficient vessels, or have taken advantage of 'semi-dormant' tonnage of which a further ~3000GT remains. (Belgium and Ireland: Reductions in Fleets).

- A portion of the Basque demersal trawl fleet now targets mackerel during the winter months in ICES areas VIIIabd (Spain: Implications: partial switch in effort).
- Approximately 25% of the Basque VHVO demersal fleet opted for decommissioning during 2007/2008. This has affected older vessels. In addition 10–20% of the remaining side trawlers have been replaced by modern stern trawlers (Spain: Implications: reduction in fleet capacity partially negated by fleet modernisation).
- As reported in 2007 effort levels by Irish vessels in the Porcupine Bank *Nephrops* fishery have increased significantly with approximately 12–14 boats consistently participating in this fishery in 2006–2008. Landings are reported to be stable with most vessels landing 8–10 tonnes of *Nephrops* for 7–10 day trips. 3–4 vessels are now freezing *Nephrops* on board and landing to lucrative markets in Spain. Fishermen report that *nephrops* have tended to be of a much smaller size range in 2007. There was also a high percentage of females (> 75%) in some areas and this has resulted in lower returns to vessels (average of €9/kg for males compared to 5/kg for females). (Ireland: Implications: Shift of effort into different fisheries).
- Despite the closure of the hake gillnet fishery in Areas VIIb-k in depths > 200m for part of 2006, and subsequent regulations introduced in 2007 that restrict the length of gear and soak time in the hake fishery, Irish gillnet fishermen reported that the 2007/2008 hake fishery was in fact quite poor contrary to the scientific advice. Irish gillnetters tend to work in depths between 200–300m. Many vessels switched back to trawling due to poor catches and there are now only 7–8 gillnet vessels > 12m left in the fleet and 3–4 of these have applied for decommissioning reflected the poor returns in recent years. (Ireland: Reduction in effort).
- 4–5 Irish whitefish vessels (all 24m+ vessels) have increased effort in the Rockall fishery in 2006, moving from the monkfish and mixed monkfish, megrim, hake fisheries in Areas VIIb-k to VIb. (Ireland; Implications: Quota restrictions/Changes in fleet Dynamics).
- There has been a recent shift in effort by 4–5 Irish vessels from traditional grounds in VIIj,g to areas further south to west of the Sicily Isles and into Area VIIh. This is to try and avoid catching cod and these vessels are targeting a combination of mixed demersal species, primarily hake and non-quota species such as John Dory, red mullet. (Ireland: Implications: Shift in effort to other areas).
- The UK beam trawlers have reduced fishing activity levels due to high fuel prices. Many are now focussing on scalloping as opposed to fish. (UK: Implications: reduced fishing effort).

- The Irish scallop fleet based in the south east of Ireland has been rebuilding after a bleak number of years and since decommissioning was introduced in 2005. After a period of reduction or stagnation there is now 8 > 10m vessels (1 vessel < 15m) and 3–4 < 10m vessels either participating or preparing to participate in the scallop fishery. This adds up to around 1850kw (> 10m), which is still well under the capacity limit of 4,800kw. Indications are that many fishermen are looking at this fishery as an attractive option and this illustrates that there is a need to introduce management measures to protect scallop stocks before effort increases to fill the capacity limit (Ireland: Implications: shift of effort into scallop sector).

Technological Creep

- There is renewed interest in seining by vessels on the south coast. Several 20–24m vessels have switched from trawling (monkfish) back to seining to reduce operating costs. However, there are reports of discarding/high grading by seiners due to low/fluctuating prices for round haddock and also due to quota restrictions. There are now 10 or more seiners on the south coast compared to only 4–5 in 2006. These vessels use 90mm north of 51° N and 100mm south of 51°N. (Ireland: Implications: Move to different fishing method).
- As reported in 2007 an Irish vessel is currently testing an automatic *Nephrops* tailing machine. This vessel works almost exclusively in the Irish Sea and this fishery is almost a targeted tail fishery given the small size of *Nephrops.* The prototype machine has proven quite effective but many fishermen involved in the Irish Sea *nephrops* fishery have expressed reservations at the widespread utilisation of such machines as it may lead to increased levels of effort in areas with an abundance of small *nephrops.* An introduction of a voluntary ban on landing tailed *nephrops* above a certain count per kg (80–100 tails/kg) have been muted by fishermen and co-operative managers to counter this and discourage the targeting of small *nephrops.* (Ireland: Increased efficiency).

Technical Conservation Measures

- Vessels targeting *Nephrops* in ICES areas VIIIa and VIIIb are now given the option to used one of three methods to improve size selectivity of *Nephrops* i) increased mesh size (70 to 80mm), ii) drop out panel (60mm square mesh belly panel) or, iii) a semi-rigid grid (13mm). It is unclear what the uptake is of each device, but reduction of *Nephrops* discards (<9cm TL) for each device are estimated as follows: 35% for the 13mm grid, 30% for 80mm, 25% for square mesh drop out panel (France: Implications: changes in length profile of *Nephrops* catches).
- In 2006, square mesh panel (100 mm inner opening) on the top of the rear tapered section of the trawl, to decrease catches of juvenile hakes in Nephrops fishery in the Bay of Biscay [Council regulation (EC) n° 51/2006 (22 December 2005) and 41/2007 (21December 2006); Council regulation (EC) n° 40/2008 (16 January 2008) and 41/2007 (21December 2006)]. It is estimated that this has resulted in a 25% reduction in the retention of undersize hake.

- Belgium beam trawlers operating in VIIg are reported to be using larger mesh (150mm) belly panels in order to reduce retention of weed and other benthos. Belgium fishermen's organisations are promoting the use of benthic drop out panels and full square mesh cod-ends and uptake is likely to steadily increase. One vessel is currently using these devices voluntarily but other vessels are scheduled to adopt these modifications during 2008 (Belgium: Implications: reduced bycatch of non-target species and improved gadoid selectivity).
- Belgium beam trawlers have tended towards the use of chain matrix gear over traditional tickler chain nets due to the lower towing speed and associated reductions in fuel consumption (Belgium: Implications: reduction in overall swept area).
- Encouraged by access rights, Basque vessels which target mixed demersal species in VIIIabd close to the French coast, are voluntarily using square mesh panels to reduce discards (Spain: Implications: discard reduction).
- Effort in the deepwater gillnet fisheries for hake has remained very high in 2007, particularly in the southwest Porcupine area. There are still repeated claims by Irish fishermen that there is widespread use of 100mm mesh nets, which is illegal in Area VII. The Irish Naval Service has arrested several of these vessels for breaches of regulations including the use of undersize mesh. (Ireland: Implications: Reduced selectivity through the use of small mesh size).

Ecosystem Effects

- Predation of fish catches by Grey seals from gillnet/tangle net fisheries has become an increasing problem on the south coast of Ireland. Many inshore gillnet fishermen are considering shifting into other fisheries as the problems has become so bad. One fisherman (12m vessel) reported 100% losses from tangle net gear targeting monkfish, ray and turbot from one particular set and average losses to seals of between 50%-75% as commonplace. There has also been an increase in gear damage. As many as 20 or more vessels maybe affected by this phenomenon. (Ireland: Implications: Predation to fish catches).
- There has been a considerable increase in the quantities of small *nephrops* on the Smalls grounds in 2007 and 2008 leading to very high landings by boats from the East coast with a high proportion of tails to whole *nephrops*. There are a number of boats (up to 10 vessels) that have participated in this fishery but do not tail due to low crew numbers and this has lead to high discarding/upgrading. It is also reported that the seasonal Cod Closures in the Celtic Sea have lead to a shift in effort by *nephrops* vessels to the west side of the ground leading to the size of *nephrops* noticeably reducing as effort increases. When the boxes have reopened, initial landings taken within the box on the east of the ground have comprised a high proportion of larger whole *nephrops.* The introduction of these boxes has completed shifted the previous pattern in the Smalls fishery. (Ireland: Implications: Negative impacts of technical measure e.g. closed area).
- High discarding of cod in Area VIIb-k was reported in Q3 and Q4 in 2007 due to exhaustion of quota. This has been repeated in 2008, when 80%+ of the quota in the Celtic Sea Area was caught by mid-March. Discarding has been widespread across all Irish demersal fleets. An example of the scale is

reports from the owner of one seine net vessel, who discarded over 30 boxes of marketable cod (1–1½ tonnes) from one 5–6 day trip. The problems in 2008 have been put down to poor quota management which effectively led to unrestricted landings during February-March. Heaviest landings were made by the Irish gillnet fleet of around 6–8 vessels. Heavy landings led to very low prices and cod were sold as low as €1.20–1.40/kg during this period. (Ireland: Discarding).

- As in 2007, vessels are now discarding 0–500g and 500–1kg monkfish to meet quota restrictions. This discarding is reportedly at quite a high level, particularly in around 200m-400m. (Ireland: Discarding).

Development of New Fisheries

- A portion of the Belgium beam trawl fleet operating in VIId and VIIe has targeted squid and cuttlefish during the winter months (Belgium: Implications: partial switch towards non-quota and non-assessed species).
- Despite poor results from experimental trials carried out in 2007 by BIM, a potential fishery for deepwater rose shrimp is being explored by an Irish vessel off the south west coast. This vessel has landed samples of frozen rose shrimp from 400–800m using standard scarper trawls with 80mm codend mesh size and is reportedly gearing up with two specially designed shrimp trawls with 32mm codend mesh size. (Ireland: new fishery for non-quota species).

Annex 8b: FTFB report to WGBFAS

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes on ecosystem effects in the Baltic Sea and Kattegat. No other relevant information was given.

It should be noted that the information contained in this report does not cover fully all fleets engaged in Baltic; information was obtained from Sweden only.

Changes in Fleet Dynamics 2007 to 2008

- In the first quarter of 2008, the number of vessels fishing in the Kattegat has decreased due to an increased effort cost (2.5 days at sea per effort day deployed). This effort has mainly been reallocated to the Skagerrak and the Baltic Sea. Vessels without the possibility to change area have mainly target *Nephrops* using grid-equipped trawls (This gear type is not subject to the new effort limitation). (Sweden: Implications: reallocation of effort from Kattegat towards the Baltic and Skagerrak.)
- In the recent years there has been an increase in the numbers of Swedish *Nephrops* vessels. This has contributed to subsequent increases in effort and landings during 2006–2007 with the highest historical catch rates. The increase in number of vessels may be attributed to input of new capital transferred from pelagic fleets after the introduction of an ITQ-system for pelagic species. (Sweden: Implications: increased effort).

Technical Conservation Measures

- In the Swedish trawler fleet there has been a steady increase in uptake of the Nephrops grid since introduction into legislation in 2004. Approxi-

mately 75% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2006 and 2007 (40% of *Nephrops* trawl landings). This can be explained by the fact that use is mandatory on coastal waters and that there are strong incentives due to unlimited days at sea. (Sweden: Implications: Improved selectivity in *Nephrops* fisheries).

- During the first Quarter of 2008 a "day at sea" in Kattegat without the grid was counted as 2.5 days. This has further increased the incentives to use the sorting grid to the point were 80% of all *Nephrops* landings in the first quarter of 2008 were caught with sorting grids (20% previous years). (Sweden: Implications: changed effort allocation from cod towards Nephrops, decreased discard rates of roundfish).

Ecosystem Effects

- The Swedish Baltic cod trawl fishery has been concentrating effort close to the coastal areas of 25W, both due to a high abundance of fish and high fuel prices. This costal area has been considered to be an important nursing area for predominately juvenile cod and discarding maybe high. (Implications: potential increased discard rates of juvenile cod).

Annex 8c: FTFB report to WGNSDS

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the Northern Shelf Assessment Area including the Irish Sea.

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

Changes in Fleet Dynamics 2007 to 2008

- There has been a shift for Scottish vessels from using 100mm-110mm for whitefish on the west coast ground (area VI) to 80mm *Nephrops* codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries. (Scotland: Implications: Effort shift Via to Iva, and less selective gear, bycatch/discards).
- There is a new 2008 Scottish Conservation Credits scheme, with a number of implications:
- In early 2008, a one-net rule was introduced in Scotland as part of the new Conservation credits scheme. This is likely to improve the accuracy of reporting of landings to the correct mesh size range. Another element of the package is the standardisation of the mesh size rules for twin rig vessels so that 80mm mesh can be used in both Areas IV and VI (north of 56°N) by twin rig vessels – previously the minimum mesh size for twin rig in area VI was 100mm. As a result there may be some migration of twin riggers from area IV to area VI, thus switching effort from IV to VI. (Scotland: Implications: Selectivity is not expected to change greatly for prawns because 80mm nets must be made of 4mm single twine whereas 100mm nets were allowed to use 5mm double twine. Whitefish selection may improve be-

cause from July 2008, all nets in the 80mm range will have to have a 110mm square mesh panel installed).

- Scottish seiners have been granted a derogation from the 2 net rule until end Jan 2009 to continue to carry 2 nets (e.g. 100–119mm as well as 120+mm). They are required to record landings from each net on a separate logsheet and to carry observers when requested. (Scotland: Implications: Potential for misreporting by mesh category).
- From February 2008 there has been a concerted effort not to target cod. Real time closures and gear measures are designed to reduce cod mortality. The implication is that there will be greater effort exerted on haddock, whiting, monk, flats and *Nephrops*. (Scotland: Implications: Switch in effort to other species).
- During 2008 Ireland introduced a further decommissioning scheme which aims to remove 11,140GT from the fleet register. This is targeted at vessels over 10 years and >18m. To date applications represent ~45% of the total target, which is expected to be over subscribed. The majority of applications emanate from East and west coast ports from vessels which traditionally target *Nephrops* with uptake from the South East also. No applications have so far been received from vessels from the South West which traditionally target whitefish. It is expected that much of the actual effort removed from the decommissioning scheme may be partially negated through the introduction of ~21 modern second hand vessels (mostly ex-French) into the fleet. These have either replaced existing older, less efficient vessels, or have taken advantage of 'semi-dormant' tonnage of which a further ~3000GT remains. Ireland: Implications: Reductions in Fleets but actual impact unknown).
- The increased effort by Irish vessels in the Rockall fishery reported in 2007 has continued in 2008. There are now 9–10 Irish vessels targeting this fishery and it is anticipated that quotas for haddock, monkfish and megrim will be exhausted by July/August. Current regime is 30 tonne of haddock per month, which is barely viable for the larger vessels and is reportedly leading to high-grading given the volatility of the round haddock market. Two of the largest Irish whitefish vessels (34m/2000hp) have shifted effort from deepwater species (black scabbard, orange roughy, and grenadier) in Area VIa and VIIb-k to the Rockall in 2007. One of these vessels has been subsequently sold out of the fleet but at least 4 additional (24m+/750hp) vessels have participated in this fishery. These vessels generally targeted monkfish in Area VIa and VIIb-c. (Ireland: Implications: Shift of effort into Rockall fishery).
- Irish vessels have reported increased activity by the Russian fleet prosecuting a small mesh fishmeal fishery for haddock both inside and outside the EU 200 mile limit at Rockall. These vessels have been observed on the grounds much earlier than in previous years. There was a peak in haddock abundance in April but in early May haddock were reported scarce and the Russian vessels left the grounds) (Ireland: Implications: Increased effort on Rockall haddock stock).
- As reported in 2007 effort levels by Irish vessels in the Porcupine Bank *Nephrops* fishery have increased significantly with approximately 12–14 boats consistently participating in this fishery in 2006–2008. Landings are reported to be stable with most vessels landing 8–10 tonnes of *Nephrops* for

7–10 day trips. 3–4 vessels are now freezing *Nephrops* on board and landing to lucrative markets in Spain. Most boats still work 80mm on Porcupine Bank and nephrops have tended to be of a smaller size range in 2007. There was also a high percentage of females (> 75%) in some areas and this has resulted in lower returns to vessels (average of €9/kg for males compared to 5/kg for females). (Implications: Increased effort).

- During 2007/2008 5% of the Belgian beam trawl fleet was removed through decommissioning. (Belgium: Implications: Reductions in Fleets but actual impact unknown).

Technology Creep

- Shift from fish/monkfish twin trawling to single rig and an increase in the use of pair trawl/seine. Also a shift by large powered whitefish vessels to *Nephrops* and targeting North Sea grounds with double bag trawls. This is very much driven by fuel costs. (Scotland: Implications: Probable reduction in LPUE, possible increase in discarding).
- In January 2008, multi-rigs (more than 2 nets) were banned under new Scottish legislation. However, a derogation to end April 2008 was granted to vessels currently fishing multi-rigs to continue. Applies to all Scottish boats everywhere. (Scotland: Implications: again some possible reduction in LPUE).
- With increasing fuel prices there has been a significant switch by Irish trawlers to reduce gear size in some cases by as much as 20%. There is also evidence of larger vessels of once again switching from twin-rigging to single rigging to reduce fuel consumption. In the 24m+ range vessels are now working at around 50–60% of their total power in a bid to reduce fuel costs. (Ireland: Implications: reduction in LPUE).
- As reported in 2007 an Irish vessel is currently testing an automatic *Nephrops* tailing machine. This vessel works almost exclusively in the Irish Sea and this fishery is almost a targeted tail fishery given the small size of *Nephrops.* The prototype machine has proven quite effective but many fishermen involved in the Irish Sea *nephrops* fishery have expressed reservations at the widespread utilisation of such machines as it may lead to increased levels of effort in areas with an abundance of small *nephrops.* An introduction of a voluntary ban on landing tailed *nephrops* above a certain count per kg (80–100 tails/kg) have been muted by fishermen and co-operative managers to counter this and discourage the targeting of small *nephrops.* (Implications: Increased efficiency).

Technical Conservation Measures

- Some of the *Nephrops* fleet have been using SMP's with mesh sizes in the 100mm to 110mm still using a codend mesh size of 80mm x single 4mm twine. Also vessels have been installing the smp into the end of the tapered section of the trawl. This position offers more stability for the panel and reduces the chance that it can twist. Note: for current year: all twin-rig gear in the 80–99mm category will have to use a 110mm square mesh panel at 15–18m from the codline. This will also apply to single-rig gears from July 2008. (Scotland: Implications: Improved selectivity).
- The option of 18 extra days if a 120mm SMP at 4–9m was used with a 95mm x 5mm double codend was not taken up by the Scottish *Nephrops*

fleet in 2007. The main reasons were that fishermen claim that *Nephrops* would be lost due to twisting and too many marketable haddock and whiting lost which the extra days would not compensate for. In 2008 this option attracts 39 extra days but is in competition with the Scottish Conservation Credits option whereby 21 extra days are available when a 110mm SMP is used with an 80mm codend so again uptake is zero. (Scotland: Implications: No uptake of selective gear option).

- There is possibly a 30% increase in L50 of haddock, whiting, and saithe due to use of 110mm SMP. Smaller increase in L50 of perhaps 10% for cod (Scotland: Implications: Improved selectivity).
- A large number of 110mm SMPs have been bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet. (Scotland: Implications: Uptake of selective gear).
- Problems with the introduction of the 5% bycatch limits for dogfish (*Squalus acathias*) on west coast and North Sea grounds. They can be encountered in large congregations but it is almost impossible for vessels to identify them using sonar etc so they are difficult to avoid. (Scotland: Implications: likely discarding when encountering large aggregations).
- Regulations introduced at the start of 2008 preventing the targeting of spurdog have created problems, particularly for inshore gillnetters off the North Galway and Mayo coasts. Some 10 vessels which had earned an average of €20k per vessel in 2007 from spurdog now have no other demersal fishery that they can diversify into and therefore have no alternative but to target lobster and crab with pots. Most of these vessels relied on spurdog in 2007 to compensate earnings lost from the closure of the salmon driftnet fishery. This regulation has also affected a small number of vessels on the south coast and has also caused problems for trawlers which at times catch large quantities of spurdog occasionally. The regulation may lead to discarding of this species. (Ireland: Implications: Discarding of dogfish and shift of effort into different fisheries).
- Effort in the deepwater gillnet fisheries for hake has remained very high in 2007, particularly in the southwest Porcupine area. There are still repeated claims by Irish fishermen that there is widespread use of 100mm mesh nets, which is illegal in Area VII. The Irish Naval Service has arrested several of these vessels for breaches of regulations including the use of undersize mesh. (Ireland: Implications: Reduced selectivity through the use of small mesh size).
- High discarding of cod in Area VIIb-k was reported in Q3 and Q4 in 2007 due to exhaustion of quota. This has been repeated in 2008, when 80%+ of the quota in the Celtic Sea Area was caught by mid-March. Discarding has been widespread across all Irish demersal fleets. An example of the scale is reports from the owner of one seine net vessel, who discarded over 30 boxes of marketable cod (1–1½ tonnes) from one 5–6 day trip. The problems in 2008 have been put down to poor quota management which effectively led to unrestricted landings during February-March. Heaviest landings were made by the Irish gillnet fleet of around 6–8 vessels. Heavy landings led to very low prices and cod were sold as low as €1.20–1.40/kg during this period. (Ireland: Implications: High discarding).

- As in 2007, vessels are now discarding 0–500g and 500–1kg monkfish to meet quota restrictions. This discarding is reportedly at quite a high level, particularly in around 200m-400m on the Achill grounds and Stanton Banks (Ireland: Implications: High discarding).

Ecosystem Effects

- Reports of problems with discarded longlines and gill nets along the Scottish west coast deep water grounds. A lot of longline activity reported at south end Rockall plateau. (Scotland: Implications: Potential for gear conflicts).
- Despite the closure of the hake gillnet fishery in Areas VIIb-k in depths > 200m for part of 2006, and subsequent regulations introduced in 2007 that restrict the length of gear and soak time in the hake fishery, Irish gillnet fishermen reported that the 2007/2008 hake fishery was in fact quite poor contrary to the scientific advice. Irish gillnetters tend to work in depths between 200–300m. Many vessels switched back to trawling due to poor catches and there are now only 7–8 gillnet vessels > 12m left in the fleet and 3–4 of these have applied for decommissioning reflected the poor returns in recent years. (Ireland: excessive gear lengths and soak times).
- Under Natura 2000, UK-Scotland has proposed a SAC on the Stanton Banks off the north-west coast of Donegal in Area VIa. The proposed area, which would be closed to trawling, dissects the grounds fished extensively by Irish vessels. While the number of vessels working this area has decreased in the last number of years to around 5 vessels (part-time) the impact would nonetheless be adverse. Through the NWWRAC a case has been made to reduce the impact of this proposed closure (Ireland: Compliance with regulation).

Development of New Fisheries

- Despite poor results from experimental trials carried out in 2007 by BIM, a potential fishery for deepwater rose shrimp is being explored by an Irish vessel off the south west coast. This vessel has landed samples of frozen rose shrimp from 400–800m using standard scarper trawls with 80mm codend mesh size and is reportedly gearing up with two specially designed shrimp trawls with 32mm codend mesh size. (Ireland: Implications: Effort in small mesh fishery with potential for high discards).
- There has been increased catches of squid reported at Rockall in Q2 of 2008. In previous years catches of squid had been much reduced on 1990 levels but one 34m/1200hp Irish vessel is now freezing squid on board. This vessel is landing upwards of 2–3 tonne of frozen squid per trip in addition to quantities of fresh squid caught on the last days of the trip. This is becoming of increasing importance and as quotas become exhausted at Rockall; vessels will undoubtedly begin to target this fishery more. (Ireland: Implications: targeting non-quota species).

Annex 8d: FTFB report to WGNSSK

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the North Sea and Skagerrak.

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

Changes in Fleet Dynamics 2007 to 2008

- There is a gradual shift from beam trawling on flatfish to twin trawling on other species e.g. gurnards, and *Nephrops*, etc. in the Dutch fleet. A number of beam trawlers decided to shift to other techniques such as outrigging or fly-shooting in the British Channel. Caused by TAC limitations of plaice and sole and rising fuel costs. A detailed report on trends in the NL fleet is attached as Annex 1 to this section. (Netherlands: Implications: reduction in effort/landings of flatfish, transfer of effort to other species).
- There has been a shift for Scottish vessels from using 100mm-110mm for whitefish on the west coast ground (area VI) to 80mm prawn codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries. (Scotland: Implications: Effort shift Via to Iva, and less selective gear, bycatch/discards).
- There is a new 2008 Scottish Conservation Credits scheme, with a number of implications:
- In early 2008, a one-net rule was introduced in Scotland as part of the new Conservation credits scheme. This is likely to improve the accuracy of reporting of landings to the correct mesh size range. Another element of the package is the standardisation of the mesh size rules for twin rig vessels so that 80mm mesh can be used in both Areas IV and VI (north of 56°N) by twin rig vessels – previously the minimum mesh size for twin rig in area VI was 100mm. As a result there may be some migration of twin riggers from area IV to area VI, thus switching effort from IV to VI. (Scotland: Implications: Selectivity is not expected to change greatly for prawns because 80mm nets must be made of 4mm single twine whereas 100mm nets were allowed to use 5mm double twine. Whitefish selection may improve because from July 2008, all nets in the 80mm range will have to have a 110mm square mesh panel installed).
- Scottish seiners have been granted a derogation from the 2 net rule until end Jan 2009 to continue to carry 2 nets (e.g. 100–119mm as well as 120+mm). They are required to record landings from each net on a separate logsheet and to carry observers when requested. (Scotland: Implications: Potential for misreporting by mesh category)
- From February 2008 there has been a concerted effort not to target cod. Real time closures and gear measures are designed to reduce cod mortality. The implication is that there will be greater effort exerted on haddock, whiting, monk, flats and *Nephrops*. (Scotland: Implications: Switch in effort to other species).

- 24 boats were decommissioned in the beginning of 2008 from the Dutch fleet. There is also a general tendency to opt for smaller multi-purpose vessels replacing the conventional beam trawler for fishermen left in the fleet (Netherlands: Implications: Reduced fleet size and shift of effort into other sectors).
- 5 beam trawlers left the Belgium fleet in 2007 (approx 5%) (Belgium: Implications: Reduced effort).
- In the first quarter of 2008, the number of vessels fishing in the Kattegat has decreased due to an increased effort cost (2.5 days at sea per effort day deployed). This effort has mainly been reallocated to the Skagerrak and the Baltic Sea. Vessels without the possibility to change area have mainly target *Nephrops* using grid-equipped trawls (This gear type is not subject to the new effort limitation). (Sweden: Implications: reallocation of effort from Kattegat towards the Baltic and Skagerrak.)
- In the recent years there has been an increase in the numbers of Swedish *Nephrops* vessels. This has contributed to subsequent increases in effort and landings during 2006–2007 with the highest historical catch rates. The increase in number of vessels may be attributed to input of new capital transferred from pelagic fleets after the introduction of an ITQ-system for pelagic species. (Sweden: Implications: increased effort).
- The Farne deeps *Nephrops* fishery has been very poor in 2008. The *Nephrops* disappeared very early, so the season was very short. This will shift effort into other fisheries for whitefish (UK: Implications: increased effort in other fisheries).

Technology Creep

- A number of Dutch beam trawlers are continuing to investigate the 'outrigging' method as an alternative to beam trawling, similar to the work in Belgium and UK. Some boats have also moved over to seining (flyshooting) (mainly in the English Channel). (Netherlands: Implications: change in effort from flatfish to range of other species).
- The Dutch Beam trawler UK153 who was trialling the electrified pulse trawl was sold, and the skipper has opted for a smaller multi-purpose vessel. (Netherlands: Implications: Electric bam trawl method may be obsolete as an alternative method).
- Belgian Beam trawlers are generally fishing more with R-nets and chain matrices than with V-nets, using tickler chains. Fishing speed for beam trawls with R-nets is generally lower. Due to high fuel prices fewer beam trawler use of V-nets. Fewer vessels are using the outrigger trawls. Some beam trawlers have changed to twin trawls. All driven by fuel price. A Numbers of national project investigations of beam trawl modifications are continuing. (Belgium: Implications: Not clear, but fleet is in flux, and investigating many alternative options for fuel and discard reduction).
- Shift in the Scottish fleet from fish/monkfish twin trawl to single rig and an increase in the use of pair trawl/seine. Also a shift by large powered whitefish vessels to *Nephrops* and targeting North Sea grounds with double bag trawls. This is very much driven by fuel costs. (Scotland: Implications: Probable reduction in LPUE, possible increase in discarding).

- In January 2008, multi-rigs (more than 2 nets) were banned under new Scottish legislation. However, a derogation to end April 2008 was granted to vessels currently fishing multi-rigs to continue. Applies to all Scottish boats in all areas. (Scotland: Implications: again some possible reduction in LPUE).
- There has been an increasing emphasis on the use of T90 trawls in Iceland. Bottom trawls made entirely of T90° except in the codend are now being constructed and 14 stern trawlers targeting cod and haddock have shifted to T90 trawls. Some other vessels are experimenting in other fisheries as well (*Nephrops* and shrimp) in area Va. Changes in catchability/efficiency are not known but this is being driven by high fuel costs as these trawls have reportedly reduced drag. It is known nine T90° trawls have been sold to different Europe countries (Iceland: Implications: not known but possibly reduced fuel consumption).

Technical Conservation Measures

- The Dutch beam trawl fleet is sensitive to the bad reputation of beam trawl and this is stimulating research into selective nets and reduced bottom impact. Combined research activities were started in 2007, mostly catch comparison experiments but there is an industry focus to solve this image problem (Netherlands: Implications: Improved selectivity and reduced bottom impact potentially).
- Some of the *Nephrops* fleet have been using SMP's with mesh sizes in the 100mm to 110mm still using a codend mesh size of 80mm x single 4mm twine. Also vessels have been installing the smp into the end of the tapered section of the trawl. This position offers more stability for the panel and reduces the chance that it can twist. Note: for current year: all twin-rig gear in the 80–99mm category will have to use a 110mm square mesh panel at 15–18m from the codline. This will also apply to single-rig gears from July 2008. (Scotland: Implications: Improved selectivity)
- The option of 18 extra days if a 120mm SMP at 4–9m was used with a 95mm x 5mm double codend was not taken up by the Scottish prawn fleet in 2007. The main reasons were that prawns would be lost due to twisting and too many marketable haddock and whiting lost which the extra days would not make up for. In 2008 this option attracts 39 extra days but is in competition with the Scottish Conservation Credits option whereby 21 extra days are available when a 110mm SMP is used with an 80mm codend. (Scotland: Implications: Possibly a 30% increase in L50 of haddock, whiting, saithe due to use of 110mm SMP. Smaller increase in L50 of perhaps 10% for cod).
- A large number of 110mm SMPs have been bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet. (Scotland: Implications: Uptake of selective gear).
- Problems with the introduction of the 5% bycatch limits for dogfish (*Squalus acathias*) on west coast and North Sea grounds. They can be encountered in large congregations but it is almost impossible for vessels to identify them using sonar etc so they are difficult to avoid. (Scotland: Implications: likely discarding when encountering large aggregations).

- In the Swedish trawler fleet there has been a steady increase in uptake of the Nephrops grid since introduction into legislation in 2004. Approximately 75% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2006 and 2007 (40% of *Nephrops* trawl landings). This can be explained by the fact that use is mandatory on coastal waters and that there are strong incentives due to unlimited days at sea. (Sweden: Implications: Improved selectivity in *Nephrops* fisheries)
- During the first Quarter of 2008 a "day at sea" in Kattegat without the grid was counted as 2.5 days. This has further increased the incentives to use the sorting grid to the point were 80% of all *Nephrops* landings in the first quarter of 2008 were caught with sorting grids (20% previous years). (Sweden: Implications: changed effort allocation from cod towards Nephrops, decreased discard rates of roundfish)
- One Belgian beam trawler (1200hp) is using a combination of T90-codend, benthos release panel, big meshes in the top panel and roller gear. This is a research project but it is expected that more vessels will be using larger mesh sizes in the top panel of the beam trawl and/or T90- or square mesh codends (80mm) and/or the benthos release panel. Fishermen's organisation is taking initiatives to motivate fishermen to use modifications that reduce beam trawl discards. Four beam trawlers are planning to use technical modifications in 2008. The driving factor for changes is generally reduced fuel consumption. Implications: The use of bigger meshes in the top panel is expected to increase the species selectivity, i.e. reduce the bycatch of roundfish species, especially haddock and whiting. (Belgium: Implications: improved selectivity and voluntary use of TCM).

Ecosystem Effects

- Bycatch of benthic fauna and several non-target fish species (e.g. gobies) in beam trawls. Voluntarily use of longitudinal release holes in the lower panel of the trawl, which open when nets are filled with benthos, and of Benthic Release Panels. Research is being carried out with the industry to optimise a Benthic Release Panel for the Dutch beam trawling segment. Similar initiatives in Belgium (Netherlands & Belgium: Implications: reduced benthic impact).
- Reports of problems with discarded longlines and gill nets along the Scottish west coast deep water grounds and in the northern North Sea. A lot of longline activity reported at south end Rockall plateau. (Scotland: Implications: potential for gear conflicts/ghost fishing).

Development of New Fisheries

- There has been an increase by Dutch vessels in *Nephrops* fisheries using twin trawls. Outrigger trawls are also replacing beam trawls, or flyshooting (seining) mainly for non-quota species such as red mullet and cuttlefish. (Netherlands: Implications: These are not new fisheries but represent new trend in Dutch fishing resulting in effort and target species shift. Full implications not yet known).
- Belgium: wide range of experimental new fisheries being tried in Belgium – see Annex 2
- Squid fishery in Moray Firth continues to develop when species available on grounds, using very unselective 40mm mesh. Not much take-up in 2007

due to few squid. (Scotland: Implications: 40 mm mesh means potential high bycatch of young gadoids esp. cod and haddock. This fishery may provide an alternative outlet for the *Nephrops* fleet seasonally, and hence reduce effort in that sector).

Economic report on Netherlands fishing fleet 2007

This information is taken from:

Taal, C., Bartelings, H., Klok, A., van Oostenbrugge, J.A.E. 2007. Fisheries in figures 2007. The Hague, LEI, 2007, Report PR 07.04; ISBN 978–90–8615–192–9.

General

The revenue of 438 million euros generated by the Dutch high-sea and coastal fisheries in 2006 was slightly lower than in the previous year. The total turnover, including the fish farming sector (48 million euros), amounted to 486 million euros.

The cutter fleet's revenue increased (by 7%) to 256 million euros. The large high-sea fishing fleet recorded a landing value of 125 million euros, a decline of al-most 9% as compared to 2005. The mussel farming sector's revenue fell by 7 million euros to 49 million euros (-12%).

The active high-sea and coastal fishing fleet was comprised of 440 vessels, al-most the same number as in the previous year. The number of jobs provided by the fisheries sector declined by almost 8% to about 2,100. Following the extremely low investments in 2005, the sector's investments almost trebled to 30 million euros in 2006.

The turnover of the Dutch fish auctions increased slightly to 336 million euros, whilst the volume of landings declined by 3%. In particular, the volume of sole landed in 2006 was lower (-23%), whereas the volume of plaice increased slightly (+3%). The volume of the landings of almost all other types of fish was lower. The average landing price at the auctions rose by 3% to 3.42 euros per kg. The landings of shrimp increased slightly (2%); however, the price increased by 4%.

Cutter fisheries

The cutter sector once again recorded a net loss in 2006 (for the fifth consecutive year). The economic loss amounted to ten million euros, almost the same as in the previous year.

The landing value increased by almost 7% to 256 million euros. Although the deployment of the fleet declined by 2.5%, the total costs increased by the same percentage as the revenue (+7%). The major cost item - gas oil - increased by 17% in 2006. The average price of gas oil increased to 41 Euro cents per litre (2005: 35 Euro cents per litre). The revenues from sole increased by 2 million euros; although the price increased by 22%, landings fell by 16%. The revenues from plaice increased by 4 million euros: the price was 3% higher, and landings increased by 7%. The landing value of shrimps increased to 38 million euros, the net result of the 3% increase in volume of landings and the 6% increase in price. The total labour income from cutter fishing (landing value less the technical costs) increased slightly to 54 million euros.

The number of vessels in the active cutter fleet fell to 344 cutters, and the total engine power declined by 8% to 304,000 horse power. The number of crew members also declined further by almost 5%, especially on the large beam-trawling cutters. Gas-oil consumption remained at roughly the same level, due to the virtually unchanged deployment of the fleet.

Cutters in the 261–300 HP categories (primarily Euro cutters) recorded a total landing value roughly equal to the level in 2005. This group exhibits a very large variation in the costs and landing values: the highest daily landing value was 43% above average, and the lowest 33% below. On average, the cutters operated at a net loss. The earnings of the crew members amounted to 42,000 euros, the same level as in the previous year.

The largest category of large beam-trawling cutters (2,000 HP) accounted for more than 53% of the total engine power. The deployment of these cutters increased in 2006. Although the average landing value increased by 21%, this was insufficient to offset the greatly increased costs (fuel). Consequently, the operations, as in 2005, recorded a loss (-89,000 euros).

Shrimp cutters with an engine power of up to 261 HP recorded a 9% increase in revenue in 2006, and the net profit amounted to 7,000 euros per vessel.

The financial position of the cutter sector deteriorated slightly as compared to the previous year, a year in which the sector's solvency had already exhibited a substantial decline. The overall cutter fisheries sector's equity at the beginning of 2005 averaged about 0% of the total balance sheet capital. Investments were at a low level, and the level of loans increased slightly. The long-term borrowed capital now amount to 270 million euros, more than 960,000 euros per company. The net cash flow was negative in the year under review (-11 million euros).

The initial forecasts for the cutter fisheries sector in 2007 indicate a result equal to or slightly higher than that in 2006, although on balance the sector will still operate at a loss. The total deployment of the fleet is expected to remain virtually unchanged, at just under 54 million HP days. Estimates based on the data until the end of September 2007 indicate that the sector's revenue will probably be slightly higher, and will amount to a maximum of 260 million euros.

Only a small fraction of the beam-trawler fleet will be able to operate at a profit. The prospects for this major segment of the cutter fisheries sector remain gloomy. The shrimp fisheries sector would appear to be having a good year; shrimp prices have re-turned to a high level for the first time in many years (a few dozen percent higher), and it would seem that the problems encountered by the sector for many years have come to an at least temporary end. The smaller shrimp cutters, in particular, will be able to close the year with a profit. In analogy with the previous year, the twin-rigs and snurrevod (Danish nets) would once again be appearing to achieve reasonable to good results.

The cutter fisheries sector's labour income and net results have, in general, remained stagnant during the past years. These are estimated to amount to about 54 million euros, roughly the same level as in 2006.

A restructuring round is scheduled for the end of 2007, and consequently the size of the fleet will probably decline by some 24 cutters (primarily beam-trawlers) to a total active fleet of 320 vessels. When expressed in terms of capacity (in HP), the size of the fleet will probably decrease by at least 15% (when expressed in terms of the flatfish fleet, about 20%).

Large-scale high-seas fishing (pelagic fleet)

The size and composition of the large high-sea fishing fleet changed once again, in analogy with 2005, following the sale of a further two vessels outside the Netherlands. The fleet now totals 13 freezer trawlers. With the exception of a limited num-

ber of relatively minor renovations of the vessels, virtually no further investments were made in the fleet. The total deployment in terms of days at sea was 12% lower, primarily due to the reduced size of the fleet. Fishing declined, in particular in African waters. A new development was the deployment of one trawler in the fishing grounds around Chile and Peru (international waters). Landings decreased as compared to the previous year by 19%, to a little over 378,000 tonnes of fish. Landings of herring, blue whiting and sardinella, in particular, exhibited a substantial decline. Only Atlantic horse mackerel landings increased.

The total costs fell by 9%, primarily due to the reduced deployment. Following the great increase in the price of fuel (fuel oil), this cost item now accounts for 18% of the revenue. The average price of fuel oil was 29 Euro cents per litre.

The landing value decreased by 9% to more than 125 million euros, a decline of more than 11 million euros. The fleet closed 2006 with a net profit of almost 7 million euros.

Table showing changes in the Belgian Fleet 2006–2008.

	2006/2007	2007/2008
Outrigger trawl fisheries (mixed fisheries)	4 beam trawlers	2 beam trawlers (and 1 on project scale, aiming for squid, see below)
Handline fisheries for seabass (seasonally: May-October, ICES-Subarea IVc)	1 catamaran	2 catamarans (one new vessel, replacing a beam trawler)
Scallop dredging in ICES-Subarea VIId and VIIe (seasonally, during winter months)	None.	1 beam trawler is now scallop dredging.
Squid fisheries (project scale)	Several beam trawlers target squid and cuttlefish in winter months in ICES-Subarea VII	Next to those beam trawlers, 2 beam trawlers will target squid and cuttlefish (one with an outrigger trawl and one with a twintrawl)
Fisheries on project scale: i. Gill net fisheries for turbot (ICES-Subarea IVc) ii. Gill net fisheries for cuttlefish (ICES-Subarea IVc) iii. Gill net fisheries for sole (ICES-Subarea VIIf) iv. Whelk pots (ICES-Subarea VIIe) v. Pots for cuttlefish (ICES-Subarea IVc) vi. Longlining for seabass	None.	3 netters (generally using trammel nets for sole and/or gill nets for cod) will conduct experimental trials for the mentioned passive fishing methods.

Annex 8e: FTFB report to WGWIDE

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in pelagic fisheries for horse mackerel, mackerel, anchovy, sardine, herring and blue whiting.

It should be noted that the information contained in this report does not cover fully all fleets engaged in pelagic fisheries; information was obtained from Ireland, Netherlands, UK-Scotland, Spain (Basque Country), Norway, Faroe Islands and France.

Changes in Fleet Dynamics 2007 to 2008

- The size and composition of the large Dutch high-seas pelagic freezer fleet has changed, in analogy with 2005, following the sale of a further two vessels outside the Netherlands. The fleet now totals 13 freezer trawlers. Landings of herring, blue whiting and sardinella, in particular, exhibited a substantial decline. Only Atlantic horse mackerel landings have increased (Netherlands: Reduced number of vessels).
- The Scottish fleet stands at 23 vessels and new builds are continuing to take place. Average age of vessels is now 6–8 years (Scotland: Improved efficiency).
- No changes are reported in the Norwegian Pelagic Fleet.
- Rising fuel prices has meant that a very high percentage of the total quotas for pelagic species have been landed locally by Irish vessels this season. Proximity of fish to port is now a driving factor in determining port of landing compared to a few years ago when Irish vessels preferred to steam to Norway or Scotland to land due to higher prices for mackerel. This has been a positive development to the processing industry in Killybegs (Ireland: Implications: shift in fishing effort).
- Most of Irish blue whiting quota in 2008 has been frozen for human consumption instead of reduction to fish meal. This has been a very positive development and the fish processing factories for the first time have reported making profits from the blue whiting fishery. Irish landings have been supplemented by Norwegian, Danish and Faroese vessels (Ireland: Implications: increasing focus on blue whiting fishery).

Technological Creep

- Two Icelandic pelagic trawlers and three bottom trawlers have changed from using steel wires to dynex warps. Changes in the type of warps in the pelagic fishery for blue whiting and to some extent for herring in area Va, Vb, VIa and VIb. Some reports of this in Scottish and Irish pelagic fleet also. (Iceland: Implications: Not known, probably improved in fuel efficiency).

Technical Conservation Measures

- In the Blue whiting fishery, both Icelandic and Faroese vessels are using flexible grids with 55 mm between bars to exclude cod and saithe from

catches of blue whiting. Trials with this approach being conducted in Norway, no uptake yet. (Iceland & Faroe Islands: Implications: There are predominantly large cod and saithe in the areas where the Blue whiting is caught, thus the grid is believed to reduce bycatch of those species by >90%. 80% uptake)

- Pelagic vessels in Scotland and Ireland have been fitting escape grids/panels. These are believed to allow release of juvenile mackerel, horse mackerel and herring. Recent trials gave equivocal results. Uptake around 50% in Irish fleet and 10% in Scottish fleets. (Scotland and Ireland: Implications: possible reduced mortality on recruiting year classes, but no data on survival rates from escaping fish is available and therefore could be a source of unaccounted mortality).

Ecosystem effects

- As reported in 2006 and 2007, management regulations in the scad fishery, restricting the bycatch of mackerel to 5% has lead to widespread slipping in the pelagic fisheries when catches have been mixed. This discarding is reported to be substantial. There is also evidence of high grading in the mackerel fishery as due to economic pressures vessels are only landing mackerel of 300g+ and discarding catches of smaller fish. Again the levels of discarding are quite high compared to actual reported landings (Scotland: Implications: discarding).
- Norwegian trials estimated mortality of mackerel after crowding and slipping in purse seines has been continuing. Three trials were completed in 2007, crowding for 10–15 min, gave mortality rates of 80–100%. Work will continue with herring in 2008 and a large project is planned for 2009, which will also include new design of the purse seine, cooperation with the industry (Norway: Implications: unaccounted fishing mortality).

New Fisheries

- Up to eight of the pelagic vessels have continued to fish for boarfish (*Capros aper*) during Q4 2007 and Q1 2008. Two vessels fished for this species in 2006 and approximately 8 vessels in 2007. With the very short fishing time now on all of the pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Nonetheless landings by Irish vessels have continued to increase and are now probably in excess of 5,000–6,000 tonnes valued at around €1 million. An initial biological study reports that fishing effort has not had any significant impact on the stock but without management measures the stock may come under pressure quite quickly given it is a relatively slow growing pelagic species. (Ireland: Development of new fishery for species with limited scientific data available).

Annex 8f: FTFB Report to AFWG

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); ecosystem effects; and the development of new fisheries in the Arctic Fisheries areas.

It should be noted that the information contained in this report does not cover fully all fleets engaged in fisheries; information was obtained from Iceland, Faroe Islands and Norway.

Changes in Fleet Dynamics 2007 to 2008

- In the Faroese pair trawler fleet mainly targeting saithe there has been a substantial change in resent years. One of the major shipowner with eight vessels (four pairs) was allowed by the Fisheries Ministry to replace these old vessels with six new vessels. The new vessels were slightly larger but by reducing the number from eight to six vessels the total size (length, width, depth) and power (kW) should be maintained. The first new pair was introduced in late 2002. After one year in operation these two vessels were able to land twice as much fish as an old pair (FTFBWG, 2004). The second pair started fishing in October 2007 and the third pair in December 2007. No estimate has been made of the increase in fishing capacity of the latter two pairs compared to old vessels (Faroe Islands: Implications: Increased efficiency).
- In the Faroese fleet of small trawlers (Hp<500) vessels are now using specific trawls in specific fisheries as compared to general standard trawls used for many different fish species. The motivation for this is high fuel prices (Faroe Islands: Implications: more targeted fisheries).
- As a result of increasing fuel prices several large Faroese 'Deep-Sea' trawlers have plans to move to pair trawling (Faroe Islands: Implications: shift to different fisheries).
- There has been a reduction of 2% by tonnage in the Icelandic large stern trawler fleet and a reduction of 45 by number and 5% by tonnage in the rest of the dermersal fleet between 2006 and 2007. There were 107 Icelandic boats that opted for decommissioning in 2007 or 11.8% of the fleet (Iceland: Implications: reduced vessel numbers).
- At least five large Icelandic stern trawlers have switched from single to twin rig trawling targeting cod and haddock (Iceland: Implications reduced LPUE)

Technology Creep

- Faroese pair-trawlers are planning experiments with double trawls instead of a single trawl (Faroe Islands: Implication: increased gear efficiency).
- The 'fishing-day' management system has been in place in the Faroes since 1996. Several stakeholders in the fishing industry have raised their concerns that the management system is undermined due to technical creep in the Faroese fishing fleet. The Fisheries Ministry has appointed a committee to describe developments and estimate technical creep in the different

parts of the Faroese fishing fleet. This committee will report in June 2008 (Faroe Islands: Implications: identification of technology creep impacts).

- Three Icelandic bottom trawlers have changed from using steel wires to dynex warps to improve fuel efficiency (Iceland: Implications: reduced fuel consumption).
- There has been an increasing emphasis on the use of T90 trawls in Iceland. Bottom trawls made entirely of T90° except in the codend are now being constructed and 14 stern trawlers targeting cod and haddock have shifted to T90 trawls. Some other vessels are experimenting in other fisheries as well (*Nephrops* and shrimp). All in area Va. Changes in catchability/efficiency are not known but this is being driven by high fuel costs as these trawls have reportedly reduced drag. It is known nine T90° trawls have been sold to different Europe countries (Iceland: Implications: not known but possibly reduced fuel consumption).
- Two Icelandic boats are using an underwater camera system as an aid in the Sea cucumber fishery using dredges (Iceland: Implications: increased efficiency).

Ecosystem effects

- In Iceland changes in length distributions on the fishing grounds with larger rates of small haddock reported in some areas. Due to the amount of small haddock, Mls regulations were reduced from 45cm to 41cm. This meant some closed areas were opened although many remained closed due to high catch of small cod (<55cm) (Iceland: Implications: increased effort on haddock stock).
- Following reduction in cod quotas but increased quotas for haddock, the Icelandic fleet has begun targeting haddock with all demersal fishing gears. Most vessels avoid catching cod, which is now taken as bycatch (Iceland: Implications: increased effort on haddock).
- Some Icelandic gillnetters have shifted over to longlines. Exact numbers are not known. This reduction has been a result of pressures over bycatch of seabirds and small cetaceans. The level of bycatch is not known but is felt to be quite high given the shifts in fishing method (Iceland: Implications: reduced impact on marine mammal and seabird bycatch).
- One Norwegian vessel has carried out experiments using pelagic trawl doors fished off the seabed (approx. 5 m) with a clump (weight) connected 50 m behind the doors to ensure proper bottom contact. This method is being used to target demersal trawl fishing for gadoids in the Barents Sea but with reduced seabed contact (Norway: Implications: reduced bottom impact).

Development of New Fisheries

- A new fishery has developed in Iceland for sea cucumber. This new fishery has not significantly removed effort from other fisheries. But after a collapse in the scallop stock (Breiðafjörður 2003 Chlamys islandica) some smaller fish boats previously targeting scallops have now shifted to the cucumber fisheries (Iceland: Implications: shift of effort from scallop fisheries).

Annex 8g: FTFB Report to WGECO/WGMME/WGDEEP

Ecosystem effects

- Predation of fish catches by Grey seals from gillnet/tangle net fisheries has become an increasing problem on the south coast of Ireland. Many inshore gillnet fishermen are considering shifting into other fisheries as the problems has become so bad. One fisherman (12m vessel) reported 100% losses from tangle net gear targeting monkfish, ray and turbot from one particular set and average losses to seals of between 50%-75% as commonplace. There has also been an increase in gear damage. As many as 20 or more vessels maybe affected by this phenomenon. (Ireland: Implications: Predation to fish catches)
- There has been a considerable increase in the quantities of small *nephrops* on the Smalls grounds in 2007 and 2008 leading to very high landings by boats from the East coast with a high proportion of tails to whole *nephrops*. There are a number of boats (up to 10 vessels) that have participated in this fishery but do not tail due to low crew numbers and this has lead to high discarding/upgrading. It is also reported that the seasonal Cod Closures in the Celtic Sea have lead to a shift in effort by *nephrops* vessels to the west side of the ground leading to the size of *nephrops* noticeably reducing as effort increases. When the boxes have reopened, initial landings taken within the box on the east of the ground have comprised a high proportion of larger whole *nephrops.* The introduction of these boxes has completed shifted the previous pattern in the Smalls fishery. (Ireland: Implications: Negative impacts of technical measure e.g. closed area).
- High discarding of cod in Area VIIb-k was reported in Q3 and Q4 in 2007 due to exhaustion of quota. This has been repeated in 2008, when 80%+ of the quota in the Celtic Sea Area was caught by mid-March. Discarding has been widespread across all Irish demersal fleets. An example of the scale is reports from the owner of one seine net vessel, who discarded over 30 boxes of marketable cod (1–1½ tonnes) from one 5–6 day trip. The problems in 2008 have been put down to poor quota management which effectively led to unrestricted landings during February-March. Heaviest landings were made by the Irish gillnet fleet of around 6–8 vessels. Heavy landings led to very low prices and cod were sold as low as €1.20–1.40/kg during this period. (Ireland: Discarding)
- As in 2007, vessels are now discarding 0–500g and 500–1kg monkfish to meet quota restrictions. This discarding is reportedly at quite a high level, particularly in around 200m-400m. (Ireland: Discarding)
- Reports of problems with discarded longlines and gill nets along the Scottish west coast deep water grounds. A lot of longline activity reported at south end Rockall plateau. (Scotland: Implications: Potential for gear conflicts).
- Despite the closure of the hake gillnet fishery in Areas VIIb-k in depths > 200m for part of 2006, and subsequent regulations introduced in 2007 that restrict the length of gear and soak time in the hake fishery, Irish gillnet fishermen reported that the 2007/2008 hake fishery was in fact quite poor contrary to the scientific advice. Irish gillnetters tend to work in depths between 200–300m. Many vessels switched back to trawling due to poor catches and there are now only 7–8 gillnet vessels > 12m left in the fleet

and 3–4 of these have applied for decommissioning reflected the poor returns in recent years. (Ireland: excessive gear lengths and soak times).

- Under Natura 2000, UK-Scotland has proposed a SAC on the Stanton Banks off the north-west coast of Donegal in Area VIa. The proposed area, which would be closed to trawling, dissects the grounds fished extensively by Irish vessels. While the number of vessels working this area has decreased in the last number of years to around 5 vessels (part-time) the impact would nonetheless be adverse. Through the NWWRAC a case has been made to reduce the impact of this proposed closure (Ireland: Compliance with regulation).
- Bycatch of benthic fauna and several non-target fish species (e.g. gobies) in beam trawls. Voluntarily use of longitudinal release holes in the lower panel of the trawl, which open when nets are filled with benthos, and of Benthic Release Panels. Research is being carried out with the industry to optimise a Benthic Release Panel for the Dutch beam trawling segment. Similar initiatives in Belgium (Netherlands and Belgium: Implications: reduced benthic impact).
- As reported in 2006 and 2007, management regulations in the scad fishery, restricting the bycatch of mackerel to 5% has lead to widespread slipping in the pelagic fisheries when catches have been mixed. This discarding is reported to be substantial. There is also evidence of high grading in the mackerel fishery as due to economic pressures vessels are only landing mackerel of 300g+ and discarding catches of smaller fish. Again the levels of discarding are quite high compared to actual reported landings (Scotland: Implications: discarding).
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- In Iceland changes in length distributions on the fishing grounds with larger rates of small haddock reported in some areas. Due to the amount of small haddock, Mls regulations were reduced from 45cm to 41cm. This meant some closed areas were opened although many remained closed due to high catch of small cod (<55cm) (Iceland: Implications: increased effort on haddock stock).
- Following reduction in cod quotas but increased quotas for haddock, the Icelandic fleet has begun targeting haddock with all demersal fishing gears. Most vessels avoid catching cod, which is now taken as bycatch (Iceland: Implications: increased effort on haddock).
- Some Icelandic gillnetters have shifted over to longlines. Exact numbers are not known. This reduction has been a result of pressures over bycatch of seabirds and small cetaceans. The level of bycatch is not known but is felt to be quite high given the shifts in fishing method (Iceland: Implications: reduced impact on marine mammal and seabird bycatch).
- One Norwegian vessel has carried out experiments using pelagic trawl doors fished off the seabed (approx. 5 m) with a clump (weight) connected 50 m behind the doors to ensure proper bottom contact. This method is be-

ing used to target demersal trawl fishing for gadoids in the Barents Sea but with reduced seabed contact (Norway: Implications: reduced bottom impact).

- In the last years it is reported that there is a growing number of sea turtles are accidentally caught by bottom and pelagic trawlers in the Central Northern Adriatic Sea. It is estimated that in this area more than 4000 turtles per year are caught by trawls, longlines and bottom gillnets. Pelagic sharks are also caught. No mitigation measures are currently enforced although research has been continuing (Mediterranean: Implications: Bycatch of targeted species).
- In Italy there has been considerable experimentation with a new type of beam trawl to replace the traditional Rapido trawl. This trawl is much more environmental friendly gear and can reduce bottom impacts. Around 4/5 fishermen from the Central Adriatic coast are currently using this new trawl design (Italy: Implications: reduced bottom impact).

Development of New Fisheries

- A new fishery has developed in Iceland for sea cucumber. This new fishery has not significantly removed effort from other fisheries. But after a collapse in the scallop stock (Breiðafjörður 2003 Chlamys islandica) some smaller fish boats previously targeting scallops have now shifted to the cucumber fisheries (Iceland: Implications: shift of effort from scallop fisheries).
- Up to eight of the pelagic vessels have continued to fish for boarfish (*Capros aper*) during Q4 2007 and Q1 2008. Two vessels fished for this species in 2006 and approximately 8 vessels in 2007. With the very short fishing time now on all of the pelagic species this new fishery has been identified as an opportunity to extend the vessels operating time. The fish are suitable only for fishmeal production with a good quality oil content (between 8–10%) but discharging from the vessels and handling in the factories is proving very difficult with the discharge in particular an extremely slow process. Nonetheless landings by Irish vessels have continued to increase and are now probably in excess of 5,000–6,000 tonnes valued at around €1 million. An initial biological study reports that fishing effort has not had any significant impact on the stock but without management measures the stock may come under pressure quite quickly given it is a relatively slow growing pelagic species. (Ireland: Development of new fishery for species with limited scientific data available).
- There has been an increase by Dutch vessels in *Nephrops* fisheries using twin trawls. Outrigger trawls are also replacing beam trawls, or flyshooting (seining) mainly for non-quota species such as red mullet and cuttlefish. (Netherlands: Implications: These are not new fisheries but represent new trend in Dutch fishing resulting in effort and target species shift. Full implications not yet known).
- Squid fishery in Moray Firth continues to develop when species available on grounds, using very unselective 40mm mesh. Not much take-up in 2007 due to few squid. (Scotland: Implications: 40mm mesh means potential high bycatch of young gadoids esp. cod and haddock. This fishery may provide an alternative outlet for the *Nephrops* fleet seasonally, and hence reduce effort in that sector).

- Despite poor results from experimental trials carried out in 2007 by BIM, a potential fishery for deepwater rose shrimp is being explored by an Irish vessel off the south west coast. This vessel has landed samples of frozen rose shrimp from 400–800m using standard scarper trawls with 80mm codend mesh size and is reportedly gearing up with two specially designed shrimp trawls with 32mm codend mesh size. (Ireland: Implications: Effort in small mesh fishery with potential for high discards).
- There has been increased catches of squid reported at Rockall in Q2 of 2008. In previous years catches of squid had been much reduced on 1990 levels but one 34m/1200hp Irish vessel is now freezing squid on board. This vessel is landing upwards of 2–3 tonne of frozen squid per trip in addition to quantities of fresh squid caught on the last days of the trip. This is becoming of increasing importance and as quotas become exhausted at Rockall vessels will undoubtedly begin to target this fishery more. (Ireland: Implications: targeting non-quota species).
- In France new pot fisheries for Nephrops, octopus, crawfish, whelk and also for fish (dorado and conger) in coastal and continental slope waters are being tried (France: Implications: Development of new fisheries).

Annex 8h: 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 France and Spain.

Changes in Fleet Dynamics between 2006 and 2008

- In France there has been a shift by the Bluefin tuna purse seine fleet from fishing areas off Balearic islands to Libyan and Eastern African waters (France: Implications: Shift in effort).
- In France a targeted decommissioning programme for the Mediterranean fleet began last year and has begun slowly to reduce the number of older trawlers as well as some more modern vessels. The reduction in the number of trawlers is estimated at 20%. This programme is also targeted at the French tuna purse seiners and driftnetters. (France: Implications: Reduction in overall effort).
- In France and Italy the ban on pelagic driftnets in the EC has forced the small scale fleets involved to shift their activity to other techniques targeting large pelagic species with longlines and purse seines by the Italian fleets. Some French vessels have also shifted effort to demersal species mainly hake and sole with gillnet and trammels nets. (France and Italy: Implications: Shifts of effort that may have impacts on pressure stock species).
- In France there have been increasing attempts to develop pot and trap fishing particularly in non trawling areas and deep slope and reefs (France: Implications: Use of more environmentally friendly fishing methods).

Technology Creep

- In France since 2006 a number of vessels have used high opening trawls to target midwater fish such as hake, sea bream and sea bass. Some of these vessels are using a specialist 4-door rig with small pelagic doors mounted on the top wings to open the trawl. This has been driven by market demand for these species (France: Implications: Increased efficiency).
- Recently some Italian bottom trawlers, mainly in the central and southern Italian coasts have switched from single to twin-rig trawling, and some others have changed to a new "Atlantic" shapes named by the Italian fishermen: "Americana trawl" (Italy: Implications: Increased efficiency).
- The increase of fuel price has forced the French trawl fleets to reduce the size of their gear and for some of them have shifted from high opening bottom trawl for hake to twin trawl for sole and monkfish (France: Implications: Improved fuel efficiency).
- Both in Italy and France in the Mediterranean fisheries there has been increasing use of high specification sonars for pelagic gears and gear moni-

toring sensors for demersal trawls. (France and Italy: Implications: Increased efficiency).

- Both French and Italian fishermen are increasingly fitting econometeres to monitor fuel consumption and using thinner twines to reduce net drag. Some vessels have also removed Kort nozzles to improve fuel efficiency (France and Italy: Implication: Improved fuel efficiency).
- In Italian static gear fisheries there is increasing use of net stacking machines decreasing setting time. Also there is increasing use of sewing machines for mounting the headline and leadline reducing construction times (Italy: Implications: Improved operating efficiency).

Technical Conservation Measures

- In the Mediterranean new EU regulations have been introduced requiring the use of 40mm square mesh codends. The implications are not known at present but in Italy this represents a large increase in mesh size from codend mesh sizes currently used. Other regulations are planned to limit fishing effort through limitations on bollard pull and on gear size by restricting the headline length and trawl circumference; limiting the number of hooks for longlines and maximum lengths for static nets. (Italy and France: Implications: Not known but potentially increased selectivity).
- In France enforcement of new EC regulations for the Mediterranean sea has meant French Mediterranean trawlers replacing their illegal but widely used 28 or 35 mm mesh codends with legal 40 mm diamond mesh codends (France: Implications: Improved selectivity).
- There has been increasing efforts by French vessels in the Mediterranean to target small hake because of market demand but this conflicts with the new Mediterranean regulations in terms of mls and may well have an impact on the French fleet (France: Implications: Potential discard problems if mls regulations are enforced).

Ecosystem Effects

- In the last years it is reported that there is a growing number of sea turtles are accidentally caught by bottom and pelagic trawlers in the Central Northern Adriatic Sea. It is estimated that in this area more than 4000 turtles per year are caught by trawls, longlines and bottom gillnets. Pelagic sharks are also caught. No mitigation measures are currently enforced although research has been continuing (Mediterranean: Implications: Bycatch of targeted species).
- In Italy there has been considerable experimentation with a new type of beam trawl to replace the traditional Rapido trawl. This trawl is much more environmental friendly gear and can reduce bottom impacts. Around 4/5 fishermen from the Central Adriatic coast are currently using this new trawl design (Italy: Implications: reduced bottom impact).

Development of New Fisheries

- In France new pot fisheries for Nephrops, octopus, crawfish, whelk and also for fish (dorado and conger) in coastal and continental slope waters are being tried (France: Implications: Development of new fisheries).

Annex 9: Compendium of Mitigation Technologies

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Active acoustic devices	Pingers	Gillnets	porpoises	Cetaceans	US, EU, Mediterranean Gillnet fisheries	effective	Required		Larsen, 1999; Kraus 1997
Active acoustic devices	Pingers	Driftnets	sea lions	Pinnipeds	California swordfish and sharks fishery	Effective	Required		Barlow & Cameron 2003
Active acoustic devices	Pingers	Gillnets	harbour seals	Pinnipeds	Washington salmon and sturgeon fishery	Ineffective	Required		Gearin *et al.*, 2000
Active acoustic devices	Pingers	Gillnets	Franciscana river dolphin	Cetaceans	Argentinian fishery	reduced bycatch but dinner bell for sea lions			Bordino *et al.*, 2002
Active acoustic devices	Pingers	Bottom trawl?	dugongs	Dugongs	Australian fishery	Inconclusive	Not required		Anon., 2003
Active acoustic devices	Pingers	Fish traps	Humpback whale	Cetaceans	Newfoundland cod and pollack	Effective			Lien *et al.*, 1992
Active acoustic devices	Pingers	Gillnets	Hector's Dolphin	Cetaceans	New Zealand fishery	Effective			Stone *et al.*, 1997
Active acoustic devices	Pingers	Gillnets	Common Murre, Rhinoceros auklet	Birds	Puget sound salmon, NW US Pacific	Not significant		Reduced bycatch of Common Murre, but not the Rhinoceros auklet	Melvin *et al.*, 1999

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Active acoustic devices	Pingers	Gillnets, longline	Bottlenose Dolphins, harbour porpoise	Cetaceans	Mediterranean Sea	Inconclusive & inconsistent	Not required		
Active acoustic devices	Modified/Interactive Pingers	Pelagic trawls	Common dolphins	Cetaceans	IRL, DM, FR pelagic trawls bass albacore, bowriding	Inconclusive & Inconsistent	Not required		Anon., 2006
Active acoustic devices	Modified/Interactive Pingers		Bottlenose Dolphins	Cetaceans	IRL, Bowriding experiments	Effective	Not required		Leeney *et al.*, 2007
Active acoustic devices	Oil Filled tubes	Purse Seine	Dolphins	Cetaceans	Japanese and Tunisian fisheries	Short term, followed by habituation			SGFEN, 2001.
Active acoustic devices	pyrotechnics		killer whales	Cetaceans	Alaska Sablefish	Ineffective	Illegal	Also ineffective for California Sea Lion	Dahlheim, 1998
Active acoustic devices	Transponder signaled closed cod-ends	Trawls				Operationally possible, yet to be tested in sea trials	Not required		Pennec & Woerther, 1993
Active acoustic devices	Arc-discharge transducer	Trawls, Purse Seines	fur seals	Pinnipeds	South Africa Hake fishery	Some effect in trawls, Not effective in P. seines			Shaughnessy *et al.*, 1981
Active acoustic devices	AHDs	Gillnets, trawls	harbour seal, fur seals	Pinnipeds	Oregon Salmon fishery, New Zealand hoki	Worked for porpoises in Bays in British Columbia	Ineffective		Geiger & Jefferies, 1987; Stewardson & Cawthorn, 2004

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Active acoustic devices	Predator sounds (Killer whales)	Area tests	Gray whale Beluga whale Dall's Porpoise	Cetaceans	California Coast, Alaska, Japan		effective		Cummings & Thompson 1971; Fish & Vania 1971; Jefferson and Curry, 1996
Active acoustic devices	Predator sounds (Killer whales)	Purse Seine?	California Sea Lion	Pinnipeds	Washington	Scordino & Pfeifer, 1993	Ineffective		Cummings & Thompson 1971; Fish & Vania 1971; Jefferson and Curry, 1997
Active acoustic devices	AHDs	Traps and gillnets	Grey Seal	Pinnepeds	Baltic Sea		Not required	Mixed results. Testing driven by increasing predataion by seals	Fjalling *et al.*, 2006
Active acoustic devices	Pingers	Gillnets	Grey Seal	Pinnepeds	Baltic Sea		Ineffective	Negative results. Dinner bell and increased predation observed	Stridh, 2008
Alternative buoy ropes	Break away lines, light messenger ropes, glow ropes, acoustic triggers	Traps and Gillnets	Northern Right whales	Cetaceans	US and Canada fisheries	more data required			Werner *et al.*, 2006

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Bait & Lure Alterations	Dyed bait (blue)	Longlines	albatross spp	Birds	Hawaiian swordfish/tuna	Effective			McNamara, 1999 ; Boggs, 200; Gilman *et al.*, 2003a
Bait & Lure Alterations	Dyed bait (blue)	Longlines	loggerhead, leatherback turtles	Turtles	Costa Rica, West Atlantic	Ineffective			Swimmer *et al.*, 2005 ; Watson *et al.*, 2002
Bait & Lure Alterations	Weighted Bait	Longlines	albatross spp	Birds	Atlantic swordfish	Effective			Boggs, 2001
Bait & Lure Alterations	Novel Bait switch to mackerel	Longlines	loggerhead, leatherback turtles	Turtles	Atlantic	No effect		Noxious bait no effect on California Sea Lion either	Watson *et al.*, 2005
Bait & Lure Alterations	Streamer Lines & towed buoys	longlines	albatross other seabirds	Birds	Hawaiian swordfish, Norwegian Longline	effective			Boggs, 2001; Lokkeborg, 2001; McNamara *et al.*, 1999
Bait & Lure Alterations	Circle Hooks	Longlines	turtles	Turtles	Global Longline fisheries	effective but may increase shark catches	Required in some instances	Other: Deeper sets, single bait hooking, minimising day soak time,	Gilman *et al.*, 2005 ; Gilman *et al.*, 2006 ; Watson *et al.*, 2004
Bait & Lure Alterations	Circle Hooks	Longlines	Turtles	Turtles	Mediterranean Sea	Some success with circle hooks	Not required	Experimental stage	FTFB, 2008
Exclusion Devices	TEDs	Trawls	turtles, sharks, rays	Turtles	Global Shrimp fisheries	extremely effective	Required		Clark *et al.*, 1991; Shiode and Tokai, 2004

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Exclusion Devices	TEDs	Bottom trawls	Turtles, sharks, rays	Turtles	Mediterranean Sea	Effective at reducing turtle bycatch and reducing debris. Losses of marketable fish a problem	Not required	Experimental and needs further development	Sala *et al.*, 2008 (project LIFE 04 NAT/IT/000187) and E.Taskavak and S. Atabey (Turkish study)
Exclusion Devices	TEDS	Shrimp trawls	Turtles	Turtles	Cameroon	Not yet evaluated	Proposed	Experimental but extensive testing of super shooter, double flap cover.	
Exclusion Devices	TEDS	Shrimp trawls	Turtles	Turtles	Nigeria		Required (Super shooter, double flap cover) US certified	Big incentives in US market certification; socio-economic effects need to be studied	
Exclusion Devices	TEDS	Shrimp trawls	Turtles	Turtles	Mexico	Effective in reducing turtle bycatch	Required (Super shooter, double flap cover) US certified		
Exclusion Devices	TEDS	Shrimp trawls	Turtles	Turtles	Venezuela	Effective in reducing turtle bycatch	Required (Super shooter, double flap cover and single cover net) US certified	50% of commercial catch is lost through the use of TEDs	Marcano *et al.*, 1998.

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Exclusion Devices	TEDS	Shrimp trawls	Turtles	Turtles	Columbia	Effective in reducing turtle bycatch	Required (Super shooter, double flap cover) US certified	Big incentives in US market certification; socio-economic effects need to be studied; 20–40% loss of marketable fish catch	
Exclusion Devices	TEDS	Shrimp trawls	Turtles	Turtles	Costa Rica	Effective in reducing turtle bycatch	Required (Modified Super shooter with a separation between bars of 6 inch, double flap cover) US certified	Big incentives in US market certification; socio-economic effects need to be studied	
Exclusion Devices	TEDs	Shrimp/Fish Trawls	Turtles	Turtles	Trindad & Tobago		Not required	Extensive experimentation with different designs	
Exclusion Devices	TEDs	Shrimp/Fish trawls	Turtles	Turtles	Bahrain		Not required	Extensive experimentation with different designs	

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Exclusion Devices	TEDs	Shrimp/Fish Trawls	Turtles	Turtles	Iran		Required (super shooter, double flap net cover & AUSTED)		
Exclusion Devices	TEDs	Shrimp trawl	Turtles	Turtles	Indonesia		Required (super shooter, double flap net cover) US Certified		
Exclusion Devices	TEDs	Shrimp trawls	Turtles	Turtles	Southeast Asia (Thailand)	Effective in reducing turtle bycatch	Required (TTFD); US certified		
Exclusion Devices	TEDs	Shrimp trawls	Turtle, sharks, rays	Turtles	Madagascar	Effective in reducing turtle bycatch;	Required (Super shooter, double flap cover); US Certified	Big incentives following certification by US.	Report on TED implementation to the fishermen's association
Exclusion Devices	TEDs	Shrimp trawls	Turtles, sharks, rays	Turtles	French Guyana	Effective in reducing turtle bycatch	Proposed (Nordmore grid, double flap net cover)		
Exclusion Devices	TEDs	Shrimp Trawls	Totoaba mcdonaldi	Fish	Upper Gulf of California (Mexico)	Effective in reducing turtle bycatch	Required in MPA (Fish eye)	Bycatch reduction of 40%	Managament plan for fishing in the Upper Gulf of Claifornia (Mexico)

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Exclusion Devices	SEDs	Pelagic Trawls	fur seals, sea lions	Pinnipeds	Australia, NZ, Tasmaina, squid, hoki, blue grenadier fisheries	effective, esp. with top escape hatch in large mw trawls	Required ?		Gibson and Isaken, 1998; Cawthorn & Starr, in prep; Anon., 2003.
Exclusion Devices	REDs (Rigid)	Pelagic Trawls	Common dolphins	Cetaceans	UK Bass, French albacore fisheries	inconclusive	Not required		Anon., 2006
Exclusion Devices	Net panels	Pelagic trawls	Common dolphins, other MF off Africa	Cetaceans	Dutch N. Africa, UK and FR Bass fisheries	Inconclusive, difficult to handle, major loss of target species	Not required		Anon., 2006
Exclusion Devices	Net panels	Purse Seine	dolphins	Cetaceans	Eastern Tropical Pacific yellowfin tuna fishery	effective		Called the Medina panel	Werner *et al.*, 2006
Exclusion Devices	Turtle chains/modified dredges	Scallop dredge	turtles	Turtles	US scallop fisheries	effective			Smolowitz, 2006
Exclusion Devices	Trap guards (bungee cord)	Traps (crabs)	bottlenose dolphins	Cetaceans	Indian River Lagoon	effective			Noke and Odell, 2002
Operational Practices	Night Sets	Longlines	seabirds	Birds	Hawaii fishery	effective			McNamara *et al.*, 1999; Boggs, 2003
Operational Practices	Side Sets	Longlines	Albatross spp	Birds	Hawaiian swordfish/tuna Western North Pacific	effective			Gilman *et al.*, 2003a; Gilman *et al.*, in press; Yokota and Kiyota, 2006

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Operational Practices	Underwater Sets (chutes)	Longlines	seabirds	Birds	Hawaiian tuna, Norwegian Longline	effective		Increased catch rate for target species	Lokkeborg, 2001; Gilman *et al.*, 2003 b
Operational Practices	Underwater Sets (subsurface)	Gillnets	Bottlenose and Long-snouted spinner	Cetaceans	North Australia multi species	effective (reduction ~50%)			Hembree & Harwood, 1987
Operational Practices	Discarding offal during shooting	Longlines	Albatross spp	Birds	Hawaiian swordfish/tuna	effective		Distracted the birds so presume was effective?	McNamara *et al.*, 1999
Operational Practices	Time area closures	Gillnets	Hector's Dolphins	Cetaceans	New Zealand fisheries	highly effective	Required		Read *et al.*, 2006
Operational Practices	Decoys (anchored boats)	Static Gears	Grey Seal	Pinnepeds	Baltic	Short term effects noted	Not required		Fishermen's Information
Operational Practices	Dropping headline of pelagic trawls	Pelagic Trawls	Small cetaceans	Cetaceans	NE Atlantic/Bay of Biscay	Not assessed	Voluntary	Main motivation is to target larger tuna	NECESSITY project
Passive acoustic devices	Reflector devices		small cetaceans	Cetaceans	SA Beach protection	effective for short period	Not required		SGFEN, 2001.
Passive acoustic devices	Reflector devices (Aquatec)	Gillnets	porpoises	Cetaceans	EU gillnet and tangle net fisheries	Tested in Albacore tuna fishery but inconclusive results	Not required		

Mitigation Methods	Specific Device	Fishing Gear	Species	Species Category	Test forum	Performance	Regulatory status	Comments	References
Passive acoustic devices	Reflector devices, metallic heads, barriers	Gillnets, float lines	Bottlenose Dolphins, porpoises	Cetaceans	NZ Gillnets, Simulated gilllnets Scotland, float lines Canada	metallic head ineffective, Scotch exp. Effective, Porpoises ineffective			Hembree & Harwood, 1987; Goodson & Mayo, 1995; Koschiski & Culik 1997
Passive acoustic devices	Reflector nets barium/iron oxide	Gillnets	porpoises	Cetaceans	Bay of Fundy,Canada fisheries, North Sea,	mixed results, generally effective, but not in UK North Sea	Not required	Use with pingers/TADs recommended, also effective for Shearwaters in Canada	Koschinski *et al.*, 2006; Larsen *et al.*, 2007 ; Trippel *et al.*, 2003, Northridge *et al.*, 2003
Passive acoustic devices	Echolocation disruptors	Gillnets	bottlenose dolphins	Cetaceans	Mediterranean fisheries	promising, but habituation may occur	Not required		Werner *et al.*, 2006
Twine alterations	Multi-monofilament, Thinner twines	Gillnets	porpoises	Cetaceans	North Sea and West of Scotland fisheries	multi mono ineffective thinner twine effective for porpoises and seals		thinner twine also effective for seals	Northridge *et al.*, 2003
Twine alterations	White Mesh	Gillnets	Common Mure, Rhinoceros auklet	Birds	Puget sound salmon, NW US Pacific	Effective	Some reductions in salmon landings	Some reductions in salmon landings	Melvin *et al.*, 1999

Annex 10: Loggerhead Turtle (*Caretta caretta*) bycatch, case study: Mediterranean Sea

Alessandro Luchetti and Antonello Sala, ISMAR-CNR, Ancona, Italy

There are three turtle species in the Mediterranean Sea: the leatherback (*Dermochelys coriacea*), the green (*Chelonia midas*) and the loggerhead turtle (*Caretta caretta*).

Loggerhead sea turtles are listed as endangered in the Red List of Threatened Species of the International Union for Conservation of Nature and Natural Resources (IUCN; Hilton-Taylor, 2000). The Barcelona Convention adopted an Action Plan for the Conservation of Mediterranean Marine Turtles in 1989, acknowledged that catches by fishermen are the most serious threat to turtles and that their conservation deserved special priority (Tudela, 2000). In the Mediterranean Sea, they represent the most abundant species of marine turtles. Moreover *C. caretta* is one of the two marine turtle species with nesting beaches in the Mediterranean Sea; Broderick *et al.* (2002) estimated that there are 2.280–2.787 loggerheads nesting annually in the Mediterranean.

Laurent *et al*. (1992) considered that adult survival as the main factor affecting population growth rates, fecundity being less significant; this emphasizes the importance of limiting fishing bycatch of these species.

The knowledge of the biology of the loggerhead turtle represents a crucial part in evaluating the impact of different fishing activity in different areas. In the Mediterranean sea it is possible to count ten different countries with nesting beaches (Cyprus, Egypt, Greece, Israel, Italy, Lebanon, the Libyan Arab Jamahiriya, the Syrian Arab Republic, Turkey and Tunisia), but probably the Eastern Mediterranean sea (Greece and Turkey) represents the most important area. Furthermore it is possible to define two main ecological phases in the loggerhead turtle's life: the pelagic phase and the demersal phase. The greatest density of specimens in the demersal phase is found in shallow waters (< 100m). Thus, different types of fishing gear can produce different capture and mortality rates and may affect different ecological phases (pelagic or demersal; Gerosa and Casale, 1999). In the Mediterranean, interactions of sea turtles with fishing gears, including trawl nets, are still insufficiently studied (Casale *et al*., 2004). Surface longline, driftnet and bottom trawl boats operating in the Mediterranean are the major threats to the survival of this species, even if the impact of fixed gears (gillnets and trammel nets) needs also to be carefully considered.

Several countries (22 Mediterranean and 15 non-Mediterranean) fish normally in the Mediterranean Sea and an undefined number of small boats are active in non-EU countries but reported levels are not recorded. Thus the fishing effort in this area is a key factor in considering turtle bycatch levels.

Caminas (2004) reports a possible direct exploitation of loggerhead turtle mainly in the North Africa countries and an illegal market probably exists in Egypt. Nevertheless the main threat for the conservation of *C. caretta* population in the Mediterranean Sea remains bycatch in fishing gears.

Mediterranean fisheries have a huge impact on the turtle stock: more than 60.000 turtles are estimated to be caught annually as a result of fishing practices, mortality rates ranging from 10 percent to 50 percent of individuals caught (Lee and Poland, 1998). Delayed mortality is mostly unknown.

Bottom trawling activity mainly impacts turtles in the demersal phase since they prefer the shallow waters of the North Adriatic Sea, South Turkey, Tunisia and Egypt. It

is possible to estimate annual catch of over 4.000 specimens in the central-northern Adriatic Sea (Casale *et al*., 2004), 2.500 (Bradai, 1992) to 5500 (Jribi *et al*., 2004) in the Gulf of Gabés (Tunisia) and high unreported catches in Turkey and Egypt (Laurent *et al*., 1996). The main factors affecting the bycatch of loggerhead turtle are:

- the fishing area: mainly in shallow waters;
- the period of the year: most of catches are obtained in winter (Casale *et al*., 2004), during the demersal phase (foraging areas); and
- the haul duration which affects the physical condition of the turtle. Individuals have been observed in a comatose state and other non-healthy specimens (dead or injured) observed due to long haul durations in bottom trawl fisheries (Casale *et al*., 2004; Casale *et al*., 2007).

The surface longline gear deployed over the continental shelf (for tuna-like species) or offshore waters (for swordfish, albacore and bluefin tuna) is considered as the main threat to marine turtles in the Mediterranean (Margaritoulis *et al*., 2003). Panou *et al*. (1992) estimated an annual catch of about 35.000 specimens alone for the western and central Mediterranean Sea.

Some studies investigating the Spanish longline fleet targeting swordfish in the South Western Mediterranean (up to 60–80 vessels in the summer months, in the early 1990s) suggested that turtle bycatches in this region are very high (Aguilar *et al*., 1995). From 22.000 to 35.000 individuals per year were estimated to be caught in the period 1990–91. Bycatch by the foreign industrial longline fleets operating in the area (Japanese, flag of convenience) could have led to even higher figures. Data on annual catches are also available for other countries (Italy, Morocco, Tunisia, Malta, Algeria, and Greece) but in some cases there is a concern over the validity of the data. Moreover no data are collected in some countries at all.

The main problems with longline fisheries are that 20–30% of the turtles caught by longline gear may die (Aguilar *et al*., 1993). 80% of turtles hooked are released alive but with the hook still inside the mouth, pharynx or oesophagus (Camiñas and Valeiras, 2000), and the eventual delayed mortality is unknown although expect to be high.

Fishermen agree on the important economic losses due to turtle interactions with longlines. Loss of hooks, bait, branch lines and other components of the gear are an economic problem that fishermen want to solve. The capture of sea turtles also produces a decrease in the fishing effort and yields, as a consequence, of the reduction in the number of hooks and the time necessary to repair or replace gear.

Concerning other fishing gears, few official and published data are available. For drift nets bycatch was estimated by Italian drift nets in Ionian Sea at around 16.000/year; (De Metrio and Megalofonou, 1988). Illegal drift nets are still widely used in many countries, and the amount of bycatch is estimated to be very high. Moreover several driftnet vessels from EU countries were sold to non-EU countries, mainly Moroccan fleets, shifting the bycatch problems from the north to the south basins.

Turtle captures seem to be also high in passive gears, such as fixed nets; gillnets and trammel nets. Captures by these gears cause direct mortality since turtles get caught in them when trying to feed and are entrapped and drown. Fixed nets represent a threat for sea turtles mainly in coastal areas (Lazar *et al*., 2004a), however, quantification of turtle captures in these widely spread fisheries is very difficult to assess and juveniles are frequently caught nearby nesting areas in Greece, Turkey and Cyprus

(Godley *et al*., 1998; Suggett and Houghton, 1998). Fixed nets probably are responsible for high mortality rates. Delaugerre (1987) reported a mortality rate of 94.4% for *C. caretta* specimens caught in Corsica by trammel nets placed at depths of more than 60 m. Argano *et al*., 1992 found that the mortality rate for specimens tagged and then recaptured by set gill nets in different countries was 73.7%. Lazar *et al*., (2004b) recorded a high mortality rate (62.5%) for turtles captured in gill nets in Adriatic. Thus in the Mediterranean the interaction of sea turtles with the static net fishery could be very important and comparable to other fisheries (Casale *et al*., 2005).

Purse seines seem to represent a minor problem for turtles since the annual catches are probably very low and any turtles caught are released alive, but further investigation are required to verify this assumptions

Different approaches should be taken into account in reducing the bycatch of loggerhead turtle including:

- gear modifications;
- effort reductions;
- time closures;
- protected areas and sanctuaries (i.e. in nesting areas);
- changes in fishing tactics (i.e. reduction of haul duration can reduce direct mortality; set longline in depth etc.); and
- better cooperation and education of fishermen (i.e. keeping the turtles onboard and allowing them to recover before releasing them or removing the hooks from turtle's mouth etc.)

Concerning gear modifications in bottom trawls, very few studies have been carried out in the Mediterranean Sea. Sala *et al*. (unpublished results, ongoing project LIFE 04 NAT/IT/000187) developed and tested at sea four different types of TEDs (Turtle Excluder devices). The main goal of these tests were to implement the TEDs in order to show that they can be used with minimal losses of target species while also providing benefits to fishermen in terms of reduced sorting time. The first attempts were not satisfactory because the debris (mainly stones) caused damage to the grid or the commercial losses were too high. Other grid designs were tested and step by step the performances of TEDs were improved. A flexible but resistant TED made of steel and rubber showed a good effectiveness in reducing bycatch, and debris, and turtles, with no commercial losses, and this seemed to be a good solution. Finally a Supershooter TED was tested and very good results were obtained in reducing discards and in releasing turtles, even if the setting the angle of the grid was difficult. Atabey and Taskavak (2001) tested the Supershooter TED in the shrimp fishery off Turkey. They obtained very good results because both *C. caretta* and *Chelonia mydas* were excluded by the modified Supershooter, and unwanted incidental catches, such as jellyfish, sharks, and rays could also be excluded. They also found that most turtle catches occurs at the depths between 11 and 30 meters and that the proportion of dead and comatose turtles resulting from trawls increased with towing time. The final recommendation of the authors was that modified Supershooter TEDs could greatly assist fishermen in reducing catches of turtles and unwanted bycatch without losing valuable prawns or fish.

Considering longlines the main factors affecting sea turtle bycatch are:

- number of hooks;
- hook size and shape: J shape and circle shape;

- hook material: some observations seem to point to a rapid degradation (2–3 months) of non-stainless hooks in the mouth of the turtles released (Panou *et al*., 1999);
- bait type: catch rates of loggerhead turtles are higher with squid baits than with fish baits, use of lightsticks;
- bait colour: differences between blue-dyed baits and non-dyed baits;
- fishing depth: depth at which the branch line is positioned;
- location of fishing grounds in relation to the topographic and oceanographic features, sea temperature; and
- total catch: higher catches sink the gear and increase turtle mortality.

One of the most important mitigation measures tested in the southern Italian longline fisheries is the change in hook shape (project Life Nature 2003 – NAT/IT/000163). Some studies have tested the effectiveness of circle hooks in comparison to J shape hooks and found that no significant differences in catch efficiency on the target species (swordfish) was observed; turtle bycatch was observed only in J shape hooks; and also the circle hook showed good efficiency in avoiding the bycatch of pelagic stingray *Dasyatis violacea*. Tests carried out in the Strait of Sicily seemed to confirm these results: 82% of turtle were caught with J shape hooks, while only 18% with circle hooks. Furthermore 88.2% of the turtles were caught in the mouth, while 11.8% swallowed the hooks: all swallowed hooks were J type. Finally also in this case no differences were found in the number and total weight of target swordfish captured.

The influence of different bait types in the bycatch of loggerhead turtle was also investigated. In the Western Mediterranean sea some authors found that the combination of hook and bait type resulted in the lowest bycatch of turtles and the highest catches of swordfish was with J hooks with mackerel bait (project FISH/2005/28A, 2008). In the Alboran Sea some authors found that the use of mackerel bait can effectively reduce incidental capture of loggerhead sea turtles compared to squid bait. A total of 38 loggerhead turtles were caught, 27 (71%) were caught on squid while 11 (29%) on mackerel bait. Also in this case there were no significant differences between the numbers of individuals or weight of target species (swordfish) between the 2 bait types.

In the Ionian Sea "size of hook" was studied (Deflorio *et al*., 2005). The main result was that the smaller hooks used for albacore tuna fishing are more likely to catch turtles as they are easier for the turtles to feed on them.

Acoustic deterrent experiments were carried out on 4 juveniles and 7 sub-adults of loggerhead turtles in open tanks at the Cattolica (Italy) "Delphynursery". At frequencies between 50 and 400 Hz, some avoidance behaviour was observed with the maximum level of avoidance at (20%) 50Hz. A "neutral" behaviour (turtles reacting to the sound but not moving towards or away from its source) was observed between 50 and 700 Hz with highest levels (40%) between 50 and 100 Hz. The most frequent behaviour at all frequencies was "no response" and at frequencies above 700 Hz, no response was observed in any of the tests. This results, even if based on a small sample, together with the increased level of acoustic pollution in the Mediterranean did not lead to further experiments.

The effect of bait colours (yellow, red and blue) and bait odour was tested with experiments carried out with 27 loggerheads (22 immature and 5 adults) in open tanks. Juveniles reacted to baits colour differently compared to sub-adults and furthermore, sub-adults showed distinctive individual differences in behaviour. As the reaction to

different colours depended strongly on individual age as well as other factors, such as smell, it was concluded it was not worthwhile to continue with these tests. Moreover, it is very difficult to see how this solution could be adopted as a mitigation measure, also because of problems associated with absorbance of colours with depth. These experiments were conducted within the confines of shallow pools where there was very little light attenuation.

Some studies were performed to evaluate the effect on sea turtle bycatch with the setting depth of longlines. Increasing the set depth for longlines has been found to reduce the overall catch rates of turtles. In the Ionian Sea preliminary results (project Life Nature 2003 – NAT/IT/000163) seemed to indicate that most sea-turtle bycatches happened when hooks were set at between 10 and 15 m deep, however, more data is needed to confirm whether this is a significant result. Other studies (Laurent *et al.*, 2001) showed that the maximum depth at which the marine turtles were caught was 60 m for swordfish longline and 20 m for albacore longline. There are concerns though that the deeper setting of longlines may result in an increase in mortality rate of turtles that are hooked and die through drowning.

The final consideration on mitigation measure can be summarised as follows:

TEDs:

TEDs represent a good solution in bottom trawls provided they are set optimally for the trawls used. This has proved very difficult in Mediterranean Sea where even very small species are marketable. Reduction of haul duration may also be an effective operational measure for reducing direct mortality and occurrence of injuries as well as weak and comatosed individuals

Circle hooks:

With circle hooks the following has been concluded:

- circle hooks show good efficiency in reducing bycatch of turtles and throat hooking but some differences in fishermen's attitude to them were observed: circle hooks are not accepted by Spanish fishermen (Baez *et al*., 2006) as their use is considered to diminish yields of target species (Gilman *et al*., 2006). On the contrary Italian fishermen did not find any appreciable difference (project life nature 2003 - NAT/IT/000163).
- Circle hooks seem to shift the bycatch problem from turtle to cetacean and shark (Caminas and Valerias, 2001).
- Casale (2005) reviewed the available data presented by Watson *et al*. (2003, 2004); the conclusion was that the overall effect of the circle hooks in reducing bycatch is largely limited to the soft-shelled leatherback turtle.
- Studies with loggerhead turtle carried out by NOAA in the Atlantic strongly suggest that catch rate of these species is affected more by hook size and bait and not so much by hook shape.
- When considering hook design as a mitigation measure one should keep in mind the effects on catch rates for target species (fish) and bycatch of fish. The SGRST/SGFEN 05–01 (2005) evidenced that, in a given fishery and area, circle hooks (compared to J-shaped hooks): decreased the catch of swordfish; increased the catch of bigeye tuna and bluefin tuna; and did not affect the catch of blue sharks (research in Azores found that there was an increase in blue shark catches; Bolten and Bjorndal, 2003)

- In a recent review on the efficacy of circle hooks in reducing sea turtle mortality Read (2007) concluded that "circle hooks have the potential to reduce the mortality of sea turtles captured in many (but not all) pelagic longline fisheries, but that they should be field tested in a rigorous experiment before they are required in any fishery"
- Efficiency of hook shape seems to vary depending on target species and fishing areas, thus according to the results reported for this specific fishery, the consequences of the hook type to target species and the other sea turtles should be considered before introduction of mitigation measures.

Acoustic deterrent:

Results did not encourage continuation of this type of experiments for sea turtles catch mitigation (SGRST/SGFEN 05–01)

Dyeing bait:

Although effective in laboratory experiments with captive turtles, dyeing bait does not appear to have potential as an effective mitigation measure to reduce sea turtle bycatch in longline fisheries (Swimmer *et al*., 2005).

Type of bait:

The use of mackerel bait can effectively reduce incidental capture of loggerhead sea turtles as compared to squid bait and no significant differences were observed with target species catch. Lightsticks used in swordfish fisheries were found to strongly attract turtles.

Tank test:

The importance of physical factors (light penetration and colour absorbance, currents, oceanographic factors, etc.) of at-sea conditions should be taken into consideration in analysing the results from experiments on captive animals, particularly with respect to colour and odour, but also the isolation of a single turtle in a captive environment is another important factor as it may affect behaviour. Tank tests results should be considered with caution.

Bait size:

It is another important factor to be taken into account, but reliable information is not available to assess whether this is significant or not is not available.

Set depth:

Increasing the set depth for longlines has been found to reduce the overall catch rates of turtles but has led to increased mortality of turtles that are still hooked and subsequently die through drowning. Swordfish longlines catch turtles at a depth between 0 to 60m; albacore longline catch turtles between 0 and 20m

Set nets:

Mainly in Turkey and Greece, avoiding areas known to have high turtles abundance, which might occur seasonally (i.e. after nesting) could be a good avoidance practice. Using gillnets instead of trammel net could also reduce entanglement of turtles. In the Mediterranean the interaction and bycatch of sea turtles with the static net fishery could be very important and comparable to other fisheries (Casale *et al*., 2005).

Fishermen cooperation:

Comatose specimens can survive or die, depending on the circumstances. If released immediately these turtles would probably die, because they cannot swim to the surface to breathe. Fishermen can substantially reduce this problem by keeping the turtles onboard and allowing them to recover before releasing them. Fishermen cooperation and education is also essential in removing the hooks from the turtle's mouth.

References

Aguilar, R., Más, J., Pastor, X. 1993. Las tortugas marinas y la pesca con palangre de superficie en el Mediterráneo. Greenpeace. Proyecto internacional.

Aguilar, R., Mas, J. Pastor, X. 1995. Impact of Spanish swordfish long-line fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. *In* J.I. Richardson & T.H. Richardson, eds. Proc. 12th Annual Workshop on Sea Turtles Biology and Conservation, pp. 1–6. NOAA Technical Memorandum NMFS-SEFSC- 361.

Argano, R., Basso, R., Cocco, M., Gerosa, G. 1992. New data on loggerhead (*Caretta caretta*) movements within Mediterranean. Boll. Mus. Ist. Biol. Univ. Genova, 56–57:137–163.

Atabey, S., Taskavak E., 2001. A preliminary study on the prawn trawls excluding sea turtles. Urun. Derg./J. Fish. Aquat. Sci. Vol. 18, no. 1–2, pp. 71–79. 2001.

Báez, J.C., Camiñas, J.A., Rueda, L. 2006. Accidental fishing capture of marine turtles in South Spain. Mar Turtle Newsletter, 111:11–12

Bolten, A.B., Bjorndal, K.A., 2003. Experiment to evaluate gear modification on rates of sea turtle bycatch in the swordfish longline fishery in the Azores – Phase 2. Final Project Report. NOAA Award Number NA16FM1378. ACCSTR. 19 pp.

Bradai, M.N. 1992. Les captures accidentelles de Caretta caretta au chalut benthique dans le Golfe de Gabés. Rapp. Comm. int. Mer Médit. 33: 285.

Broderick, A.C., Glen, F., Godley, B.J., Hays, G.C. 2002. Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. Oryx, 36(3): 227–236.

Caminas, J.A. 2004. Sea turtles of the Mediterranean Sea: population dynamics, sources of mortality and relative importance of fisheries impacts. FAO Fisheries Report 738: 27–84.

Camiñas, J.A., Valeiras, J. 2001. Marine turtles, mammals and sea birds captured incidentally by the Spanish surface longline fisheries in the Mediterranean Sea. Rapp. Comm. Int. Mer Medit., 36: 248.

Casale, P. 2005. Holes in the circle. A critical review of circle hooks as a measure for reducing the impact of longline fishery on sea turtles. Report June 2005. (Unpublished report to WWF).

Casale, P., Laurent L., De Metrio, G., 2004. Incidental capture of marine turtles by the Italian trawl fishery in the north Adriatic Sea. Biological Conservation 119: 287–295.

Casale, P., Freggi, D., Basso, R., Argano, R. 2005. Interaction of the static net fishery with loggerhead sea turtles in the Mediterranean: insights from mark-recapture data. Short note, Herpetological Journal, 15: 201–203.

Casale, P., Catturino, L., Freggi, D., Rocco, M., Argano, R. 2007. Incidental catch of marine turtles by Italian trawlers and longliners in the central Mediterranean. Aquatic Conserv: Mar. Freshw. Ecosyst. Published online in Wiley InterScience. (www.interscience.wiley.com) DOI: 10.1002/aqc.841.

Deflorio, M., Aprea, A., Corriero, A., Santamaria, N., De Metrio, G. 2005. Incidental captures of sea turtles by swordfish and albacore longlines in the Ionian Sea. Fisheries science, 71: 1010–1018.

Delaugerre, M. 1987. Statut des tortues marines de la Corse (et de la Mediterranee). *Vie Milieu* 37(3–4): 243–264.

De Metrio, G., Megalofonou, P. 1988. Mortality of marine turtles (*Caretta caretta* L. and *Dermochelys coriacea* L.) consequent to accidental capture in the Gulf of Taranto. Rapp. Comm. int. Mer Médit. 31(2): 285.

FISH/2005/28A - Service Contract SI2.439703. 2008. Field study to assess some mitigation measures to reduce bycatch of marine turtles in surface longline fisheries. Final report. 215 pp.

Gerosa, G., Casale, P. 1999 Interaction of Marine Turtles with Fisheries in the Mediterranean. Mediterranean Action Plan – UNEP Regional Activity Centre for Specially Protected Areas.

Gilman, E., Zollet, E., Beverly, S., Nakano, H., Davis, K., Shiode, D., Dalzell, P., Kinan, I. 2006. Reducing sea turtle bycatch in pelagic longline fisheries. Fish, 7: 2–23.

Godley, B.J., Gucu, A.C., Broderick, A.C., Furness, R.W., Solomon, S.E. 1998. Interaction between marine turtles and artisanal fisheries in the eastern Mediterranean: a probable cause for concern? Zool. Middle East, 16: 49–64.

Jribi, I., Bradai, M.N., Bouain, A. 2004. Étude de l'Interaction Tortue Marine Caretta Caretta-Chalut Bentique dans le Golfe de Gabès (Tunisie). Rapp. Comm. Int. Mer. Médit: 37: 528.

Hilton-Taylor, C. (compiler). 2000. 2000 IUCN Red List of Threatened Species. IUCN, Gland, Switzerland and Cambridge, UK.

Laurent, L., Clobert, J., Lescure, J. 1992. The demographic modelling of the Mediterranean loggerhead sea turtle population: first results. Rapp. Comm. int. Mer Médit. 33:300.

Laurent, L., Abd El-Mawla, E.M., Bradai, M.N., Demirayak, F., Oruc, A. 1996. Reducing sea turtle mortality induced by Mediterranean fisheries: trawling activity in Egypt, Tunisia and Turkey. Report for the WWF International Mediterranean Programme. WWF Project 9E0103. 32pp.

Laurent, L., Caminas, J.A., Casale, P., Deflorio, M., De Metrio, G., Kapantagakis, A., Margaritoulis, D., Politou, C.Y., Valeiras, J. 2001. Assessing marine turtle bycatch in European drifting longline and trawl fisheries for identifying fishing regulations. Project-EC-DG Fisheries 98–008. Joint project of BIOINSIGHT, IEO, IMBC, STPS and University of Bari. Villeurbanne, France. Available at http://www.seaturtle.org/documents/EMTP-FINAL-REPORT.pdf.

Lazar, B., Margaritoulis, D., Tvrtkovic, N. 2004a. Tag recoveries of the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea: implications for conservation. Journal of the Marine Biological Association of the United Kingdom, 84: 475–80.

Lazar, B., Margaritoulis, D., Tvrtkovic, N. 2004b.

Lee, H.A., Poland, G.C.R. 1998. Threats by fishing. Euro turtle (available at www.Ex.ac.uk/telematics/Euroturtle).

Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Camiñas, J.A., Casale, P., De Metrio, G., Demetropoulos, A., Gerosa, G., Godley, B., Houghton, J., Laurent, L., Lazar, Y.B. 2003. Loggerhead turtles in the Mediterranean: Present knowledge and conservation perspectives. In: A.B. Bolten and B.E. Witherington, Eds. Ecology and conservation of loggerhead sea turtles. Washington, DC, Smithsonian Institution Press.

Panou, A., Antypas, G., Giannopoulos, Y., Moschonas, S., Mourelatos, D.G. Mourelatos, Ch., Toumazatos, P., Tselentis, L., Voutsinas, N., Voutsinas, V. 1992. Incidental catches of loggerhead turtles, *Caretta caretta*, in swordfish longlines in the Ionian Sea, Greece. Testudo, 3(4): 46–57.

Panou, A., Tselentis, L., Voutsinas, N., Mourelatus, Ch., Kaloupi, S., Voutsinas, V. Moschonas, S. 1999. Incidental catches of marine turtles in surface longline fishery in the Ionian Sea (Greece). Contrib. Zoogeography and Ecol. Eastern Mediterranean Region, 1: 435–445.

Read, A.J. 2007. Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. Biological Conservation, 135: 155–169.

SGRST/SGFEN 05–01. 2005. Drifting longline fisheries and their turtle bycatches: biological and ecological issues, overview of the problems and mitigation approaches. Report of the first meeting of the subgroup on bycatches of turtles in the EU longline fisheries. Brussels, 4–8 July 2005.

Suggett, D.J., and Houghton, J.D.R. 1998. Possible link between sea turtle bycatch and flipper tagging in Greece. Mar. Turtle Newsletter, 81: 10–11.

Swimmer, Y., Arauz, R., Higgins, B., McNaughton, L., McCracken, M., Ballestero, J., Brill, R. 2005. Food color and marine turtle feeding behaviour: Can blue bait reduce turtle bycatch in commercial fisheries? Mar Ecol Prog Ser, 295: 273–278.

Tudela, S. 2000. Ecosystem effects of fishing in the Mediterranean: An analysis of the major threats of fishing gear and practices to biodiversity and marine habitats. FAO project for the preparation of a Strategic Action Plan for the conservation of biological diversity (SAP BIO) in the Mediterranean Region. Rome. 45 pp.

Watson, J.W., Foster, D.G., Epperly, S., Shah, A. 2004. Experiments in the western Atlantic Northeast Distant Waters to evaluate sea turtle mitigation measures in the pelagic longline fishery. Report on experiments conducted in 2001–2003. February 4, 2004.

Watson, J.W., Hataway, B.D., Bergmann, C.E. 2003. Effect of hook size on ingestion of hooks by loggerhead sea turtles. Report of NOAA National Maritime Fisheries Service, Pascagoula, Miss., USA.

Annex 11: WGECO request as part of the OSPAR QSR 2010

Introduction

With increasing public and political concerns on marine fisheries and environmental issues, fisheries science and management has become increasingly complex. The move to the ecosystem based approach to Fisheries Management has gained momentum as the multiple uses of marine resources have broadened to take account of ecosystem considerations and the recommendations from the numerous international agreements, conferences and summits held on the subject. Some of the most important of these include:

- The 1972 World Conference on Human Environment.
- The 1982 United Nations Law of the Sea Convention.
- The 1992 United Nations Conference on Environment and Development and its Agenda 21.
- The 1992 Convention on Biological Diversity.
- The 1992 Habitats Directive
- The 1995 United Nations Fish Stocks Agreement.
- The 1995 FAO Code of Conduct for Responsible Fisheries.
- The 2001 Reykjavik Declaration.
- The 2002 World Summit on Sustainable Development.
- The 2002 Green Paper of the European Commission
- UN 2006 General Assembly to ensure protection of vulnerable marine ecosystems
- The 2007 Committee on Fisheries of the UN FAO on IUU and protecting the marine environment
- The 2007 Integrated Maritime Policy for the European Union

ICES is in the process of restructuring its Science and Advisory processes and is collaborating with HELCOM and OSPAR, among others, in the evolution of a holistic ecosystem-based approach to fisheries management. WGFTFB have been discussing the subject of fishing impacts for a number of years and has addressed it as a specific ToR in 2004 (ICES, 2004). Much of this though has been in isolation with limited dialogue between other EG's including WGECO. WGFTFB has recognised this and has discussed internally the need to define its new research direction, beyond the traditional focus of bycatch reduction, into developing environmentally responsible fisheries (ERF) in support of the ecosystem approach to fisheries management. The stimulus for these discussions were prompted by the ever increasing 'international calls for ban on bottom trawling on high seas' and also debate at the '2006 ICES Symposium on Fishing Technology in the 21st Century: Integrating Fishing and Ecosystem Conservation' held in Boston (Glass *et al.*, 2007). Since WGFTFB works closely with and has industry people as part of their membership it felt that it should be more proactive in the issue of ERF.

Recognizing this at last year's meeting in Dublin (ICES, 2007) an ad hoc group made a first attempt to address this and explore ways of enhancing links with other ICES WG's. WGFTFB also addressed a joint ToR with WGECO on the impacts of *Crangon* beam trawl fisheries in the North Sea in 2007. Later in 2007 at the ICES ASC in Helsinki a ToR was formulated between the Chairs of WGFTFB and WGECO as follows:

> "*For each OSPAR region, select and succinctly describe one or more representative examples of gear modifications, which have resulted in changes to the ecosystem effects of these gears, including if possible a range of ecosystem components.*"

The work contributes to WGECO ToR b) which will pull together an environmental assessment of the impact of fisheries, in preparation for the OSPAR QSR. It is also seen as means to begin the wider debate on how to properly assess the effect and impact of gear based measures through the development of a proper assessment framework. This will be worked on at WGECO in 2009.

The representative case studies identified by WGFTFB to illustrate the positive and negative impacts of different gear based technical measures are presented in Table 20–1 below.

Table 20-1. Case studies, identified for the description of representative examples of gear modifications that are designed and selected for the mitigations of ecosystem effects.

Case study	Fishing gear	Target species	OSPAR-region	Ecosystem component
1 (IRL)	Gill net	Mixed demersal	OSPAR-Region II, III & IV	Marine mammals
2 (Eng)	Demersal otter trawl	Norway lobster (Nephrops norvegicus)	OSPAR-region II	Fish species
3 (B, NL, UK)	Flatfish beam trawl	Mixed, demersal fish species, mainly sole (Solea solea) and plaice (Pleuronectes platessa)	OSPAR-regions II, III, IV	Fish species Benthic invertebrate species
4 (B, DK, F, GER, NL, UK)	Shrimp beam trawl	Brown shrimp (Crangon crangon.)	OSPAR-region II	Mainly commercial fish species
5 (Faroe islands)	Pelagic otter trawl	Blue whiting (Micromesistius poutassou)	OSPAR-region I & V	Fish species

The case studies are written in the following format.

i) Brief overview of the situation prior to mitigation measures/regulation.

ii) The drivers that initiated gear measures being developed or introduced.

iii) A description of what was done in terms of mitigation measures.

iv) A description of what management measures were taken after the research i.e. was the mitigation measure introduced into regulation or was it only tested and then used or not used voluntarily

v) A description of how the impacts of the gear modifications have been assessed.

vi) A description of how successful this has been in terms of reducing impacts.

References

Glass, C. W., Walsh, S.J., Marlen, B., van, (Conveners). 2007. Fishing technology in the 21st century: integrating fishing and ecosystem conservation ICES Journal of Marine Science. 64(8):1499–1502.

ICES. 2007. Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 23–27 April 2007, Dublin, Ireland. ICES CM 2007/FTC:06. 197 pp.

ICES. 2004. Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 20–23 April 2004, Gdynia, Poland. ICES CM 2004/B: 05:Ref. ACE. 189 pp.

Case study 1 – introduction of Acoustic Deterrent Devices to reduce Cetacean bycatch in Gillnet Fisheries

Brief overview of the situation prior to mitigation measures/regulation

The bycatch of marine mammals in European waters is not a new phenomenon, with records of incidental cetacean mortality in driftnets dating back to the time of the Roman Empire (Caddell, 2005).I more recent times, since the inception of the CFP according to scientific advice, most fishing gears commonly used in European fisheries have been linked with some small cetacean (dolphin and porpoise) bycatch with the most serious problems reported from static net fisheries. However, despite fears within the scientific community over these large numbers of cetaceans being taken as bycatch in European fisheries, any semblance of a coordinated policy to mitigate bycatch was only established with the adoption of the Habitats Directive in 1992. Although expressed in rather broad terms, Article 12.4 of the directive did establish a clear mandate for Member States to address incidental catches of protected species within areas under their jurisdiction but implementation has generally been insufficient and uneven across Member States. Concerns at the level of cetacean bycatch, therefore, have remained and highlighted by a number of EU funded studies, e.g. by Sea Mammal Research Unit (SMRU) and Trengenza *et al.* (1997) which have demonstrated the scale of the problem in certain fisheries.

As a result of these continuing concerns, the European Commission asked ICES in 2001 to provide advice on the fisheries concerned, the risk posed by these fisheries to identified populations and possible remedial action. It also asked the Scientific, Technical, and Economic Committee on Fisheries (STECF) to review this advice and to provide possible management advice. Following this review, in April 2004, EU legislation was adopted to promote bycatch mitigation, in the form of a regulation that sought to address the specific issue of incidental cetacean mortality in Community waters. This case study describes the introduction of this legislation and its subsequent impact on cetacean bycatch rates.

Drivers that initiated gear measures being introduced

Although not exclusive to European Community fisheries by any means, the incidental mortality of significant numbers of charismatic and photogenic marine mammals and turtles has catalyzed the introduction of the measures to mitigate bycatch at global, regional, and national levels. It is fair to say that the management goals in most cases in introducing these measures were driven strongly by societal values rather than scientific ones. Administrations have come came under increasing pressure from NGO's and the general public to act on this issue and ultimately forced managers, including the EU to bring in legislation, even though there was an obvious knowledge deficient in terms of actual level of bycatch in different fisheries and in the development of suitable mitigation measures.

It should be noted though that as identified by Werner *et al.* (2006), marine mammal bycatch reduction is a very active area of research with numerous ongoing studies and the frequent development and testing of novel initiatives and mitigation devices. This research in many cases has been driven by genuine concerns among fisheries managers, researchers and fishermen to protect endangered species, while some research has been motivated by the need to reduce gear damage caused by interactions with marine megafauna or reducing predation of target catch by these species.

Mitigation measures or gear changes tested

In considering the issue of cetacean bycatch in gillnet fisheries, many researchers in EU countries with perceived bycatch problems saw acoustic devices as a potential solution. Such acoustic deterrents or 'pingers' are small self-contained battery operated devices that emit regular or randomised acoustic signals, at a range of frequencies, and typically loud enough to alert or deter animals from the immediate vicinity of fishing gear. Active pingers were first tested in Canada, primarily as a means to reduce entrapment of baleen whales in coastal set nets and fish traps. These first devices, operated at 2.5 kHz, were subsequently tested on gillnets in the Bay of Fundy and appeared to minimise harbour porpoise bycatch. Similar pingers were also deployed in the Makah salmon fishery off the Seattle coast and in Australia on beach protection nets with reasonable results (SGFEN, 2001).

More complex devices were developed after experiments with gillnets in the Gulf of Maine (Kraus *et al.*, 1997). A design operating at 10 kHz was found to be effective at reducing porpoise bycatch and ultimately formed the basis for legislation under NFMS regulations. In the regulations the specifications for porpoise pingers were defined as 300ms pulses of 10 kHz tonal pulses repeated at 4 second intervals with a minimum source level of 132dB re 1 μPa.

A third generation pinger was developed in the late 1990s by Loughborough University in the UK on the basis of tests with captive porpoises in Holland and Denmark. These "PICE-97" devices were trialled successfully in the Danish cod fishery during the autumn of 1997, with a significant reduction in Harbour porpoise bycatch observed (Larsen, 1999). They differed from the original pingers in that they emitted a variety of wide band frequency sweep type signals with randomised inter-pulse intervals, rather than simple single tonal pulses.

Further research with these devices followed in the UK (Goodson *et al.*, 2001), Mediterranean (Imbert *et al.*, 2002) and in the US (Barlow and Cameron, 1999) and at least two devices the Aquamark and Dukane pingers had been shown to reduce bycatch. In the STECF report of 2002 it was concluded:

"There was general agreement that devices considered suitable for use should have proven aversive abilities within the fishery and for the species giving concern. Two of the currently available devices (AQUAmark, Dukane) fitted this definition for bottom-set gill nets and porpoises and therefore could be regarded as suitable standards that any further pinger should equal or exceed in these circumstances. It was noted field trials to demonstrate operational effectiveness were needed in addition to evidence of aversion by the species of concern to the specific acoustic signal of any new device".

STECF also recommended that within an overall management framework there must be a monitoring and surveillance programme to identify fishery métiers, or times and areas, where cetacean bycatch is a problem, and to provide quantitative estimates of the levels of bycatch for each species/'stock'. Timely population assessments are also required within this framework. There must be a recognised means of determining

unacceptable bycatch levels, and an institutional framework for devising bycatch reduction plans where these are necessary. Beyond this, there needs to be a means of implementing any bycatch reduction plan, including methods of enforcement, and of continued monitoring and feedback to ensure the overall objectives are met. The subgroup concluded with a series of recommendations, headed by the recommendation that a by catch management framework should be established at an EU level at the earliest opportunity.

Management measures introduced after initial research

In 2004 the EU took a decision to better protect cetaceans in EU waters, following much of the advice received from ICES and STECF. The measures introduced in Regulation 812/2004 included a step by step reduction of the use of driftnets from 1 January 2005 until complete prohibition by 1 January 2008, the monitoring of bycatches through observer schemes and the compulsory use of acoustic deterrent devices on fishing nets.

The use of acoustic devices or 'pingers', was made mandatory for gillnet fisheries (from June 2005 for the North Sea and the Baltic Sea, from January 2006 in the Celtic Sea and the western Channel and 2007 in the eastern Channel) for all vessels over 12m. The regulation provided technical specifications for the efficiency of the acoustic deterrent devices, while there was also a requirement for scientific studies or pilot projects to increase knowledge about the effects over time of the use of acoustic deterrent devices. Member States were encouraged to test newly developed and efficient types of acoustic deterrent devices not in conformity with the technical specifications laid down in this Regulation on a temporary basis.

Impact Assessment of the gear modifications

The measures introduced were to be closely monitored in order to allow for their adaptation over time, while Member States were tasked with ensuring full monitoring of the state of cetacean populations as required under the Habitats Directive. Subsequently, though, the introduction of acoustic deterrent devices under Regulation 812/2004 has been compromised due to a combination of factors. In most EU countries anecdotal evidence suggests there is only limited enforcement of the regulations and only a limited number of vessels complying with the regulations; e.g. Denmark reports around 30 vessels, while Sweden report 9 vessels in the Baltic Area using pingers. In both of these Member States pilot projects funded under FIFG have been used as a mechanism to supply pingers to vessels. Such pilot projects or grant aid schemes to offset costs for introduction have some merit but are not the complete solution and probably result in initial uptake by fishermen but as such schemes usually only apply to first purchase, subsequent maintenance or replacement is at best sporadic

In addition, adequately quantifying bycatch of protected species and the impact of introducing mitigation technologies requires essentially a high level of on board observer coverage (typically at a level of 25–30% of total fishing effort) to be able to provide accurate estimates and associated confidence limits around estimates (Northridge and Thomas, 2003). Levels of coverage by nation and fishery on introduction of mitigation technologies are frequently at much lower levels than this. Regulation 812/2004 seeks assessment and monitoring of the impact of pingers on bycatch but in reality very few Member States have been able to carry out such monitoring. This is mainly due to the costs involved in maintaining observer programmes. In some cases a large amount of data from anecdotal sources has been used to sup-

plement the quantitative data gathered from observer programmes. This lack of systematic monitoring has prevented the true extent and potential impacts of pingers on protected species bycatch from being fully understood or documented in EU waters. Scientific monitoring is essential to identify unexpected negative effects of mitigation devices.

It is also worth noting that fishermen in a number of European countries have raised concerns about the resilience of the current commercially available "pingers" and also the practicalities of using these devices for commercial fisheries. These concerns have been addressed in a series of trials carried out in Ireland, UK, Sweden, Denmark and France in 2005 and 2006 (Cosgrove *et al*., 2005). As a result of this work, all available models of pinger have now been extensively assessed in terms of ease of use, resistance to damage and long-term running costs. The trials have highlighted a number of serious issues and difficulties relating mainly to the reliability of the devices. Problems with deployment were found, although some of these problems have been resolved by changes to rigging or operating practice. It is clear that more consideration of the construction, practical handling and deployment of such devices is required before they can be considered a universal solution to certain bycatch problems in gillnet fisheries. Costs associated with the introduction of mitigation technologies remain an issue for fishermen and ways to help mitigate economic costs should be carefully considered. For instance the requirement for fishermen to use pingers under Regulation 812/2004 has very real cost implications for fishermen. In Europe current commercially available devices cost in the region of €50–100 per device and a vessel fishing with 10km of gillnet gear using the recommended spacing between devices of 100m-200m would require 50–100 devices at a cost in the region of €2,500–5,000. Given there are still technical difficulties with these devices, which were flagged when 812/2004 was being formulated, these costs are significant and have undoubtedly been a hindrance to acceptance by fishermen in Europe.

In adopting measures it is important to define which species the mitigation devices are designed to protect. Once again in this respect Regulation 812/2004 is perhaps flawed given the objective of the regulation is to mitigate incidental catches of cetacean species in general. Research and development, however, has mainly been focused on the use of pingers to reduce harbour porpoise bycatch in gillnet fisheries and the results of trials involving other cetacean species are less clear-cut, with somewhat contradicting results (Barlow and Cameron, 2003; Anon., 2006). It is likely that the use of pingers in their present form as required in Regulation 812, even with 100% compliance would lead to a reduction in bycatch of species such as common or bottlenose dolphins.

At the currently there are five recognised manufacturers of commercial pingers, although other "cruder" devices exist. Two of these devices are made in the US, one in the UK, one in Italy and one in the Netherlands. While their signal characteristics are well suited for Harbour porpoises, only limited success has been achieved with other cetacean species. For species such as bottlenose dolphins, tests have shown them to be wholly ineffective (Anon., 2006).

Conclusion

In conclusion it is clear that the successful implementation of a framework for bycatch reduction can be encouraged by appropriate legislation, while conversely legislation can also unwittingly be an impediment to successful introduction of bycatch mitigation technologies (ICES, 2008). Framing legislation therefore needs to be done after consideration of all of the issues raised above. In this sense 812/2004 has largely

failed in introducing the use of pingers into the identified problem fisheries by being unrealistically prescriptive and not taking account of all of the technical, biological and economic issues fully. In this case there has perhaps been a failure by managers to consider all of the issues and impacts of adopting legislation to use bycatch reduction devices leading to:

- Poor compliance by fishermen with the regulations;
- Negative Ecological Impacts;
- Economic Impacts on stakeholders;
- Technical Problems with the devices;
- Biological Impacts;
- Poor monitoring; and
- Poor acceptance by stakeholders.

References

Anon. 2006. Nephrops and Cetacean species selection information and technology. EU Project NECESSITY. 501605. Interim Report (restricted).

Barlow, J., and Cameron, G.A. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Presented to the Scientific Committee of the International Whaling Commission, Grenada, 1999.

Barlow, J., and G. A. Cameron. 1999. Field Experiments Show that Acoustic Pingers Reduce Marine Mammal Bycatch in the California Drift Gillnet Fishery. Presented to the Scientific Committee of the International Whaling Commission, Grenada, 1999.

Caddell, R. 2005. Bycatch mitigation and the protection of cetaceans: recent developments in EC law. Journal of International Wildlife Law & Policy.

Cosgrove, R., Browne, D., and Robson, S. 2005. Assessment of Acoustic Deterrent Devices in Irish Gill Net and Tangle Net Fisheries. BIM Report, 05MT07. 30pp.

Goodson, A.D., Datta, S., Di Natale, A., Dremiere, P-Y. 2001. Project ADEPTs - AcousticDeterrents to Eliminate Predation on Trammels. Final Report to the European Commission DX XIV 898/019, p110+Appendices and a CD-Database.

ICES. 2008. Report of the Study Group for Bycatch of Protected Species (SGBYC), 29–31 January 2008, ICES, Copenhagen, Denmark. ICES CM 2008/ACOM:48. 82 pp.

Imbert, G., J.-C. Gaertner, S. Cerbonne, and L. Laubier. 2002. Effet des repusifs acoustiques sur la capture de dauphins dans les thonailles. Report to the Direction de l'Agriculture et des Ressources Naturelles. Universite de la Mediterranee Centre D'Oceanologie de Marseille, Marseille.

Kraus, S.D., Read, A.J., Solow, A., Baldwin, K., Spradlin, T., Anderson, E., Williamson, J. 1997. Acoustic alarms reduce porpoise mortality. Nature, 388: 525–526.

Larsen, F. 1999. The effect of acoustic alarms on the bycatch of harbour porpoises in the Danish North Sea set gill net fishery: a preliminary analysis. Paper SC/51/SM41 submitted to the 51st IWC meeting, Grenada.

Northridge, S.P., and Thomas, L. 2003. Monitoring levels required in European fisheries to assess cetacean bycatch, with particular reference to the UK fisheries. Final Report to DEFRA (EWD). 37pp.

SGFEN (Subgroup on Fishery and Environment). 2002. Incidental catches of small cetaceans. Report of the second meeting of the subgroup on fishery and environment (SGFEN) of the scientific, technical, and economic committee for fisheries (STECF), Brussels, 11–14 June 2002. Commission Staff Working Paper, Commission of the European Communities. SEC(2002) 1134.63pp.

SGFEN (Subgroup on Fishery and Environment). 2001. Incidental catches of small cetaceans. Report of the first meeting of the subgroup on fishery and environment (SGFEN) of the scientific, technical, and economic committee for fisheries (STECF), Brussels, 10–14 December 2001. Commission Staff Working Paper, Commission of the European Communities. SEC(2002) 376.83pp.

Tregenza, N. J. C., Berrow, S. D. *et al*. 1997. Harbour porpoise (*Phocoena phocoena* L.) bycatch in set gillnets in the Celtic Sea. ICES Journal of Marine Science, 54(5): 896–904.

Werner, T., Kraus, S., Read, A., and Zollet, E. 2006. Fishing techniques to reduce the bycatch of threatened marine animals. Marine Technology Society Journal, Volume 40, 3: 50–68.

Case study 2 – Farne Deep *Nephrops* fishery, England

Brief overview of the situation prior to mitigation measures/regulation

The EU *Nephrops norvegicus* fishery in the North Sea is currently managed by three regulatory mechanisms: output (for some species) is restricted by TACs; input is controlled by limiting days-at-sea; and exploitation patterns are modified by technical conservation measures specifying gear restrictions and Minimum Landing Sizes. An important *Nephrops* trawl fishery in the North Sea lies adjacent to the Farne Deep, off the east coast of England. In the 2001/2002 season, up to 82 vessels worked on this fishery; the fleet consisted of vessels less than 30m long. The vessels use single and twin *Nephrops* otter trawls. Nets with a small mesh size are legally allowed to catch *Nephrops norvegicus*, compared to other demersal whitefish species and consequently large quantities of other organisms can also be caught, and much of this is discarded dead. Since 2002 the fleet number has fluctuated but a significant fleet still prosecutes this fishery.

Drivers that initiated gear measures being introduced

The amount of material caught and subsequently discarded in the English *Nephrops* fishery was estimated at 4890 tonnes in the 2001/2002 season equating to a discard rate of 57%. Discards in this fishery are dominated by whiting; other significant components of the discards include haddock, *Nephrops* and commercial flatfish species. It has been estimated that whiting discards from this fishery account for 16% of the estimated whiting discards for the entire North Sea. The weight of discarded whiting was estimated at six times that of the landed weight.

Scientists considered that the high discard mortality on small commercial fish was destructive and had contributed to the decline of the important North Sea stocks and consequent reduction in yields. Moreover, changes in community structure through discarding, either directly through discard mortality or indirectly, modify the energy flow through foodwebs with the potential to alter ecosystem dynamics. Therefore, the economic and ecological consequences of discarding are intrinsically linked and not confined to the direct mortality of commercial species. Despite the absence of predictable outcomes for the reduction in discards of all species, reducing discards of all species meets the requirements of the precautionary principle and ecosystem-based approach as defined in EU legislation, the Bergen Declaration and OSPAR biodiversity action plans.

Mitigation measures or gear changes tested

Considerable research into fishing gear-based measures to improve selectivity has been undertaken. The potential for structural changes in trawls to facilitate the release of unwanted fish was recognized as early as the 1980s and is the method of discard reduction most supported by North Shields fishers. The different behaviours

exhibited by the main discarded species in *Nephrops* trawl fisheries can be exploited to improve the selectivity of trawls. Whiting and haddock rise when inside the trawl, while *Nephrops* and cod remain near the bottom. Separating cod, and other groundfish, from *Nephrops* remains the most challenging task for gear technologists in this fishery. However, a recent review concluded that there is currently adequate technical ability to significantly improve the selectivity of *Nephrops* trawls.

If the aim of fishery managers is to retain as much of the marketable fish as possible but to reduce discards, then designs involving Square Mesh Panels, constructed of large mesh, high-strength thin twine, possibly in combination with guiding panels/funnels/ropes should be further developed. If, however, the aim of managers is to minimise all fish catch or the catch of a particular overexploited species, such as cod, then a move towards a single-species fishery is more appropriate. A selection grid system, or prawn trawls historically used, with low openings and reduced top sheet lengths offer promising solutions in this instance.

The relative difference of the effect on North Sea fish stocks of introducing five trawl designs developed by gear technologists has been modelled. The designs included using a square-mesh panel constructed of high strength and low diameter material, a selection grid in combination with a square-mesh codend, using two square mesh panels, a cutaway trawl (with a setback headline) and a 100mm codend. All the designs indicated that they would have a positive effect on the North Sea whiting stock. However, only through the implementation of a trawl with a grid combined with a square-mesh codend was there likely to be any positive effect on haddock and cod stocks. This is because this was the only design that reduced the catches of fish of all sizes and not just the juveniles and also because this fishery caught few haddock and cod relative to other fisheries in the North Sea.

Management measures introduced after initial research

Some of the selective designs developed have been implemented. The insertion of a square-mesh panel into the topsheet of single-rigged trawls has been mandatory since 1991/92 and an additional 140mm diamond mesh panel inserted behind the headline since January 2002. Furthermore, prior to 2002 the minimum legal codend mesh size was 70mm for single-rigged trawls, but since January 2002, this has been increased to 80mm. The threat of severe restrictions to fishing opportunities or closure of the English *Nephrops* fishery in 2002 in conjunction with the new regulations imposed on other fisheries provided the incentive to implement these gear changes.

Impact Assessment of the gear modifications

There has also been some evaluation of the effectiveness of these regulations. The composition of catches was monitored just before and after these regulatory changes. The trawl modifications demonstrated a reduction in discard rate for whiting of 11%. A second more recent study, utilising observer data to compare a longer period before and after the introduction of these changes has also shown that whiting selectivity has improved. The threat of severe fishing restrictions was originally due to the poor status of the cod stock, however the regulations introduced were more likely to reduce the capture of small haddock and whiting rather than benefit cod. Therefore, although the regulations successfully reduced whiting discards it is not clear whether the objectives of the managers were met. The new regulations introduced in the Farne Deep fishery did, however, allow the fishery to continue without further restrictions on fishing.

As part of the 2007 EU-Norway negotiations, it was agreed that the selectivity of whiting in vessels using trawls with an 80–99mm mesh net in the North Sea would be improved. This sector includes the vessels of this *Nephrops* fishery; a reduction of 40% in whiting discards was agreed. In 2008, trials of a double square-mesh panel, constructed of high strength low diameter twine will be undertaken onboard trawlers in this fishery. Based on previous trials this will meet the required objectives. The mechanism by which regulations have been implemented in this fishery illustrates that there is adequate technical ability to significantly improve the selectivity of Nephrops trawls but fishers are not taking up the developments until the sufficient level of incentive is generated.

Conclusions

It is apparent that technical measures in this case i.e. the gear modifications highlighted do provide a partial solution to discarding problems in North Sea *Nephrops* fisheries. All are technically feasible and workable, with some shown to provide much improved selectivity but with corresponding losses of marketable fish which have been a stumbling block for their voluntary adoption by fishermen. In the absence of appropriate incentives in terms of increased quota allocation or market position it is unlikely that this will change much in the near future without a change in focus in management..

References

Catchpole, T.L., Revill, A.S. 2008. Gear technology in Nephrops trawl fisheries. Reviews in Fish Biology and Fisheries, 18, 17–31.

Catchpole, T.L., Tidd, A.N., Kell, L.T., Revill, A.S., Dunlin, G. 2007. The potential for new Nephrops trawl designs t positively effect North Sea stocks of cod, haddock and whiting. Fisheries Research, 86, 262–267.

Catchpole, T.L., Revill, A.S., Dunlin, G. 2006. An assessment of the Swedish grid and square mesh codend in the English (Farne Deeps) Nephrops fishery. Fisheries Research, 81, 118–125.

Catchpole, T.L., Frid, C.L.J., Gray, T.S. 2006. Resolving the discard problem - A case study of the English Nephrops fishery. Marine Policy 30, 821–831.

Catchpole, T.L., Frid, C.L.J., Gray, T.S. 2006. Importance of discards from the English Nephrops norvegicus fishery in the North Sea to marine scavengers. Marine Ecology Progress Series, 313, 215–226.

Catchpole, T.L., Frid, C.L.J., Gray, T.S. 2005. Discarding in the English north-east Nephrops norvegicus fishery: the role of social and environmental factors. Fisheries Research 72, 45–54.

Enever, R., Revill, A. S., Grant, A. Discarding in the North Sea and on the historical efficacy of gear-based technical measures in reducing discards. Cefas, Unpubl.

Revill, A.S., Dunlin, G., Holst, R. 2006. Selective properties of the cutaway trawl and several other commercial trawls used in the Farne Deeps North Sea Nephrops fishery. Fisheries research, 81, 268–275.

Revill, A.S., Catchpole, T.L., Dunlin, G. 2007. Recent work to improve the efficacy of square-mesh panels used in a North Sea Nephrops norvegicus directed fishery. Fisheries Research, 85, 335–341.

Case study 3 – Flatfish beam trawl fisheries, Belgium, the Netherlands, UK

Brief overview of the situation prior to mitigation measures/regulation

Belgium, the Netherlands and the United Kingdom (UK) are the main nations with beam trawl fisheries. These fleets target species such as flatfish, mainly sole (*Solea solea*) and plaice (*Pleuronectes platessa*), and round fish species as cod (*Gadus morhua*). The fishing grounds are the greater North Sea, the Celtic Sea, Irish Sea and the Bay of Biscay (OSPAR-regions II, III and IV) in ICES-Subareas IVa, b, c, VIIa, d, e, g, h and VIIIa. The activities of these fleets have been well studied and the effort patterns, as well as the impacts are probably as well documented as any fleet in the EU.

Drivers that initiated gear measures being introduced

The most important direct ecosystem effects of beam trawl fisheries are on habitats, benthos, commercial fish species and wider fish communities (ICES, 2006). This case-study focuses on the technical alterations to beam trawls that can reduce the direct ecosystem effects of this fishing method. The need for selective beam trawls is recognised at many levels. A midterm review of the Common Fisheries Policy (Anon., 1991) at that time stressed the importance of reducing fish discards and the need for more research and acceptance of selective gears by fishermen. Later on, in 2002, the green paper of the European Commission on the Common Fisheries Policy (http://europa.eu.int/comm/fisheries/greenpaper/green1_nl.htm) stated that there was a need to further develop an ecosystem-oriented approach to all areas of fishery management, including fishing gear technology. This implied that gear technology research should not only focus on the effects of beam trawl fisheries on commercial fish species, but also on other ecosystem effects. As beam trawl fisheries also have a considerable impact on the biomass, production and diversity of benthic communities (e.g. Lindeboom and de Groot, 1998; Løkkeborg, 2005; Hiddink *et al*., 2006, Kaiser *et al*., 2006; Queirós *et al*., 2006), research has investigated ways to overcome these problems.

Mitigation measures or gear changes tested

There have been numerous projects on ways to improve fish selectivity in flatfish beam trawls. In the SOBETRA project (Optimization of a species selective beam trawl) (Fonteyne *et al*., 1997; van Marlen, 2003) a number of gear modifications were tested, aimed at the reduction of demersal fish discards in the flatfish beam trawl fisheries. The gear modifications tested aimed to create large escape zones for round fish in the top panel of the beam trawl without affecting the catch of flatfish. Two types of escape openings were tested for R-nets (beam trawlers using chain matrix), namely square mesh top panels and cutaway covers (reduced top sheets), and whereas large mesh top panels have been tested for V-nets (beam trawlers using tickler chains). Several representative categories of vessels were chosen to test the new designs extensively under commercial conditions through the catch comparison methodology. In general it was found that the species selectivity of the beam trawls could be improved for whiting and haddock, but much less for cod. This is in accordance with underwater observations showing that round fish species stay in different levels in a trawl with haddock in the upper level, whiting in the middle and cod in the lower level (Main and Sangster, 1982). Hence, the fish closest to the escape zone in the upper level have more chance to swim out of the trawl before entering the codend. These modifications were proven to work although the degree of success depended on the vessel size and gear size due to the fact that on smaller vessels using smaller nets the escape opening cannot be made sufficiently large to allow adequate

escape of round fish without incurring losses of flatfish. Therefore the conclusion from this work was that the results did not necessarily justify the use of these species selective devices across all beam trawl vessels.

Mitigating the effects of flatfish beam trawls on benthic invertebrates has been investigated in the EU-project "REDUCE" (Anon., 2002; Fonteyne and Polet, 2002; van Marlen *et al.*, 2005), several national projects (the UK national FIFG funded project FGE 158, the Belgian EFF funded project "IDEV") and is currently under investigation in the EU-project "DEGREE". Beam trawls cause direct mortality to benthos in two ways (Revill and Jennings, 2005). First, the shoes, tickler chains or chain mat hit animals on the seabed (Bergman and van Santbrink, 2000). Second, animals are caught in the net and die from injuries sustained in the net, during hauling or when the catch is processed and/or discarded (Lindeboom and de Groot, 1998). The most effective way to reduce the environmental impact of beam trawling is to control the mortality caused by shoes, tickler chains or chain mats hitting animals on the seabed (Bergman and van Santbrink 2000). While removing the ground gear and using other approaches such as wheels, water jets, dropper chains, brushes, etc, to drive target species out of the substratum can achieve this; commercially acceptable methods have yet to be fully developed (Anon., 2002; Revill and Jennings, 2005). Again losses of target species have been a problem. The use of electric pulses as alternative stimulus is currently under investigations in the Netherlands (van Marlen *et al*., 2006) and again this has shown to be technically feasible although there are concerns from fishermen on catch levels of sole, while there are concerns from ecologists of the impacts on fish that encounter the electrical stimuli but are not subsequently caught. (ICES, 2005).

Bycatch mortality of benthic organisms accounts for 5–10% of the total benthic mortality caused by beam trawling. Commercially acceptable technical modifications have been developed for this kind of mortality. The benthos release panel seems to be a simple and practical solution to release by-caught benthic invertebrates from a flatfish beam trawl without substantial loss of commercial fish species (Fonteyne and Polet, 2002; Revill and Jennings, 2005; van Marlen *et al*., 2005). The mesh size used needs to be balanced against the reduction in benthos catch and the loss of commercial fish species through the panel that can be experienced. Based on the research work carried out with this gear modification, a mesh size of 150 mm seems to be the best compromise.

Management measures introduced after initial research

In the framework of the Council Regulation laying down certain technical measures for the conservation of fisheries resources (850/98), a general increase in mesh size and the use of square mesh panels in towed gears was suggested to improve the selectivity of towed fishing gears. On 19 October 2001, EU Regulation 2056/2001 was adopted, establishing additional technical measures for the recovery of the stocks of cod in the North Sea and to the West of Scotland. It included a provision for the minimum codend mesh size of beam trawls in the North Sea must be 80 mm South of 56° N, and 120 mm North of 56 °N (with a restricted area in the western part of the central North Sea, where codends of 100 mm mesh size were made compulsory). However, a general increase in mesh size as first suggested in earlier drafts of the regulations was firmly rejected due to perceived losses of sole catches. These regulations also included the mandatory insertion of a panel of no less than 180mm in the top panel of all beam trawls.

It is interesting to note that in the SOBETRA-project, Fonteyne *et al.* (1997) advised on the basis of the results with square mesh top panels, cutaway cover sheets or a large mesh cover sheets that these modifications be included in future regulations. The mesh size used in beam trawls at that time, was 120mm, occasionally 150mm if sole were not the target species (Lindeboom and de Groot, 1998). The findings of SOBETRA were partially taken on board in Regulation 2056/2001 with the provisions for the use of the 180mm panel but these mesh sizes were a lot smaller than the ones suggested by Fonteyne *et al.* (1997) and did not differ according to vessel size contrary to the findings of the SOBETRA project that clearly demonstrated big differences in catches with such panels depending on vessel size. Effectively the regulation took account of the findings of research work but did not necessarily implement it as recommended.

On a more positive note there a number of other discard (fish and benthos) reduction devices such as benthic release panels that are not currently included in technical measures legislation, however, there is evidence of increasing voluntary use of some of them. The Belgian and Dutch fishermen's organisation each have setup national Working Group specifically examining technical modifications to beam trawls for discard reduction. Included within this Working Group is a commitment that the modifications agreed by fishermen's will be scientifically tested by the research institutes IMARES (NL) and/or ILVO (B). The UK beam trawl fisheries sector is taking similar initiatives through the Fisheries Science Partnership, building relationships between scientists from CEFAS (UK) and fishermen (Revill *et al*., 2007).

The use of more selective beam trawl gear is also being driven by the market place as well. Public perception of beam trawl caught fish has become increasingly negative putting pressure on fishermen to adopt more responsible fishing practices. This move has gained increasing momentum worldwide with the advent of certification schemes such as MSc and also through competitions such as the WWF Smart Gear competition or the Responsible Fishing Gear competition in the UK. The effectiveness of the modifications is in this way better supported by the fishing industry and is better adapted to different fishing grounds (A. Revill, pers. comm.).

Impact Assessment of the gear modifications

The effect of the existing regulations under 850/98 and the additional requirements included in 2056/2001 designed to improve species selectivity have not been properly evaluated. Enever *et al*. (submitted) has showed a significant reduction in fish discards by number by increasing mesh sizes from 80–89mm to 90–110mm and 110–120mm (Figure 20–1) but other than the original SOBETRA project there has been no assessment of the effect on stocks of using the 180mm panel.

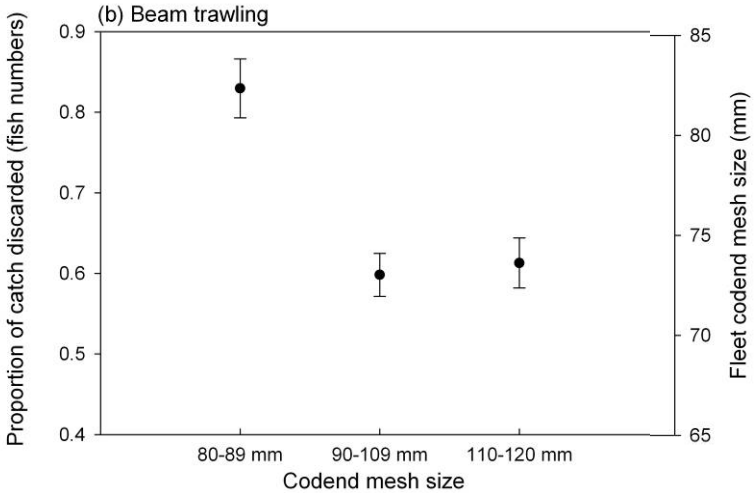


Figure 20–1. Proportion of catch discarded (all finfish numbers combined) by English and Welsh registered beam trawlers (b) in the North Sea between 1999 and 2006 fitted for varying codend mesh size groups (Modified from Enever *et al.*, submitted).

Regarding the other devices tested again only limited assessment has been carried out. Some survival studies have been completed with Benthic Release panels and impact studies of the electric beam trawl are ongoing.

Conclusions

The introduction of gear based technical measures into the beam trawl fleets to improve selectivity and reduce impact on benthic organisms largely mirrors the previous case study in the *Nephrops* fisheries. The gear measures developed are all technically feasible but have not necessarily been translated into legislation. In the case of the large mesh top sheet or square mesh panels tested the recommendations from testing have not necessarily been correctly interpreted into regulations. The voluntary uptake of the benthos release panel in particular is more encouraging and seems to be growing. The motivation for this is largely market driven.

Assessment of the impacts of the measures has proven difficult and therefore largely is a work in progress. Scientific follow-up will be difficult without fishermen's cooperation, a high input from them will be needed for any assessment. The study by Enever *et al.* (submitted) though has shown technical management measures for the protection of fish species can work. Other technical measures are still under investigation, e.g. electrified beam trawling, T90- and square mesh codends but indications are that a combination of modifications, focusing on the reduction of discards, has potential (Depestele *et al.*, 2008), especially for fish species and to a lesser extent for invertebrate species. Their effect on the reduction of short-term direct mortality has been estimated during sea trials in the developmental stage. The potential effects on fish and/or benthic invertebrate populations on the other hand has up till now not been modelled prior to implementation, nor assessed after implementation. Attempts for estimating the efficacy of technical modifications on the fleet level are currently undertaken in the EU-project "DEGREE".

References

Anon. 1991. The Common Fisheries Policy - mid-term review. Proceedings of the Conference held in Cork, Ireland on 10th and 11th May 1991, 54pp.

Anon. 2002. Reduction of Adverse Environmental Impact of Demersal Trawls (REDUCE). Final Report of EU-contract FAIR CT-97–3809. National University of Ireland, Ireland. 257pp.

Bergman, M.J.N., van Santbrink, J.W. 2000. Mortality in megafaunal benthic populations caused by trawl fisheries on the Dutch continental shelf in the North Sea in 1994. ICES J. mar. Sci., 57: 1321–1331.

Depestele, J., Polet, H., Van Craeynest, K., and Vandendriessche, S., 2008. A compilation of length and species selectivity improving alterations to beam trawls. Project report. Project no. VIS/07/B/04/DIV. Study carried out with the Financial support of the Flemisch Community, the European Commission (FIOV) and Stichting Duurzame Visserijontwikkeling vzw. Promotor: Stichting Duurzame Visserijontwikkeling vzw. 56p.

Enever, R., Revill, A. S., and Grant, A. Submitted. Discarding in the North Sea and on the historical efficacy of gear-based technical measures in reducing discards. Fish. Res.

Fonteyne, R. 1997. Optimization of a species selective beam trawl (SOBETRA). Final Project Report EU-Project AIR2-CT93–1015.

Fonteyne, R., and Polet, H. 2002. Reducing the benthos bycatch in flatfish beam trawling by means of technical modifications. Fish. Res. 55, 219–230.

Hiddink, J.G., Jennings, S., Kaiser, M.J., Queir, A.M., Duplisea, D.E., Piet, G.J. 2006. Cumulative impacts of seabed trawl disturbance on benthic biomass, production, and species richness in different habitats. Canadian Journal of Fisheries and Aquatic Sciences, 63: 721–736.

ICES. 2006. Report of the Working Group on Ecosystem Effects of Fishing Activities (WGECO), 5 12 April 2006, ICES Headquarters, Copenhagen. ACE:05. 174 pp.

Kaiser, M.J., Clarke, K.R., Hinz, H., Austen, M.C.V., Somerfield, P.J., and Karakakkis, I. 2006. Global analysis of response and recovery of benthic biota to fishing. Mar. Ecol. Progr. Ser., 311: 1–14.

Lindeboom, H.J., and de Groot, S.J. 1998. Impact-II: The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. NIOZ-rapport, 1998(1). Netherlands Institute for Sea Research: Den Burg, Texel (The Netherlands). 404 pp.

Løkkeborg, S. 2005. Impacts of trawling and scallop dredging on benthic habitats and communities. FAO Fisheries Technical Paper. No. 472. Rome, FAO. 2005. 58 pp.

Main, J., and Sangster, G.I. 1982. A study of a multi-level bottom trawl for species separation using direct observation techniques. Scottish Fisheries Research Report No. 26, 17 pp.

Marlen, B. van, 2003. Improving the selectivity of beam trawls in The Netherlands: the effect of large mesh top panels on the catch rates of sole, plaice, cod and whiting Fisheries Research 63 (2). - p. 155 – 168.

Marlen, B. Van, Bergman, M.J.N., Groenewold, S., Fonds, M. 2005. New approaches to the reduction of non-target mortality in beam trawling. Fisheries Research 72 (2–3): 333–345.

Marlen, B. Van, Grift, R.E.; Keeken, O.A. van, Ybema, M.S., Hal, R. van, 2006. Performance of pulse trawling compared to conventional beam trawling. IJmuiden: IMARES, (Report C014/06) - p. 60.

Queirós, A.M., Hiddink, J.G., Kaiser, M.J., Hinz, H. 2006. Effects of chronic bottom trawling disturbance on benthic biomass, production and size spectra in different habitats. J. Exp. Mar. Biol. Ecol., 335, 91–103.

Revill, A.S., Jennings, S.J., 2005. The capacity of benthos release panels to reduce the impacts of beam trawls on benthic communities. Fish. Res. 75, 73–85.

Case study 4 – shrimp beam trawl fisheries, Belgium, Denmark, France, Germany, the Netherlands, UK

Brief overview of the situation prior to mitigation measures/regulation and drivers that initiated gear measures being introduced

The shrimp beam trawl fisheries in the North Sea and a summary of the state of knowledge concerning its impact upon benthic habitats and the wider marine ecosystem has been described by WGECO in 2007 (ICES, 2007b) and acknowledged by WGFTFB in 2007 (ICES, 2007a). WGCRAN, in responding to the WGECO report of 2007, perceived some of the findings of the WGECO report to be incorrect or give a misleading picture of the *C. crangon* fisheries (ICES, 2007c). WGECO concluded that the removal of the target species (*C. crangon*) and the unwanted bycatch of juvenile commercial fish to be major concerns in these fisheries. WGCRAN concluded that the former one is not considered as a primary concern as the removal of *C. crangon* is necessary for the fishery to be viable and an unavoidable consequence of the fishery (ICES, 2007a). Moreover, *Crangon* stocks do not show signs of overexploitation (ICES, 2007a; ICES 2007c; Suuronen and Sarda, 2007). The latter concern of fish bycatch has largely been addressed by gear research.

Mitigation measures or gear changes tested, management measures introduced after initial research and impact assessment of the gear modifications

Revill *et al.* (1999), Revill (2001) and Polet (2003) assessed the likely outcomes of the use of selective trawls in the *Crangon* fisheries in terms of the benefits to fish stocks and their future landings. This research triggered the current technical measures (sieve nets and rigid grids) introduced into legislation in 2003 for the *C. crangon* fisheries (ICES, 2007a). This technical management measure has been assessed in a study of the UK fishery (Catchpole *et al.*, 2008). ICES (2007a) and this study legitimately assumed, given the similarity between fisheries that these findings can be applied to the North Sea *C. Crangon* fishery and concluded that sieve nets appear to function as intended in reducing bycatch of unwanted fish species but derogations applying to the main EU brown shrimp fleets of Germany and The Netherlands, which state that no selection device is required for up to half of the year do compound the situation.

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

WGFTFB in its review of the fisheries concluded that the existing technical measures used in these fisheries are the most effective gear-modifications available at present for reducing bycatch. However, the ICES-FAO WGFTFB also recommended that these existing technical measures are only partially effective, and that there is a clear need to develop further measures to reduce discarding in these fisheries beyond existing levels (i.e. new gears, spatial / temporal measures etc). These findings are confirmed by Suuronen and Sarda (2008).

WGFTFB recommended:

- That technical development with on-board catch processing and deck sorting equipment (i.e. rotary riddles with constant running water) may fur-

ther improve discard survival rates, but that scientific follow-up studies are required to confirm this.

- Their should be support for the research and development of new measures which could be used to effectively harvest *C. crangon* while reducing discards of unwanted species beyond current levels.
- That the electric-shrimp beam trawl may be one such technical measure, but as yet it is in too early a stage of development to be able to evaluate its potential effects on the ecosystem or its fishing efficiency.
- That any new technical measure, which utilises electrical stimulation as a component, should be accompanied by thorough and rigorous evaluations as to their potential environmental impact and fishing efficiency at the earliest stage possible.

Impact Assessment of the gear modifications

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

The social analysis was used to identify changes in fleet structure and fishing patterns since the legislations introduction and the extent of compliance and enforcement. The biological analysis evaluated the performance of commercially used selective gear and also identified changes in fish stocks of bycatch species. The economic analysis assessed the economic implications of the legislation. The retrospective change in productivity of the brown shrimp fleet as a consequence of the use of sieve nets was estimated using a production function approach. The analysis utilized vessel logbook data detailing brown shrimp landings by individual trip during the period January 1999 to August 2006. The analysis of the two models was performed using FRONTIER 4.1 and showed a reduction in fleet productivity of 14% following the introduction of the legislation.

Conclusions

The gear measures introduced into the *Crangon* beam trawl fisheries have largely been effective although the introduction of derogations for some fleets has reduced the effectiveness. This has been a weakness in a number of technical measures regulations. This case study also demonstrates that a protocol used to evaluate the efficacy of these technical measures in the *C. crangon* fisheries is both holistic and effective. The same protocol can potentially be used elsewhere in other fisheries to conduct similar evaluations on the efficacy of technical measures.

References

Catchpole, T. L., Revill, A. S., Innes, J., and Pascoe, S. 2008. Evaluating the efficacy of technical measures: a case study of selection device legislation in the UK *Crangon crangon* (brown shrimp) fishery. – ICES Journal of Marine Science, 65: 267–275.

ICES. 2007a. Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 23–27 April 2007, Dublin, Ireland. ICES CM 2007/FTC:06. 197 pp.

ICES. 2007b. Report of the ICES Working Group on Ecosystem Effects of Fishing Activities (WGECO), 11–18 April, 2007, ICES Headquarters, Copenhagen, Denmark. ICES CM 2007/ACE:04. 162 pp.

ICES. 2007c. Report of the Working Group on Crangon Fisheries and Life History (WGCRAN), 22–24 May 2007, Helgoland, Germany. ICES CM 2007/LRC:08. 40 pp.

Polet, H. 2003. Evaluation of bycatch in the Belgian brown shrimp (*Crangon Crangon* L.) fishery and of technical means to reduce discarding. Phd thesis, University of Ghent, Belgium.

Revill, A., Pascoe, S., Radcliffe, C., Riemann, S., Redant, F., Polet, H., Damm, U., Neudecker, T., Kristensen, P., and Jensen, D. 1999. The economic & biological consequences of discarding in the European Crangon fisheries. Final report to the European Commission, Contract No. 97/SE/025.

Revill, A.S. 2001. Technical measures and the North Sea *Crangon* fisheries. Annex 11. *In* Evaluation of the effectiveness and applicability of technical measures in fisheries management (TECMES). Final Report (EU Study Contract no. 98/016).

Case study 5 - Pelagic trawling for blue whiting, Faroe Islands

Brief overview of the situation prior to mitigation measures/regulation

Blue whiting (*Micromesistius poutassou*) is one of the major pelagic fish resources in the Northeast Atlantic. In 2004 the total recorded catch of blue whiting in the North Atlantic reached 2 377 569 t mainly taken by Norway, EU countries, Iceland, Faroe Islands and Russia. The total blue whiting catch in the Faroese EEZ in 2004 was 435 000 t (ICES, 2005). It is thus a highly valuable fishery, although essentially the only restrictions on this fishery have been in the form of quotas and mesh size.

In the last decade there have huge technical developments in pelagic fishing, both in vessels size and design, as well as in development of trawl design. Today pelagic trawls used for blue whiting have horizontal openings of 200 m wide with vertical openings of 100 m encompassing meshes of 64 m in the mouth of the trawl gradually tapering back to 32 mm in the cod-end. These trawls have the ability to catch several 100 tonnes in a few minutes towing time using towing speed of 3–4 knots.

Drivers that initiated gear measures being introduced

In recent years an increasing bycatch of demersal species, mainly saithe (*Pollachius virens*) and to a lesser degree cod (*Gadus morhua*), have been observed in the blue whiting fishery, particularly in the Faroese area. Preliminary findings at the Faroese Fisheries Laboratory have shown that the average bycatch of saithe on one vessel in November/December 2004 was 3.2% in weight per tow (range 0%-20%) and in May/June 2005 2.2% in weight per tow (range 0.6%-14.9%) (Lamhauge, 2004, 2005). The Faroese Fisheries Inspection estimated an average bycatch in Faroese waters to be approximately 1% with Similar findings have been made in Icelandic waters (Pálsson, 2005). Given the catch sizes in this fishery, these bycatches leaves have the potential to impact on saithe and cod stocks.

For the Faroese pelagic fishermen this bycatch was valueless as it could not be sorted from the blue whiting catch so given the main problems were in Faroese waters there was a strong motivation for them to look at ways of reducing saithe and cod catches to the benefit of the Faroese demersal fleets. Saithe is an important stock to the Faroese fishing fleet. It was also pointed out by scientists that the bycatch was a source of an unaccounted mortally in the stock assessment of cod and saithe in the area, which needed to be addressed. This motivated research into gear mitigation measures for this fishery.

Mitigation measures or gear changes tested

Experiments to introduce sorting grids for use in pelagic trawls to solve the bycatch problem were undertaken in a joint project between the Faroese Fisheries Laboratory, the Faroese Fisheries Ministry, the pelagic vessel owners and the Faroese gear manufacturer "Vónin" Ltd. Since 2004 a range of rigid and flexible grids have been tested to reduce the bycatch. Underwater video techniques have been used to observe the function of different grids. The original rigid steel grids tested, of similar design to the successful Nordmore grid used in shrimp fisheries, could not withstand the huge forces in play in these big trawls. There were also considerable problems with these grids becoming blocked with blue whiting causing handling difficulties and loss of catch. Further testing led to the development of a compromise flexible grid made of plastic tubes mounted on frame ropes. Preliminary results indicated that bycatch could be reduced by more than 95% without losing more than 1% of the targeted fish catch. Further testing provided these levels could be consistently achieved. More details are given in Zachariassen and Thomsen (2007).

Management measures introduced after initial research and impact Assessment of the gear modifications

Following this research on the 1 January 2007 it became mandatory for the Faroese blue whiting fishery to use a sorting grid in Faroese waters where bycatch is an issue. The type of sorting grid is not specified, but the bar spacing has to be 55mm. Acceptance of this gear measure is reportedly high for the Faroese fishing industry and this has largely been helped with a strong education campaign by the Faroese laboratory in assisting fishermen with the installation and use of the grid. Grants for purchase and installation costs have also been instigated. This strong collaboration between the Faroese fisheries laboratory and the Faroese fishing industry, in parallel with the technical assistance provided has led to this high level of acceptance of adopting the sorting grid. The request for this type of project came from the fishing industry, motivating by an understanding that they needed to address the issue of saithe bycatch or otherwise regulations such as closed areas or restricted catches would have been imposed upon them. The Russian blue whiting fleet, however, did not adopt the sorting grid that well, although communication between the Faroese fisheries laboratory and Russian vessels is ongoing.

Monitoring of the use of the grid has been intense and as part of the introduction of the regulation the Faroese authorities have sought to assess the effectiveness of this measure can through monitoring catches at sea and landings ashore. The monitoring of the landings reflects whether bycatch levels have been reduced effectively and reports suggest this is the case. Any effects on saithe and cod stocks have not yet been observed given the regulations have only been enforced for 18 months but this is being closely monitored.

Conclusions

The introduction of the flexible grid into the blue whiting fishery shows how gear measures properly researched with full industry support can work and what is really interesting about this gear measure is that from inception to regulation took only a year or so. The Faroese experience shows the importance of industry collaboration but also the need for back up technical support and education of fishermen to encourage acceptance. The adoption of this grid is perhaps paralleled to the introduction of Turtle Excluder Devices in the US, South-east Asia and Australia where education programmes that have accompanied their introduction to advise fishermen

on correct installation and handling, as well as provision of back up technical assistance to solve rigging and handling problems that may have arisen.

References

ICES. 2005. Report of the Northern pelagic and blue whiting fisheries Working Group (WGNPBW). ICES CM 2005 (ACFM:05), 241 pp.

Lamhauge, S. 2004. Hjáveiða í flótitroli. Faroese Fisheries Laboratory, Tórshavn. Faroe Islands (In Faroese).

Lamhauge, S. 2005. Hjáveiða í flótitroli. Faroese Fisheries Laboratory, Tórshavn. Faroe Islands (In Faroese).

Pálsson, O. K. 2005. An analysis of bycatch in the Icelandic blue whiting fishery. Fisheries Research, 73 (2005) 135–146).

Zachariassen, K., and Thomsen, B. 2007. Sorting grids in large blue-whiting trawls. ICES Boston Symposium "Fishing Technology in the 21st Century". ICES Journal of Marine Science (in press).

Conclusions

The integration of fishing gear technology research in the framework for fisheries management is a prerequisite for achieving an ecosystem-based approach. It is recommended that many of the issues evolving from the selected case studies should be taken into account in a framework for assessing impacts and management measures related to fishing gear based technical measures.

Fishing gear technologists tend to focus on single or multiple commercial fish species. With the exception of charismatic species, very little fishing gear research is focused on non-target fish species and benthic invertebrates; although such gear modifications might have an effect on non-target fish and invertebrate species. Most of the fishing gear research is driven by the fisheries management objectives, which is in its turn mainly driven by the healthiness of commercial fish stocks. There is gradually a focus on a more ecosystem-based approach, but very few fishing gear research is yet focusing on other ecosystem components. Therefore there is need to consider biological and ecological impacts of gear measures during the research phase and before inception into legislation.

Fisheries gear research has and is focusing on the reduction of physical habitat impacts (e.g. EU-project "DEGREE"), but few of these efforts have been implemented in the actual fisheries and this is reflected in the fact that the authors could not identify a good case study to address this.

Research on gear modifications to improve selectivity of commercial fish species through a variety of sorting devices has been proven to reduce bycatch and discards rates, mainly of fish species (Valdemarsen and Suuronen, 2003, Suuronen and Sarda, 2008). The application of these gear modifications can be achieved through regulations or sometimes through the voluntary use by fishermen. Regulatory and market incentives both can lead to an improvement of fishing practice.

From the case studies, it can be seen that communication and education are vitally, when introducing gear based measure into legislation. Regulations are in some cases quickly introduced, but it takes time for the fishing industry to adapt. Case study 5 (blue whiting fisheries and the use of a flexi-grid) illustrates that the compliance and acceptance of gear measures can be high, as a consequence of the involvement of the Faroese fishing industry in the actual fishing gear research and the implementation of

the legislation. The first case study (gill net fisheries and the use of pingers) however, is a clear illustration where the very limited involvement of the fishing industry in the development of Acoustic Deterrent Devices, its application and implementation through legislation leads to much scepticism towards its use. The proven positive effects of acoustic deterrent devices for certain cetacean species and fisheries have been largely undermined and the measure has been ineffective in meeting its objectives.

Another vital aspect for an effective use of gear modifications is a good framing of the legislation. There is a need to consider all relevant issues (e.g. practicalities, socio-economic and technical aspects, etc.) to ensure that gear measures, proven effective in fishing gear research, meet their objectives after implementation.

Non-regulatory uptake of technical gear measures can be achieved through several incentives. The incentives can be market-driven, but uptake leading to an improvement of the fisheries image is also present. One example is the use of the benthos release panel. In this case, the drivers are economic incentives and an improvement the image of fisheries towards the public perception and supermarkets (achieved through e.g. the UK Clean fishing competition). The use of selective methods by fishermen in other cases is apparent, when fishermen face or are subjected to a reduction in fishing opportunities through other restrictive measures (e.g. access to closed areas, increase in fishing days, etc.). This has been apparent in the adoption of the Nordmore grid in Norwegian shrimp fisheries, where fishermen had to adopt more selective gear to remain I the fishery (Graham *et al*., 2007).

WGFTFB conclude that the protocol used in the UK-study (Catchpole *et al.*, 2008) to evaluate the legislation put into force for the *C. crangon* fisheries is both holistic and effective. The same protocol can potentially be used elsewhere in other fisheries to conduct similar evaluations on the efficacy of technical measures. This protocol includes an evaluation of the legislation text, performance of the gear modifications, including environmental effects and a socio-economic evaluation. This can be supplemented by evaluating the efficacy of technical measures through proper use of data gathered under the Data Collection Regulation, e.g. Enever *et al.* (submitted). Data collection programmes can be used to evaluate the gear measures put into force. However, these evaluations have to be used in association with survey data, to document changes in discards and/or landings/catch.

COM. 2002. Communication from the commission to the council and the European parliament on a Community Action Plan to reduce discards of fish. 22pp.

Suuronen, P., and Sarda, F. 2007. The role of technical measures in European fisheries management and how to make them work better. ICES Journal of Marine Science, 64: 751–756.

Valdemarsen, J.W., and Suuronen, P. 2003. Modifying fishing gear to achieve ecosystem objectives. *In*: Responsible Fisheries in the Marine Ecosystem, pp. 321–341. Ed. By M. Sinclair and Valdimarsson, G. FAO, Rome and CABI International Publishing.

Annex 12: Reports from National Coordinators of the FAO Project (REBYC 1)

Philippines

Jonathan O. Dickson, Bureau of Fisheries and Aquatic Resources,
jod_bfar@yahoo.com

Abstract

The pilot implementation project was carried out in Samar Sea (Calbayog City) from September 1, 2005 to December, 2006. The experiment involve 18 units of shrimp and fish trawl fishing boats were used during the experiment with a total landed catch of 1,295 tons of fish from 991 fishing trips. The average catch per-unit effort (CPUE) for shrimp trawl (panghipon) was just below 1 ton (948 kgs) per fishing trip while CPUE for fish trawl (palupad) was 2.4 tons per fishing trip. Fishing season (peak months) was clearly indicated in the months of October and November and lean season in July-August.

Of the total estimated catch of 711 tons of shrimp trawl for the study period, more than one third (37.9%) was comprised of lizard fish (lizard fish, *Saurida spp*), followed by nemipterids (*Nemipterus hexodon, Scolopsis sp.,* 10%) and about 1% of shrimps. The rejects, which comprised of the juveniles of commercially important species as well as other small-sized fish of low or no commercial value and commonly utilized as aquaculture feed, was 15.6%. The composition of rejects in shrimp trawl indicated high incidence of juveniles of commercially important species, among which were the lizard fish 8.1% (*Saurida sp.*), purple spotted bigeye 5.4% (Dilat, *Priacanthus tayenus*), cardinalfish 9.2% (Muong, *Apogon sp.,* hairtail (espada, *Trichiurus sp.*).

Shrimp trawl releasing efficiency on rejects/discard according the JTED type with V15 with the highest releasing efficiency of 59%. V10 with releasing efficiency of only 20% was way below the set target of 40% was rejected during the 1st quarter of implementation. For the commercial fish catch only V15 indicated a reduction of 10%, apparently the reason fishermen were hesitant in using the device during the trials. H15 and V10 had an even indicated increase of 11%, while V12 increased by 5%. While, fish trawl the releasing efficiency on the reject was more apparent on V12, V15 and H15 with 54%, 58% and 46% respectively. Again V10 with 20% was below the threshold. Interestingly, the commercial catch indicated a significant increase on the V15 with 66% higher catch and H15 likewise increase by 18%. Decrease was observes in V10 and V12 with 23% and 3% respectively.

On sex and maturity of Short bodied mackerel and nemipterids species has a good data in terms of maturity. The *Rastrelliger kanagurta*, locally known in Calbayog as Short bodied mackerel, showed that its longest average length appeared in April with 225mm and its shortest average length in May. The result on the average length is directly proportional with the highest result on average Gonad Weight and Gonado Somatic Index (GSI) appearing in April with 3.25 and 2.25 gms, respectively. Matured samples were likewise observed in April, May and July. Matured samples were further observed in October and December. Most of the samples were however observed in April which indicates that summer is the potential spawning season of this species. While, nemipterids as it is locally known in the area showed that its longest average length appeared in August with 179mm and its shortest average length in May (174mm). With regards to average GSI, December showed the peak with 1.91 fol-

lowed by September and October with 1.89 and 1.90 respectively. Similar months obviously showed the same trend with regards to average gonad weight. The monthly percentage composition from GSI which was practically based from the five point maturity scale. Moreover, the majority of the samples gathered were immature (stages I- III). Significant percentage of fully matured samples was observed throughout the sampling period with December showing the highest followed by October and July, September and November.

Introduction

Trawl is one of the most efficient fishing methods to harvest bottom and mid-water fishery resources. It is considered, however, as a highly non-selective gear due to the fact that it exploits a wide variety of species in different sizes giving rise to problems associated with managing fish stocks and maintaining biodiversity. Specifically, the high proportion of small juvenile fish in the catch of trawls aggravates the current serious problems of overfishing in most of fishing areas. Catches of juveniles and other non-commercial low-value species in large portions which are utilized and thrown out to the sea as discards are deplorable considering the current overfished state of coastal fishing grounds.

However, the effectiveness of contemporary measures regulating mesh size and area of fishing ground restrictions has large been acknowledged to be impractical and inadequate. Given that trawling is a major fishery and will likely remain an important sector in countries like the Philippines, it is important that methods or devices to make it a more selective by reducing the incidence of juvenile and trash fish captured are introduced in order.

Regulating mesh size and shape is a direct measure enforced for conservation of fishery resources. The minimum legal stretched mesh size is not less than 3 centimetre and above between two opposite knots of a full mesh when stretch (BFAR FAO No. 155, 1986). For trawl fisheries, the optimum mesh size is very difficult to obtain due to high diversity of catch. Shrimps may represent as little as 10% of the total catch (Ramiscal, 1996) which also happen in other trawl tropical countries (Seidel, 1975). Likewise, the operation of trawl is also delimited by fishing ground restrictions. Under the Fisheries Administrative Order 201, the operation of active fishing gears including trawls is not permitted within the municipal waters or within 15 kilometres from shore.

Trawl by and large remains an important source of food, income and employment to a significant sector in the fisheries in the country. In 1992–1995, the fishery contributed an average of 83,000 MT or 10% of the total commercial fisheries and 32,000 MT or 4.3% of the municipal fisheries. Widespread trawl operations, mainly for shrimps are known to exist in moderately deep inland seas, bays and other coastal areas, notably Visayan Sea, Samar Sea/Maqueda Bay, Lingayen Gulf, San Miguel Bay/ Polilio and Waters of Palawan. Due to overfishing problems in many areas, active fishing gears including trawls have been prohibited in municipal fishing grounds or within 15 km from the shoreline.

Several efforts have been made to introduce or study methods or devices to exclude or dissociate juveniles and other non-target or unwanted catch from the target of commercially important species thereby reducing the impact to resources and biodiversity. Among these are the square mesh cod-end and Bycatch reduction devices (BRDs), including the turtle excluder device (TED) and juvenile and trash fish excluder devices (JTEDs). JTEDs being promoted by the Southeast Asian Fisheries De-

velopment Center (SEAFDEC) Training Department under its 5-year ASEAN-SEAFDEC Plan of responsible fishing technologies and practices. Experiments have been carried out in most countries in Southeast Asian Region (Thailand, Brunei Darussalam, Vietnam, Indonesia, and Malaysia) where encouraging results in certain designs have been indicated.

The project in the Philippines is parallel project to introduce and promote selectivity devices to reduce the incidence of juveniles and trash fish and which can supplement existing management measures in shrimp trawl fishery. The project is being implemented in collaboration with FAO/UNEP/GEF, under Project EP/GLO/201/GEF entitled **"Reduction of Environmental Impact from Tropical Shrimp Trawling Through the Introduction of Bycatch Reduction Technologies and Change of Management"**. This paper covers the results of initial experiments conducted in Manila Bay, San Miguel Bay, Samar Sea, Visayan Sea and Lingayen Gulf, considered as the leading fishing grounds for shrimp trawl in the Philippines.

Methods

1. Duration and Scope

The pilot project started in September 2005 involving 30 vessels that have been allowed to operate under the Coastal Zoning Project; however, the 1st quarter review/evaluation in December 2005 necessitated revision of the implementation plan to incorporate clear and expanded effort control system. The revised plan was subsequently implemented starting April 2006 until December 2006. It involved 18 operational vessels; each allowed 5 fishing trips per month (maximum of 3 fishing days per trip) instead of the potential 7–8 fishing trips which each vessel can achieve per month. A dispatching system was devised for the departing vessels to acquire clearance from the City Agriculture Office.

In January-March 2006, while the revised pilot project was awaiting approval from concerned parties, the catch and effort was likewise monitored even while the fleet was not using JTED.

2. JTED variations and deployment

Vertical sorting grids 10mm, 15mm (V10, V15) and horizontal sorting grid (H15) were used in September 2005-Decemeber 2005. After the 1st quarter evaluation indicating poor performance of V10, the working group recommend vertical sorting grid 12mm (V12) as replacement, thus V12, V15 and H15 were utilized from April-June, 2005. Subsequently in July-December 2006, only V12 and H15 were utilized to V15 high exclusion of commercial larger-sized fish which became unacceptable to participating fishermen. Control vessels (no JTED) were maintained during the entire study period.

JTED variations and control were alternated and deployed on rotation basis among participating vessels (See appendixes for deployment pattern in Sept-December 2005; April-June 2006; July-December 2006). No JTED was used between January-March 2006 when the implementation of the pilot project was deferred.

3. Data gathering & sampling

a) Fish landing survey/monitoring

Daily fish landing/unloading was conducted at Calbayog Fish Port. In September to December 2005, sampling was scheduled every two days and subsequently pro-

gressed daily sampling or total enumeration in the remaining period of implementation. Data collected included total catch and species composition. Sub-sampling was done on dominant and commercially important species.

In order to determine the effect of the devices, the catch was classified according to general grouping as follows:

- Commercial fish – all fish of commercial value or those that are usually sold; and further sub-grouped as large, medium, small according to size groups or classification used for wholesale pricing.
- Reject – catch that is sold as fish food in aquaculture.

Size grouping (large, medium, small) of dominant commercially important species was also determined. Length measurements for dominant species were done.

On a particular sampling day, sampled boats were selected in a random manner as much as possible, however, historically vessels with accommodating operators were provided precedence to be able to gather more reliable information and execute the designed sampling procedures. Two (2) pre-designed forms are filled-up in one sampling day.

For a particular sampled boat, the total boat catch (weight) was determined by counting the number of tubs and appropriately raised by the established weight per container as it was virtually impossible and impractical to individually weigh their contents. Normally, catch were usually landed pre-sorted by species by the fishermen onboard to which the volume was recorded for that species and in instances where sorting was done according to group, size or mixed species and trashfishes/rejects. In cases of mixed species, the composition was determined by the sub-sampling method and appropriately raised to the total number of boxes and recorded accordingly in prescribed form (Form 1).

In case of mass landing and total sampling is unworkable, the total boat catch and fishing effort for each unsampled boat were simply inquired from masterfisherman or the person in charge of catch disposal at the port and recorded in Form (2).

b) Total landed catch and effort

On a regular sampling day, the total landed catch and effort of both sampled and unsampled boats as well as the species composition of sampled boats are summarized. The catch composition of the total landings of the particular sampling day is raised according to the observed catch composition of the sampled boats. The catch-per-unit effort (CPUE) was expressed as the kg/boat/trip.

c) Length frequency

On any instance, sub-sampling was randomly and proportionately undertaken from fish tubs for length measurement of the species caught or in some instances, the major species and recorded in Form (2). The total length to the nearest cm was used as the standard measurement in this project. After measuring, the frequencies are then raised according to the total catch of the sampled boats and subsequently encoded and analyzed via FiSAT Software. Moreover, the length frequency data were used in the determination of some biological and population parameters such Length Infinity (L_∞), growth increment per (k) year using the ELEFAN 1 (k scan, response surface and automatic search). The data was likewise used in analyzing the number of pulses (recruitment) per year per species.

Moreover, these data obtained from the ELEFAN 1 were used in the estimation of F (Fishing Mortality), M (Natural Mortality), Z (Total Mortality) and the E (Exploitation Rate) of some selected species. Consequently, recruitment patterns determining the number of pulses or obtaining the plot showing the seasonal pattern of recruitment, Probability of capture (25%; 50% and 75%).

d) Gonad maturity

The examination of 50 samples/tails for the five major species in Calbayog City which were taken from sampled boats every month was realized. Total Length, measured in millimetre as well as body and gonad weight were determined which are rounded to the nearest 0.1 grams were used in the determination of spawning month for the entire study period. Sex and gonad stage were determined through visual inspection using the standard 5-point maturity scale respectively. These data are used in determining the Gonado- Somatic Index (GSI) of the five major species which are used to validate the spawning month of the selected species. Furthermore, the Gonad weight multiplied by the body weight and 100 was the key in determining the GSI which likewise served as the basis in the determination of Length at first maturity of the sampled species through the practical method.

e) Biomass estimation and catch-per-unit-area (CPUA)

In determination of the Biomass and CPUA, data items recorded include the fishing boat speed, wing spread of the gear, the coordinates, species composition by weight and fishing effort (time) including the total Samar Sea Area. In principle, it appears that a trawl sweeps a well defined path which is called the "swept area" or the "effective path swept". The swept area was estimated by using the formula a=D*hr*x2.

The CPUA was determined by dividing the catch by the swept area (in NM or square kilometres. Moreover, the biomass was determined by the formula where B is the Biomass, Cw/a is the mean catch per unit area, A is the total size of the area under study and X1 is the fraction of the biomass in the effective path swept by the gear which is actually retained in the gear. In recent studies, x1 ranges between 0.4 to 1.0. In this study however, 0.5 was used which appears to be the most widely used value in Asian survey activities.

$$B = \frac{(Cw/a) * A}{X1}$$

As per recent onboard activities, the duration of each haul averages to be 2.4 hours for Fish Trawl and 4.7 hours for shrimp trawls. The duration of the haul is proportional to the distance covered so the effort has no direct influence on the catch per unit area (CPUA)

Onboard observation

Onboard observation was once a month starting April 2006 to monitor compliance to JTED deployment. Biological data includes species and size composition. Dissection to determine sex and maturity of major species caught was likewise conducted.

Logbook system

In an initial effort to determine the effect of the devices and pilot project scheme on the operation and income, logbooks accomplished by owners of participating vessels

were evaluated. Logbooks entries included catch/production, cost of operation and proceeds from sales.

Clearance/dispatching system

Participating vessels were required to secure a Clearance or Sailing Order from City Agriculture Office (CAO) as a manner to enforce the devised effort control. Clearance or Sailing Order included certification of inspection of JTED and specified dates of departure and return to port.

Agencies involved and responsibilities

i) Working Group

The working group was organized as the steering and implementer of the pilot project. Among others, its responsibilities were to plan, coordinate and ensure proper implementation. It was composed of representatives of LGU- Calbayog City, BFAR CO Project Team, BFAR RFO8 /RFTC8, OPA-Samar, CAFC, PAFC, APCO- Samar and the Fishing Boat Owners/Operators of Calbayog City. Its main responsibilities were of the Pilot Project

ii) Local government unit-Calbayog City

As co-project implementer, among others, the responsibilities of the LGU-Calbayog City were to arrange authorized/acceptable implementation among local stakeholders, to ensure participation of selected Commercial Fishing Boats (CFBs) in Calbayog City and complement in the enforcement of related laws/regulations

iii) BFAR-CO Project Team

As co-project implementer, the responsibilities of the BFAR-CO Project Team were to provide financial support on activities supported by FAO/GEF Project, provide JTEDs to be used and technical requirements and support during the entire implementation of the project

iv) Fishing boat operators and fishermen

As co-operators, the boat owners and crew were agreed to be responsible for full compliance with the conditions of the implementation plan including provision of required data and allowing researchers/enumerators to join fishing trips.

v) Periodic review/evaluation

A quarterly review and evaluation spearheaded by the working group was agreed to update concerned parties on the project implementation and address emerging issues and concerns as a condition to the continued implementation of the pilot project.

Results

Total catch and effort

For the period September 2005 to December 2006, the trawl fleet based in Calbayog City landed a total catch of 1,295 tons of fish from 991 fishing trips. The average catch per-unit effort (CPUE) for shrimp trawl (panghipon) was just below 1 ton (948 kgs) per fishing trip while CPUE for fish trawl (palupad) was 2.4 tons per fishing trip. Fishing season (peak months) was clearly indicated in the months of October and November and lean season in July-August.

It is notable that fishing effort was significantly reduced beginning in April when supplementary effort control was introduced.

Catch composition and seasonality

The total estimated catch of 711 tons of shrimp trawl for the study period, more than one third (37.9%) was comprised of lizard fish (lizard fish, *Saurida spp*), followed by nemipterids (*Nemipterus hexodon, Scolopsis sp.,* 10%). Shrimps which are considered as the target species formed just about 1% of the catch. The discards comprised of juveniles of commercially important species, as well as other small-sized fish of low or no commercial value and commonly utilized as aquaculture feed was 15.6%.

The composition of discards in shrimp trawl indicated high incidence of juveniles of commercially important species, among which were the lizard fish 8.1% (*Saurida sp.*), purple spotted bigeye 5.4% (Dilat, *Priacanthus tayenus*), cardinalfish 9.2% (Muong, *Apogon sp.*, hairtail (espada, *Trichiurus sp.*).

For fish trawls, the catch was dominated by small pelagic species e.g. roundscad 47.8% (*GG, D. maruadsi*), sardines 10.8% (*tamban, Sardinella longiceps*) and mackerel 7.8% (*short bodied mackerel, R. faughni*). Demersal fish which are the dominant catch for shrimp trawl constitute a small portion of the catch like lizardfish (lizard fish) 0.4% and threadfin bream 0.3%. The reject portion of the catch was also comparatively lower, with only 4.2% of the total catch

JTED efficiency by catch grouping

TheV15 JTED gave the highest release efficiency with 59% reduction of rejects/discards. V10 with releasing efficiency of only 20% was way below the set target of 40% was rejected during the 1st quarter of implementation for the commercial fish catch. Only V15 indicated a reduction of 10%, apparently the reason fishermen were hesitant in using the device during the trials. H15 and V10 had an even indicated increase of 11%, while V12 increased by 5%. In terms of total catch, V12 and V15 had an overall reduction effect on the catch with 3.5% and 19.8% respectively.

For fish trawl, the release efficiency for rejects was more apparent on V12, V15 and H15 with 54%, 58% and 46% respectively. Again V10 with 20% was below the threshold. Interestingly, the commercial catch indicated a significant increase on the V15 with 66% higher catch and H15 likewise increase by 18%. Decreases were observed in V10 and V12 with 23% and 3% respectively, and the total catch, V12 showed a significant increase in catch with 58% increase as compared to control net. H15 increased by 4% while there was a decrease in V10 and V12 with 23% and 6% respectively. It was surmised that the increase in V15 and H15 was attributed to less drag due to release of smaller fish and less masking on the codend.

Potential effect of JTED utilization on catch and income

To be able to demonstrate the potential impact of the devices on the catch and income on shrimp trawl, a simple projection is shown in Table 1 as computed based on the following:

- Total fishing effort = total fishing effort made by the shrimp trawls in 2006= 455 trips
- Total catch = average NOJ catch rate = 930.15 kgs/trip
- Catch composition = NOJ composition (reject, commercial-further classified into small, medium, large)
- Reduction/ increase
- Reject = Average reject reduction / increase by JTED type

- Large commercial = average large commercial reduction/increase on lizard fish by JTED type
- Medium commercial = average medium commercial reduction/increase on lizard fish by JTED type
- Small commercial = average small commercial reduction/increase on lizard fish by JTED type
- Weight increase of small commercial fish = 3 times in 6 months period
- Average price (pesos)
- Large commercial = 60
- Medium commercial = 40
- Small commercial = 30
- Reject = 5

Table 1. Projections of loss or gain from released juveniles and discards from catch.

	NQJ	v10	v12	v15	h15
Income from large fish	11,964,015	8,500,135	19,169,717	11,179,643	14,290,961
Income from medium fish	3,214,394	3,273,203	2,360,645	2,410,188	2,767,419
Income from small fish	1,648,777	2,297,024	1,081,611	602,547	1,249,731
Income from rejects	442,504	353,134	275,767	183,612	257,351
Total Income	17,269,690	14,423,496	22,887,739	14,375,990	18,566,462
Loss/Gain of income from large fish		3,463,880	(7,205,701)	784,372	(2,326,946)
Loss/Gain of income from medium fish		(58,809)	853,749	804,206	446,975
Loss/Gain of income from small fish		(648,247)	567,166	1,046,230	399,046
Total loss of income		89,371	166,738	258,892	185,153
Potential value of escaped small fish			3,402,988	6,277,381	2,394,276
Potential value of escaped reject commercial fish		804,336	1,500,639	8,607,409	1,666,381
Total potential increase in income		804,336	4,903,637	8,607,409	4,060,657
Potential production from small fish			56,717	104,623	39,905
Potential production escaped reject commercial fish (25%)		13,406	25,011	38,834	27,773
Total potential increase in production		13,406	81,727	143,457	67,678

Based on the above the following total catch by JTED type was estimated:

Sex and maturity

Rastrelliger kanagurta, locally known in Calbayog as Short bodied mackerel, showed that its longest average length appeared in April with 225mm and its shortest average length in May. The result on the average length is directly proportional with the highest result on average Gonad Weight and GSI appearing in April with 3.25 and 2.25 gms respectively.

The monthly percentage composition from GSI, which was practically based from the five point maturity scale. Sample GSIs were classified according to gonad weight where stages 4 and 5 were classified as fully matured while stages 1, 2 and 3 were as it is. Majority of the samples gathered were immature while a percent of fully matured samples were observed from April to December except June where there were no samples gathered.

The percent maturity of samples based from practical determination of maturity from GSI of 4. It further shows that a very significant portion of catch weighed less than 0 GSIs, with majority caught in May. Matured samples were likewise observed in April, May and July. Matured samples were further observed in October and December. Most of the samples were however observed in April which indicates that summer is the potential spawning season of this species.

The male and female catch maturity per month of short bodied mackerel. It shows that MI and FI Short bodied mackerel are the most dominant through out the sampling period followed by MII and MIII. Matured Male (MIV, MV) and Female (FIV, FV) Short bodied mackerel are observed to be significantly few. However, FV and MV are observed to be abundant in July (14n) and April (7n) respectively.

Based from the practical determination of samples through the GSI limit of 4, it was observed that majority of the male and female of this species appeared immature through- out the pilot project period with a minimal number of matured female appearing in April and May as well as in December. May, October and December is the appearance of insignificant number of male species.

The figures above both show that most of the catch during the entire sampling period were sexually immature with the majority appearing in the months of July to September. Significant number of sexually matured Short bodied mackerel was observed during the summer months and also in the last quarter which further validates related above figure that these times of the year are their spawning period.

For nemipterids species in Calbayog city showed that its longest average length appeared in August with 179mm and its shortest average length in May (174mm). With regards to average GSI, December showed the peak with 1.91 followed by September and October with 1.89 and 1.90 respectively. Similar months obviously showed the same trend with regards to average gonad weight.

The majority of the samples gathered were immature (stages I- III). Significant percentage of fully matured samples was observed throughout the sampling period with December showing the highest followed by October and July, September and November.

Lessons Learned

- Affect in some of fishermen in the short term?
- Discuss what Juvenile and Trashfish Excluder Devices (JTEDs) design has the highest releasing efficiency?

Future Plans

- Demonstration and pilot trials of Suripera
- Policy formulation on the use of Juvenile and Trashfish Excluder Devices (JTEDs) in commercial and small-scale trawl fisheries
- Consultations with various stakeholders affected by the policy

- Presentation and justification of the policy to the National Fisheries and Aquatic Resource Management Council (NFARMC) for approval
- Assessment, review and evaluation on the implementation of the policy
- Support to local government units for the management of coastal fisheries resources through responsible fishing operations and practices

References

Chokesanguan, B, S. Ananpongsuk, S. Siriraksohpon and L. Podapol. 2000. Study on Juvenile and Trash Fish Excluder Devices (JTEDs) in Thailand. SEAFDEC-TD/RES/47.

Chokesanguan, B, S. Ananpongsuk, S. Siriraksohpon and I. Abdul Hamid. 2001. Study on Juvenile and Trash Fish Excluder Devices (JTEDs) in v Darussalam. SEAFDEC-TD/RES/47.

Chokesanguan, B, S. Ananpongsuk, S. Siriraksohpon, W. Wanchana and N. Long. 2002. Study on Juvenile and Trash Fish Excluder Devices (JTEDs) in Vietnam. SEAFDEC-TD/RES/.

Chokesanguan, B, S. Ananpongsuk, *et al*. 2002. Study on Juvenile and Trash Fish Excluder Devices (JTEDs) in Malaysia. SEAFDEC-TD/RES/.

Chokesanguan, B, S. Ananpongsuk, I. Chanrachakij, N. Manajit and G. Tampubolon. 2002. Study on Juvenile and Trash Fish Excluder Devices (JTEDs) in Indonesia. SEAFDEC-TD/RES/.

Del Mundo, C., Agasen, E., and Ricablanca, T. 1990. The Marine Shrimp Resources of Luzon. The Philippine Journal of Fisheries, Vol. 21, pp. 45–66.

Dickson, J., R. Ramiscal, B. Magno, N. Lamarca, M. Chiuco and A. Santiago III. 1997 (unpublished). Experiments on Turtle Excluding Devices (TEDs). BFAR, Quezon City.

Ingles, J., and Aprieto, V. 1983. A contribution to the Biology of Penaeid Shrimps in the Visayan Sea. Fish. Res. J. Philipp. Vol.8, No.2 pp. 19–31.

Meemeskul, Y. 1988. Effects of a Partial Increase of Mesh Size in the Multispecies and Multifleet Demersal Fisheries in the Gulf of Thailand. FAO Fisheries Report 389.

Pope, J.A., *et.al*. 1969. Manual of Methods for Fish Stock Assessment. FAO Fish. Tech. Paper No. 41. p.4

Ramiscal, R., B. Magno, M. Chiuco and A. Santiago III. 1996 (unpublished). Shrimp Selectivity Study using Separator Panel in Manila Bay. BFAR, Quezon City.

Seidel, W.R. 1975. A shrimp separator trawl for the southeast fisheries. Proc. Gulf Caribb. Fish. Inst., 27:66–76.

Sinoda, M., S.M. Tan, Y. Watanabe and Y. Meemeskul. 1979. A method for estimating the best cod end mesh size in the South China Sea area. Bull. Choshi. Mar. Lab. 11:65–80.

Tokai, T. 1997. Methodology of Evaluating Selectivity Performance – Two Selective Process of Trawl Sorting Devices: Fish Encountering and being Sieved. Paper presented to Regional Workshop on Responsible Fishing, SEAFDEC, Thailand, p.242–249.

Wardle, C.S. 1983. Fish reactions toward fishing gears, experimental biology at sea. A G Macdonald and C G Priede (eds). London, Academic Press, 167–95 pp.

Thailand

Bundit CHOKESANGUAN, Southeast Asian Fisheries Development Center/ Training Department (SEAFDEC/TD),Post Box 97, Phrasamut-chedi, Samut-prakan, 10290, Thailand [Tel:+66 2 4256120, fax:+66 2 4256110–11, e-mail: *bundit@seafdec.org*]

Abstract

The promotion and experimental fishing trials on the escapement of juveniles and trash fish from the trawl fishing gear using JTEDs in Southeast Asian waters was implemented in the national waters off Brunei Darussalam, Cambodia, Indonesia, Malaysia, the Philippines, Thailand, Vietnam and Myanmar. In order to continually build up the resource user's awareness, there were some workshop/seminar/training courses conduction, and information dissemination to the public through websites,VCD and publications. There were two main types of technical evaluation of JTEDs demonstration and promotion were carried out; 1) the scientific data collection, the result and its interpretation was used for further modification of the divide. 2) The awareness and capacity building evaluation by using questionnaires and dockside interview. Base on situation and lesson learned from the past, there are some future plans to emphasize in research, development and promotion on the use of selective fishing gears and devices for reduced discards and bycatch of juvenile and trash in the region.

Introduction

The people in the Southeast Asian Region have greatly and historically depended on the fish in their diet. Therefore, fisheries can not be replaced by an alternate system to secure protein in food including livestock products. In this connection, the fisheries sector as a whole has been developed into a traditional and complex system compared with any other part of the world except the Far East. The Southeast Asia Countries are located in the tropical zone, fisheries resources are of comparatively multi-species composition especially in demersal stocks. In addition, dominant species do not compose the majority of catch, as in the fisheries in the Temperate Zone (dominant species compose 70–80% of the catch in the Temperate Zone; those of tropical fisheries compose 20–30% of the catch.). It has been recognized that there are big amount of bycatch are discarded from commercial fisheries especially shrimp and fish trawling which due to the poor selectivity of the fine-meshed nets. Moreover, the incidental catch of juvenile and trash fish is acknowledged as an important adjunct to fisheries management. Recently, this aspect has developed to a major issue in fisheries management, attributed to an increasing demand for fisheries resources and a growing recognition of the need to ensure that fisheries are conducted in a sustainable manner.

Methods

In the development of sustainable fisheries, reducing the incidental catch of juvenile and trash fish is a key priority. In responsible to this, the Training Department (TD) of the Southeast Asian Fisheries Development Center (SEAFDEC) initiated research in 1998 to provide a technical foundation for the development and adoption of Juvenile and Trash Excluder Devices (JTEDs) in regional trawl fisheries. The promotion and experimental fishing trials on the escapement of juveniles and trash fish from the

trawl fishing gear using JTEDs in Southeast Asian waters was implemented in the national waters off Brunei Darussalam, Cambodia, Indonesia, Malaysia, the Philippines, Thailand, Vietnam and Myanmar. Moreover, in order to continually build up the resource user's awareness, there were some workshop/seminar/training courses conduction, and information dissemination to the public through web-sites and the local people in each countries through VCD and publications such as poster, booklets, cartoon books, stickers, etc and TD have been provided information through the web-site.

There were two main types of technical evaluation of JTEDs were carried out:

- The scientific data collection, each time of the experiment in each mentioned country names, various kinds of JTEDs in different design and size of the grid interval were used in the experiments in order to make the comparison on their effective performance in maximizing the juvenile escapement while minimizing the loss of the commercial or the target catch. Base on the results analysis and the interpretation of the collected data from each fishing ground and each country, the best performance from the research was used for further modification for the better performance.
- The awareness and capacity building evaluation by using questionnaires and dockside interview. The evaluation process was carried out in each area/country.

Results of the implementation and promotion on the use of JTEDs in Southeast Asia

Brunei Darussalam, JTED was introduced and experiment in 2000 and 2002. The 51 mm square-mesh experiment gives better result than the rigid sorting grid type in term of releasing the unwanted portion of the catch in this country.

Cambodia, in 2004, the Department of Fisheries had closed cooperation with SEAFDEC/TD for training at Sihanouk Ville. The training was focused on the theory on the used of JTEDs and practice on installation of JTEDs devices.

Indonesia: JTEDs promotion and demonstration were carried out many times in Indonesia. They have found that the JTED Semi-curve rigid sorting grid with 1.5 cm of grid interval is most applicable for the fish trawl in their country. And Indonesia will focus on the technology modification of JTEDs construction, mesh figure (diamond or square).

Malaysia: The experiment was conducted at Kedah water to compare the effectiveness of fishermen net The results found that the 38 mm at cod-end can be improve the selectivity of gear and not reduce the rate of commercial catch.

Myanmar: The JTEDs can be applied to use for both fish and shrimp trawls, specially the window type JTED with 1 cm of bar spacing. But most of the fishermen do not want to loss their profit. So that they still do not use it in their trawls.

The Philippines: Training/demonstrations and sea trials of JTEDs were done in the major trawling ground of the country: Manila Bay, San Miguel bay, Lingayen Gulf, Visayan Sea and Maqueda bay/ Samar Sea. The JTED pilot project was proposed to the local government unit of Calbayog City to complement the ongoing Coastal Zoning Program in which locally based commercial fishing boats including trawlers were allocated to operate a specific area. Not only seminar, experiments to find the most applicable design of the device but the activities and promotion of by catch reduction technologies were also broadcast through the local radio station in Daet, Camarines Norte.

Thailand: JTEDs experiments and promotions in the Gulf of Thailand water. The experiments and the promotions led to the identification of the Rigid Sorting Grid Devices as an effective tool in order to release the juvenile and trash from the trawl fishing. The technical report and techniques were transferred to DOF however it also depends on the national policy in order to further continue the JTEDs promotion in Thailand.

Vietnam: The experiment of JTEDs on shrimp trawler was carried out in the Gulf of Tonkin. Vietnam continues to do the research and experiments by using square mesh of 20,25,30,35 and 40 mm and iron frame for comparison. The result found that the square mesh with 20 mm give the best performance on gear selectivity specially for squid, lizard fish and cuttlefish and economic advantage while Iron frame with 12 and 20 mm is suitable for croaker and lizard fish group.

Lesson learned

Designs and Experiments

- Existing types and designs of JTEDs are not appropriate / applicable in some geo-graphical areas and species composition that require some adaptation/modification.
- High cost of JTEDs (Sorting Grids) particularly in small-scale trawl fisheries and it needs further research on more viable designs/type of JTEDs.
- Insufficient government support in research and development on the devices.

Fishers' perceptions/attitudes/concerns on adoption of JTEDs

- High demand for trash fish such as for feeds for aquaculture.
- Inconvenient operation of the gear equipped with the devices i.e. net hauling.
- Reduction of total catch which it may be due to the design and fishing method of JTEDs use in some areas.
- Higher cost of operation for the fuel oil use during towing.

Awareness Building and Extension Activities

- Limited awareness building and capacity building activities for fishers to support the implementation.
- Convincing power of the studies/experiments' results to fishers – this may be due to the manner that fishers are involved in the conduct of such studies/experiments.

Promotion and Adoption Strategies

- Linkages between JTEDs and management in several countries.
- Enabling environment/incentives for adoption of such devices by fishers.
- Clear evidence on the escapement of fish as it's can sustain the resources.

Future Plans

Base on situation and lesson learned from the past, there are some future plans to emphasized in research, development and promotion on the use of selective fishing gears and devices for reduced discards and bycatch of juvenile and trash in the region including.

- Promotion on the use of selective fishing gears and selective devices as well as Awareness/capacity building in some selected areas should be continued. Two main target groups need to be focused – fishers for their understanding, cooperation and compliance, and policy-makers for understanding on linkages with broader management and supports. The information dissemination can be done by workshop, exhibition, publication and multi media.
- Research and study of the assessment of impacts of various kinds of fishing gear and practice on fisheries resources, sea beds, environment and ecosystem through impacts of light fishing on fisheries resources in Southeast Asia and impacts of bottom trawl net, dredges, traps and other need to be continued study. Further more the exited device as JTEDs need further adaptation for better efficiency performance and lesser cost of towing operation.
- Interaction between threatened species of international concern and fisheries and participation of international meetings for information exchange on interaction of endangered species and fisheries is one of activities in this project.

The promotion of responsible trawl fishing practices in Southeast Asia through the introduction of Juvenile and Trash Excluder Devices (JTEDs)

Abstract

The demonstrations and experiments on the use of JTEDs were conducted in Thailand, Brunei Darussalam, Vietnam, Malaysia, the Philippines, Indonesia and Myanmar. Aside from the main aim on the introduction of the devices to member countries, the research was also carried out to develop adjust and modify for the best performance of the Juvenile and Trash Excluder Devices (JTEDs). Various kinds of JTEDs were used in the experiment; there are Rigid Sorting Grid, Rectangular shaped window and Semi-curved window with different grid intervals for each device. The results show that each type and design of JTEDs gave different performance on escapement rate of juvenile and commercial catch. The escapement rates ranged from 56.69–77% for juveniles and 9.72–47.31% for the commercial or target catch. Furthermore the estimated selection curve of fish length was also considered. Based on this experiment the Rigid Sorting Grid with 1.2 and 2 cm grid intervals gave better performance than other devices in maximizing the juvenile escapement while minimizing the loss of commercial or target catch. The mean total length (TL) paralleled to the size of the grid interval. It is recommended that the Rigid Sorting Grid with 1.2 and 2 cm grid intervals is appropriate to recommend to the region. However, other importance factors such as the fishing ground, kind and size of target catch in each country have to be well considered.

Keywords: escapement, juvenile devices, JTEDs, performance, rectangular window, rigid sorting grid, selection, semi-curved window, Southeast Asia, trawl.

Introduction

The incidental catch of juvenile and trash fish is acknowledged as an important adjunct to fisheries management. Recently, this aspect has developed to a major issue in fisheries management, attributed to an increasing demand for fisheries resources and a growing recognition of the need to ensure that fisheries are conducted in a sustainable manner. Once considered mostly as a nuisance, the catch of juvenile and trash

fish are now recognized as having a detrimental impact on the fecundity of fisheries systems. Similarly, the economic value of the catch of juveniles of commercially important species are now viewed as being considerably lower than those for the same species at sizes more suited for the market.

In the development of sustainable fisheries, reducing the incidental catch of juvenile and trash fish is a key priority. In response to this, the Training Department (TD) of the Southeast Asian Fisheries Development Center (SEAFDEC) initiated research in 1998 to provide a technical foundation for the development and adoption of Juvenile and Trash Excluder Devices (JTEDs) in regional trawl fisheries.

At first, two JTED types were developed for installation into the upper part of the cod-end. One device used a rectangular shaped window, whilst the other a semi-curved window. The frames of both were constructed using stainless steel frames of 80 by 100cm, with "soft" vertical separator gratings made of 8 mm. polyethylene rope.

The general effectiveness of those JTED types was tested during at-sea fishing trials and demonstrations. Those designs have since been modified in response to more detailed testing on their efficacy influenced by various factors including the separator spacing, "soft" versus "hard" separator gratings, and the use of square mesh in the cod-end as opposed to diamond mesh. Investigations were conducted on the effect of trawl towing speed, catch loading and hydrodynamic drag on deformation of trawl netting and the ultimate performance of JTEDs, Those tests provided TD researchers with an insight on the operational considerations required to maximize the exclusion of juvenile and trash fish from the trawl fishing gear.

Since 1998, TD has completed numerous experimental fishing trials on the escapement of juveniles and trash fish from the trawl fishing gear using JTEDs in Southeast Asian waters. Work has been completed in the national waters off Brunei Darussalam, Indonesia, Malaysia, the Philippines, Thailand, Vietnam and Myanmar.

Materials and methods

Study areas: Experiments were carried out in the Prachub Kirikan and Chumporn provinces in the Gulf of Thailand, the Northern part of Brunei Darussalam, the gulf of Tonkin in Vietnam, off Alor Setar in Malaysia, Arafura Sea in Indonesia, Manila Bay in the Philippines and Thandwe town Myanmar.

Types and Designs of JTEDs: The experiments on the performance of JTEDs was conducted in different countries using different type and design in each study sites, Once the experiments were done, the adjustment and modification of JTEDs designs will be made in order to maximizing the juvenile escapement while minimizing the escape of commercial or target catch. The usual grid separator system consists of grids, a fish outlet and a funnel which guides fish and shrimp against the grid, (Tokai T at al., 1996). The types of JTEDs experimented in each country are: Thailand- Rectangular shaped window with four grid intervals of 8, 12, 16, and 24 cm, Semi-curved window with 4, 6 and 8 cm grid intervals. Brunei Darussalam- Rigid Sorting Grid with 1, 2 and 3 cm grid intervals, Semi-curved window and Rectangular shaped window with 1 cm grid interval. Vietnam- Rigid Sorting Grid with 2, 3 and 4 cm grid intervals. Malaysia- Rigid Sorting Grid with 1.2 and 2 cm grid intervals. Indonesia- Rigid Sorting Grid, Rectangular shaped window and Semi-curved window with 4 cm grid interval for all types. The Philippines- Rigid Sorting Grid with 1, 2 and 3 cm grid interval, Rectangular shaped window and Semi-curved with both 1 cm grid interval.

Myanmar- Rigid Sorting Grid with 1, 2 and 3 cm grid intervals, Semi-curved window and Rectangular shaped window with 1 cm grid interval.

Fishing operation

Each type and design of JTEDs was installed individually on fish trawler. The cover net was used to collect samples of the catch escapement. Fishing operations were scheduled and carried out during both day and night times with an hour of towing, each size of grid interval designs was tested for 5–9 times in fishing operation.

The catch categorization

The catch of each haul from both cod-end and cover net was sorted mainly into 2 main groups; commercial or target catch and juvenile including trash groups. The samples taken randomly from each group were determined for their individual weighed total length (TL) and body width (BW) in cm. The catch of each group was also weighed for calculation of CPUE and percentage of escapement rate.

Data Analysis

Rate of escapement: In order to consider the most appropriate performance of JTEDs, the important factors which need to be considered are the rate of escapement of juveniles including trash fish and the commercial catch. The purpose of the device is to maximize the catch of juvenile and trash fish while minimize the rate of escapement for the commercial and target group:

The rate of escapement was calculated by using the following equation:

$$E = (W_{cn}/(W_{cn}+W_{ce}))*100$$

Where E = Escapement rate by weight in %

W_{cn} = Catch in cover net (gm)

W_{ce} = Catch in cod-end (gm)

Selectivity

The estimate of trawl net selectivity curve was determined using a linear model. This method is the most commonly used by comparing the length compositions of the fish remaining in the cod-end and in the cover net, the probability of escape through the large mesh net can be estimated, (Pope *et al.*,1975, Jones, 1976, Kimura, 1977 and Mastawee and Theparoonrat, 2002) .

Linear model:

Trawl selection curve was approximated by the following equation.

$$S=1/\{1+\exp(a+b*l\} \quad (2)$$

Where, l is the total length of the fish and a and b are constants.

The log equation is linearizes the relationship.

$$Ln(1/S-1)=a+b*\int$$

In this model, the parameter is estimated by minimizing the following

$$\sum_{i=1}^{n}[\ln\{(1/S)-1\}-(a+b*l]^2$$

From equation 4, the regression coefficient "b" is obtained as.

$$b= \sum [(l-\bar{l})(Y-\bar{Y})]/ \sum(l-\bar{l})^2$$

Where y = ln[(1/S)-1], and y is average. The intercept "a" is calculated by the following equation.

$$a= \bar{y}-b\bar{l}$$

Results and discussion

1) CPUE comparison

The CPUE among different countries ranged from 8.45 to 283.27 kg/hr. The results show that the CPUE from Brunei Darussalam, Indonesia, Myanmar, Malaysia, Thailand, Philippines, and Vietnam was 283.27, 99.75, 86.03, 35.81, 21.2, 14.7, and 8.45 kg/hr respectively. The highest one was found in Brunei Darussalam, which indicates that the fisheries resources at the experiment site in Brunei Darussalam are still very rich compared to sites in other countries.

2) Rate of escapement

The relative mean escapement rates according to JTEDs types from each study sites are shown in Figures 1–7.

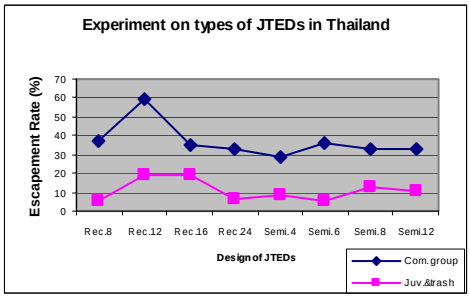


Figure 1. Mean escapement rate, Thailand.

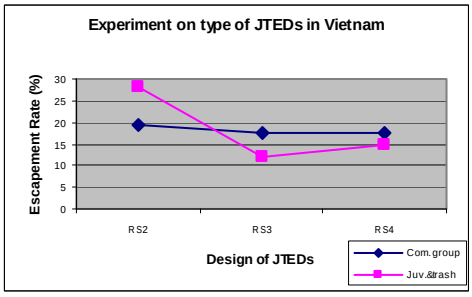


Figure 2. Mean escapement rate, Vietnam.

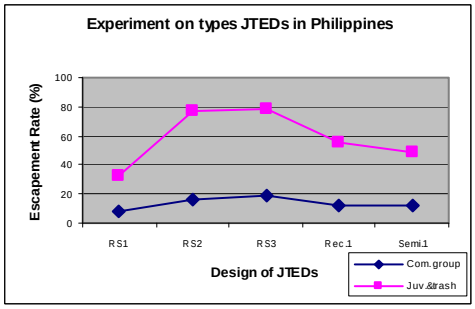


Figure 3. Mean escapement rate, Philippines.

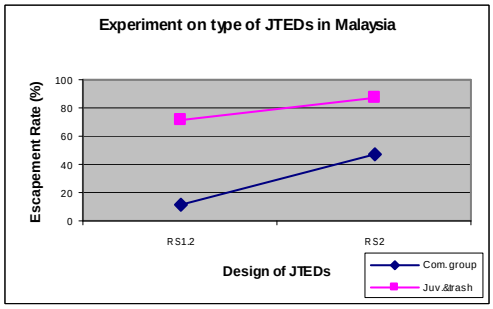


Figure 4. Mean escapement rate, Malaysia.

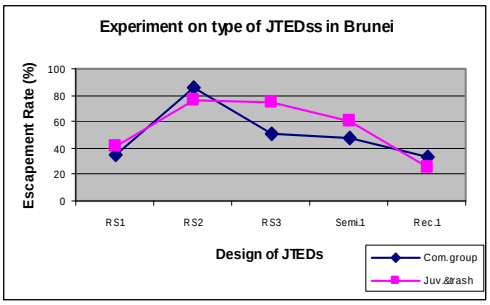


Figure 5. Mean escapement rate, Brunei.

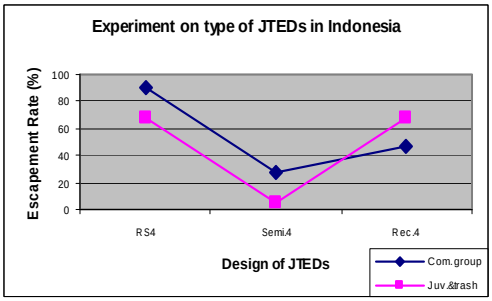


Figure 6. Mean escapement rate, Indonesia.

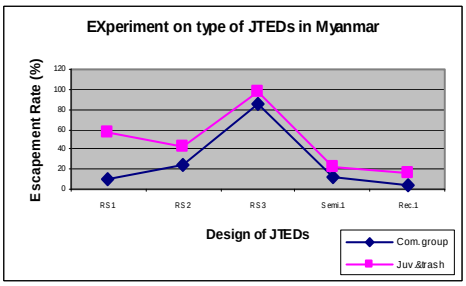


Figure 7. Mean escapement rate, Myanmar.

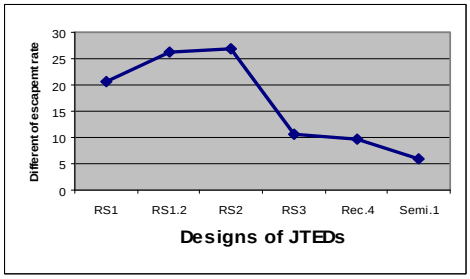


Figure 8. Escapement rates among various devices.

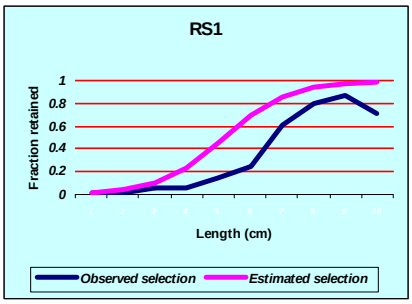
The rate of escapement calculated by weight of escaped animals from different type of JTEDs and different size of grid interval, the appropriate device should release as much as possible the juvenile and trash fish while reduce the escapement of the target catch. The results show that the value between both groups ranged from 13.78 to 61%. The highest one was obtained by using the rigid sorting grid type with 2 and 1.2 cm grid intervals while the lowest values were observed by using the rigid sorting grid with 3 cm grid interval, the rectangular shaped window and the semi-curved window type with 1 cm grid interval (Figure 8). Based on this study, it can be concluded that the better performance on type and design of JTEDs was the rigid sorting grid with 2 and 1.2 cm. grid intervals. However, others factors and conditions also have to be considered in recommending this type and designs of JTEDs to the fishermen.

Table1. Comparison of the escapement rate between juveniles and commercial target groups each superscripted number on the first raw indicate type of device used as denoted below.

	RS1[2]	RS1.2[3]	RS2[4]	RS3[5]	Rec1[6]	Semi1[7]
Escapement rate of juvenile (%)	56.69	71	77	74.31	68.52	61.09
Escapement rate of commercial group (%)	9.72	11	16	50.33	46.75	47.31
Different value of escapement rate between juvenile and commercial target catch	46.97	60	61	23.98	21.77	13.78
In percentage of different value of escapement rate between juvenile and commercial target catch	20.64	26.37	26.80	10.54	9.57	6.06

3) Selectivity by Rigid Sorting Grid JTEDs

Based on escapement rate of the juvenile and commercial/target catch groups including fish, shrimp and squids, the Rigid Sorting Grid with grid intervals of 2, 1.2 and 1 cm performs distinctively better than other types (Figure 8). The probability on size of the catch which could escape at each grid interval is compared by the observed and estimated selection curves. Due to *Leiognathus equarus* was found in all experiment sets the fraction retained for *Leiognathus equarus* is plotted against the total length in the selection curve for the Rigid Sorting Grid with 1, 2 and 3 cm grid intervals. The results show that the L50% of those designs are 6.75 cm, 12.5 cm and 13.2 cm, the L75% are 7.79 cm, 15.01 cm and 16.40 cm respectively (Figures 9–11).



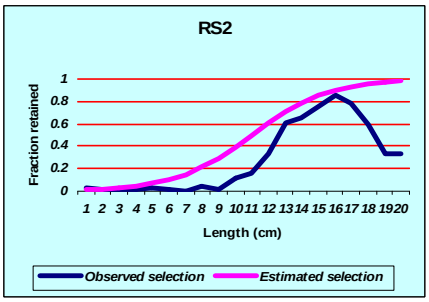


Figure 9. Selection curve by Rigid Sorting8 **Figure 10. Selection curve by Rigid Sorting9**

[2] Rigid Sorting Grid with 1 cm grid interval
[3] Rigid Sorting Grid with 1.2 cm grid interval
[4] Rigid Sorting Grid with 2 cm grid interval
[5] Rigid Sorting Grid with 3 cm grid interval
[6] Rectangular shaped window with 1 cm grid interval
[7] Semi-curved window with 1 cm grid interval
[8] Sorting grid with 1cm
[9] Sorting grid with 2cm

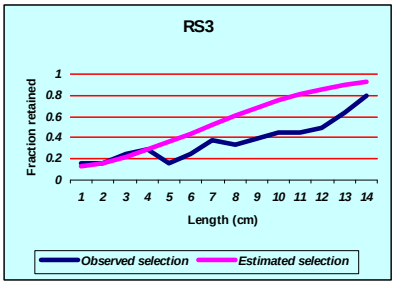


Figure 11. Selection curve by Rigid Sorting.

The mean value of the fish size able to escape from the Rigid Sorting Grid JTEDs with 1, 2 and 3 cm grid interval is 5.36, 7.9 and 14.73 cm respectively. The mean value of total fish length increases with increasing size of grid interval. However, as this region is located in the tropical zone with high species diversity, (Sparre P. *et al.*, 1989), the grid interval of JTEDs should be well designed suitable for the average size of target fish in each country.

Conclusions and recommendations

Based on the results of this experiment, Rigid Sorting Grid JTEDs with 1.2 and 2 cm grid interval has better performance in maximizing the escapement rate of the juvenile while minimizing the escapement rate of the commercial or target catch. The size of fish which escaped from the devices depends on the size of the grid interval. In this tropical region with high species diversity the fishermen are used to fish multi-target species with varying commercial size. Considering those factors it's complicated in selecting the best size of the grid interval.

The experiment was carried out in many countries to demonstrate and introduce this device in the region. Although suitable design and size of the grid interval are recommenced to continuing modification should be considered with relevance up to date fishery information in each country. More importantly, fishers should be informed and make to understand the experimental results, and encourage them to change their attitude for improved fishing operation. With achieved level of selectivity the fishers can benefit from the sustainable marine resources.

References

Chokesanguan, B., Ananpongsuk, S., Siriraksophon, S., and Podapol, L. 2004. Study on Juvenile and Trash Excluder Devices in Thailand, SEAFDEC/Training Department, pp. 1–18.

Chokesanguan, B., Ananpongsuk, S., Siriraksophon, S., and Abdul I. Hamid, 2004. Study on Juvenile and Trash Excluder Devices in Brunei Darussalum, SEAFDEC/Training Department, pp. 1–15.

Chokesanguan, B., Ananpongsuk, S., Siriraksophon, S. Wanchana, W., and Long, N. 2004. Study on Juvenile and Trash Excluder Devices in Vietnam. SEAFDEC/Training Department, pp. 1–20.

Chokesanguan, B., Ananpongsuk, S., Siriraksophon, S., and Rosidi, R. 2004. Study on Juvenile and Trash Excluder Devices in Malaysia, SEAFDEC/Training Department, pp. 1–31.

Chokesanguan, B., Ananpongsuk, S., Chanrachakij, I., Manajit, N., and Tumpubolon, G. 2004. Study on Juvenile and Trash Excluder Devices in Indonesia. SEAFDEC/Training Department, pp. 1–18.

Chokesanguan, B., Ananpongsuk, S., Siriraksophon, S., and Dickson, J. 2004. Study on Juvenile and Trash Excluder Devices in the Philippines. SEAFDEC/Training Department, pp. 1–12.

Jones, R. 1976. Mesh regulation in the demersal fisheries of the South China Sea areas, Manila, South China Sea Fisheries Development and Coordinating Program. SCS/76/WP/34:75 p.

Kimura, D.K. 1977. Logistic model for estimating selection ogives from catches of cod-end whose ogives overlap, J. Cons. CIEM, 38(1):116–9.

Pope, J.A., *et al.* 1975. Manual of methods for fish stock assessment. Pt3. Selectivity of fishing gear, FAO Fish. Tech. Pap., (41) Rev.1:65 p.

Mastawee, P., and Theparoonrat, Y. 2002. Trawl Net Mesh Selectivity for Lizardfish (*Saurida elongate*) and Blackspotted Trevelly (*Caranx leptolepis*) Using Square and Diamond Mesh Cod-end, Thai Fisheries Gazette, Vol.55.P.457–465.

Sparre, P., Ursin, E., and Venema, S.C. 1989. Introduction to tropical fish stock assessment, Part 1-Manual, FAO Fish. Tech., 306:1, 337p.

Tokai T, Omoto S., Satou, R., and Matuda, K. 1996. A method of determining selectivity curve of separation grid. Fish. Res., 27:51–60.

Indonesia

Prof. Dr. Ir Ari Pubayanto, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, Bogor

Brief background of the national (shrimp) trawl fisheries

1) Shrimp trawl fisheries were firstly introduced in Indonesia in 1970's by foreign investment industry (PMA) and had improved increasingly.

2) By the year of 1980, the government banned the use of trawl through residential Decree No. 39/1980.

3) Through Presidential Decree No. 85/1982 concerning with operational of shrimp trawler, the government of Indonesia has permitted the use of shrimp trawl to operate in certain area, limit in amount of fleets and obligated to install a TED on the net.

Fleet number and distribution

1) The shrimp trawl is licensed to operate in 1300 East to eastern around the adjacent waters of Kei, Tanimbar and Aru Island.

2) Some kinds of fishing gears (trawl like, but not trawls) are licensed to be operated by the small scale fishermen in all over Indonesia waters.

3) Fleet number of shrimp trawlers (large scale) that have been licensed approximately 200 units.

4) The small scale shrimp trawlers that have been licensed (by local government) are approximately 50,980 units. Commonly, they are named locally by fishermen themselves as shown in the Table 1.

Table 1 Types of trawl that are existing in Indonesia.

No	Name	No	Name
1	Pukek Osoh (Padang)	12	Krakat (Java Sea)
2	Pukat Ular (Sibolga)	13	Mini Beam Trawl (Java Sea)
3	Pukat Apolo (Mallacca strait)	14	Arad (Java Sea)
4	Pukat laying (Mallacca strait)	15	Arad berpalang/ berpapan (Java Sea)
5	Dogol (Mallacca strait)	16	Mini Trawl (Maccassar Strait)
6	Dogol berpalang/berpapan (Java Sea)	17	Andu (Java Sea/ DKI)
7	Cantrang berpalang/ berpapan	18	Lampara (Seram, Tomini, Sulawesi)
8	Lampara dasar berpapan/ berpalang (Java Sea)	19	Lampara dasar (Sibolga, Belawan, Makassar)
9	Cotok (Java Sea)	20	Jaring WCW (Java Sea)
10	Garuk kerang (Java Sea)	21	Katrol/ Rengreng (Makassar Strait)
11	Payang Alit (Java Sea/ East Java)	22	Paddenreng (Makassar Strait)

Goals/objectives of project implementation in Indonesia

1) Referring to nowadays fishermen's are willing to review the possibility of re-operating trawl in Indonesia waters;

2) It is necessary to assess the socio-economic and environmental impact of the fisheries to the fishermen;

3) Through the FAO-GEF Project, the government of Indonesia expect to get some goals/objectives such as:

   a) To assess the existing condition of fish resources and their habitat

   b) To assess the existing types of fishing gears used for catching the demersal fisheries/shrimp

   c) Redesign the existing BRDs to make it appropriate with the Indonesian waters and type of fishing gears (trawls)

   d) To review the existing legislation for regulating the shrimp trawl management in Indonesia

Strategies and activities undertaken since the start of implementation

1) Conducting regular meetings with the stakeholders (industries sector, scientists, NGO/ fishermen) to formulate the grand strategies for solving the shrimp trawl problem in Indonesia waters

2) Defining the national steering committee of the project to work more closely, hand in hand each other

3) Involving the regional/ international issues concerning the shrimp trawl matters

4) Preparing the national work plans for the shrimp trawl issues, that consist of:

   a) Problem identification concerning bycatch

   b) Stakeholder meetings

   c) Field surveys

d) Base line study of BRD

e) Development / adaptation of BRD technologies (optimisation and experimental trial)

f) Meeting, workshop

g) Field demonstration of new technologies

h) Research and engineering the Appropriate BRDs

i) Reviewing and enhancing Bycatch Reduction and Change Management of Trawl Fisheries through Comprehensive Regulations

j) Introduction of appropriate BRDs technology to shrimp fishing fleets

k) Dissemination of result

l) Legalizing for BRD standardization

m) Project evaluation

Members of the National Steering Committee

HPPI: Shrimp Fishing Industry Association

ASPINTU: Non-Tuna Industry Association

BRPL: Marine Fisheries Research Body

BBPPI: Fishing Technology Development Center

IPB: Bogor Agriculture Institute

STP: Jakarta Fisheries Institute

Table 2. Result and major technical achievements.

No	Activity/ Types of BRDs tested	Time	Devices tested
1	Introduction (demonstration and training on TED/JTED) in Sorong, Papua Province	26 August, – 6 September 2002	1. TED: super shooter and bent pipe 2. JTED: semi-curve window, rigid sorting grid and rectangular windows
2	Introduction (demonstration and training on TED/JTED) in Ambon, Maluku Province	20–25 October, 2003	1. TED: super shooter, Bent Pipe, 2. JTED: Semi Curve Window, Rectangular Shape window and Rigid Sorting Grid
3	Introduction (demonstration and training on TED/JTED) in Sibolga, North Sumatra Province	4–9 October, 2004	JTEDs: Rectangular shape, Circular shape, Rigid sorting grid and Semi – curve Rigid sorting grid (1 cm, 2.5 cm, 4 cm)

No	Activity/ Types of BRDs tested	Time	Devices tested
4	Introduction (demonstration and training on TED/JTED) in Tual, Souteast Maluku Province	13–21 June, 2004	1. TEDs: Super Shooter, Bent Pipe and TTFD (Thai Turtle Free Device) 2. JTEDs: Rigid Sorting Grid, Rectangular Shape Window and Semi Curve Window
5	Symposium On Present Status of Trawl In Indonesian Waters in Jakarta	25–27 April, 2005	Base line study of BRD
6	Introduction (demonstration and training on TED/JTED) in Merauke, Papua Province	28 November, 4 December, 2005	1. TED: Bent pipe 2. JTED: Semi-curve rigid sorting grid (1 cm; 1,5 cm, 2 cm and 3 cm)
7	Dissemination of Turtle Excluder Devices (TEDs) Installation on Shrimp Trawl Net in Indonesia "Promoting The Awareness of Commercial Shrimp Trawl Fisheries towards The Sustainability Fisheries"	1 March, 2006	Dissemination
8	Introduction of Turtle Excluder Devices/Ted (Super Shooter) on Small Scale Eco-friendly Trawl Net in Makassar Strait Areas	12–16 November 2006	TED Super Shooter Flat Bottom type (MV. Madina, 30 GT). TED Super Shooter Round Bottom type (MV. Karya Nelayan 2).
9	Preliminary Review of Legislative and Regulatory Frame Work in Relation to Bycatch Reduction in The Shrimp Trawl Fisheries in Indonesia	Desember 2006	Badia Sibuea Melda Kamil Ariadno

Table 3. Result and major technical achievements.

1	Translating Book Of "A Guide To Bycatch Reduction In Tropical Shrimp Trawl Fisheries" By Mr. Steve Eayrs	April – June, 2007	Eni Sutopo
2	Reviewing And Enhancing Bycatch Reduction And Change Management Of Trawl Fisheries In Indonesia Through Comprehensive Regulations	2007	FPIK IPB FH Univ. Indonesia (Prof. Daniel Monintja, team leader)
3	Research and Engineering the Appropriate BRD for Eco-riendly Trawl in Indonesia	2007	BBPPI Semarang FPIK IPB (Prof. Ari Purbayanto, team leader)

4	*Overall Expose "What and What Next":* Dissemination of Bycatch Reduction Devices (BRDs) and Change of Management for Trawl Fisheries in Indonesia	Jakarta, 18–19 March, 2008

CURRENT STATUS OF SHRIMP TRAWL FISHERIES IN INDONESIA

1) The increased of fuel price worldwide (also in Indonesia), has become a great challenges to survive for the industry;

2) Some measures are taken by the industry, i.e.:

   a) increase the effectiveness of technical trawl performance during the operation (use the smaller twine/ rope of net, enlarge the mesh size, etc to reduce the net resistance);

   b) increase the effectiveness of financial performance (maintain the valuable bycatch/ not discard them anymore, etc);

3) In the other side, the above-mentioned situation, positively bring a good atmosphere to have a closer dialogue between Industry and Government;

4) Therefore, the idea of comprehensively change management for trawl fisheries (as will be regulated through The Presidential or Ministerial Decree?; open/ close season, open/ close area, the use of TED/ BRDs, etc) are welcomed by the industry;

5) The idea to open the trawl license in right manner/ management (which was banned, especially for small scale fisheries, but in fact it was widely operated by fishermen) are welcomed;

6) The draft of new regulation introducing change manner/ management for trawl fisheries in Indonesia (comprehensively Presidential Decree on trawl management in Indonesian waters; open/ close season, open/ close area, the use of TED/ BRDs, etc) had been finished by the completion of Reviewing & Enhancing Project on 14 October 2007 to use the tested TEDs/ BRDs;

7) Further action are needed to finalize the implementation of the comprehensively change management for trawl regulation in Indonesia; socialization/ public hearing, implement the idea in a pilot project area, etc.

CONCLUSIONS

Mostly, goals of the project (as indicated in the achievable indicators) will be able to be achieved by the completion of the on-going project BRDs Research & Engineering), are:

1) By June 2008, a draft of new regulation to use the tested TEDs/ BRDs and change of management had been finished

2) (The draft of The Presidential Decree has been finished, 14 October, 2007)

3) Trial level, at least 20% reduction in discard in trials while maintaining the level of shrimp catch in 12 participating countries

4) (**13.36%,** during the fishing trial for BRDs Research and Engineering Project)

5) Socio-economic level, maintained level of net income of fishermen and industry after introducing the selected BRDs as impact of the socio-economic

6) (**No progress yet:** Pilot project for eco-friendly trawl management in Indonesia was pending)

7) On the-ground impact level, 50% of the vessels of industrial trawl shrimp fishery will introduce tested BRDs by June 2008 in Indonesia (on-process strategy: Renew the existing DG of Fisheries Decree on BRDs Construction as resulted by the Research & Engineering The Appropriate BRDs project)

8) At least 15% of the vessels of artisanal trawl fishery will introduce tested BRDs by June 2008 (No progress yet: Pilot Project for eco-friendly trawl management in Indonesia-pending)

9) Research and Engineering the Appropriate BRDs in the Indonesian Waters will be organized

10) (Has been conducted: fishing trial 29 November – 9 December, 2007)

11) Indonesia will have adopted the techniques developed and transferred by other countries at beginning of 2007 (comparative study to Australia-pending)

The consciousness on having a responsible trawl management in Indonesia waters has increased, as indicated during the latest workshop on trawl fisheries in Jakarta (Overall expose "what and what next":…, i.e.:

1) The draft of Presidential Decree on Trawl Management in Indonesia (presented by the Reviewing and Enhancing… Consultant) was agreed with minor suggestion to be taken for further action (legalizing);

2) The participants agreed with all management measures as drafted in the new regulatory for managing trawl fisheries in Indonesia;

3) The participants agreed to enlarge mesh size of cod-end become $\geq$ 50mm (for shrimp) and $\geq$ 120mm (for fish).

4) The participants agreed to obligate to install BRDs either for shrimp (TEDs) or fish (square mesh?).

RecommendationS (for REBYC Phase II)

1) A mechanism of information sharing between participating countries should have been prepared before end of project, either the project will be continued by the 2nd phase or not;

2) Before end of the project (June 2008), a new FAO-GEF Project commitment to follow up the project should be arranged. Since, each country seems to be not able to get 100% (in average less than 50%?) of achievable target as discussed at our last meeting in Philippine;

3) The new project should involve wider participating countries among each region (Asian, Western Africa, Gulf Region, Latin America and Caribbean). For instance: Malaysia, Singapore, Brunei, Vietnam, Laos, and other countries in Southeast Asia region. Since, fisheries resources are sometimes also utilized by some other countries (particularly in EEZ of each country, on which haven't been fully utilized by the shore country) also because of fishes are migratory species;

4) A wider stake holder (private sectors, researchers/ academicians, etc) also should be involved in the new project;

5) The new project should cover issues on the improvement of fishers' consciousness on fisheries resources, not only turtle conservation.

Iran

A. Mojahedi, Iranian Fisheries Organisation, Deputy for Fishing and Fishing Harbours, Tehran, Iran.

Abstract

National Research activities on Bycatch reduction started in 1992 at Persian Gulf Fisheries Research Center (Boushehr) and First BRD fabricated in the same year. After these initial measures, square mesh efficiency in Shrimp trawl net was investigated and 100 mm Square mesh window, showed improved results in excluding small fishes. Two years after obligatory use of SMW in shrimp trawl nets and achieving not ideal results, Iran Fisheries Organization in cooperation with FAO, launched new round of experiments in 1997. Different types of BRD's have been experimented during these trials, such as: RES, NAFTED, Fish eye and cone. Initial outcomes showed that NAFTED is efficient for excluding large aquatics. Broad range studies performed during years 2000–2001, on bar devices (NAFTED & Grid) and SMW comparison and results pointed out that Grid Type (NORDMOR Grid) is the most efficient one comparing with other devices. Regarding achieving results, during 2006, 100 Grid 8mm devices, have been fabricated and applied for Industrial trawlers.

Regarding this fact that, more than 90% of shrimp capture, harvested by artisanal fishing vessels fleet and graduation adjustment plan for Industrial trawlers which practically will reduce Industrial shrimp trawler numbers, therefore it is necessary to experiment and promote BRD's on artisanal vessels. Then the aim of the project based on excluding juvenile and small fish. All measures in project framework planned to achieve this goal. Net modification is the first option for excluding juvenile and small fishes, and further options could be most effective device which will be selected through experiments and advices we receive from international consultants.

Grid 80 Installation on Industrial Trawlers

Sessions and Decisions:

In total, 6 sessions have been held during this stage of project progress and different decisions have been taken.

- *Project's secretary session* held on Saturday, April14, 2007 to make decision for assembling steering committee and determine operational measures. Mr. Ali Mojahedi, Mr. Hussein Ostadmohammadi and Mr. Shahram Safiyary, attended this session and following decisions resulted:
  - i) Steering committee members determined and it is decided those committee sessions to be formed along with project progress.
  - ii) Technical committee members determined to hold a session and decide on project performance aspects and report outcomes to steering committee for approval
  - iii) Preparing a brief report on Project Background and achievements in pervious stages to Steering committee members
  - iv) Setting up Time and Cost tables
- *Two Technical Committee sessions (comprises experts from IFO and Local fisheries offices namely Boushehr, Hormozgan) held on April 23 and May 27, 2007 to make decision on Operation.*

Technical aspects with following outcomes:

- Performing trials by artisanal shrimp trawling vessels in Hormozgan and Boushehr provinces
- Grid 80 Installation training in active shrimp trawlers and surveillance during shrimp harvest season
- Following devices and modifications recommended to steering committee for trial completion:

Trawl net construction modification

- JTED
- Applying proper Grid according to artisanal vessels
- Trawl nets
- Net modification through bottom chain
- Applying Fish eye

Regarding this fact that net construction diversity is too much in two mentioned provinces artisanal vessels, most common net and Dhows, decided to report to the steering committee for further decisions.

- Artisanal vessels with engine power between 200–300 horse powers selected as most suitable group for trial performance.
- 3 amended nets, to be fabricated, based on technical committee proposed plan
- 5 JTED's to be fabricated, for each province Juvenile and small fish determined as main excluding target group.
- Three *steering committee sessions*, as the highest assembly for project's progress decision making, have been held on 25 June.
- 2007, 16 October, 2007 and 30 January, 2008 in Tehran, Bandarabbas and Qeshm Island respectively. following decisions have been finalized during these sessions and communicated for implementation:

  i) Final selection of two Dhows which introduced by technical committee

  ii) Final selection of the province which trials should be performed in its water

  iii) Review the results of Shrimp trial trawl accomplished by Ho mozgan province Dhows (results review, outcomes analyzing and discussing on Constraints and problems)

  iv) Regarding high discard level by fishing trawlers , it is decided that some project's capacities exploit for this issue , based on agreement with FAO

  v) Deciding on workshop holding time, International consultant capabilities and selection, after workshop trials

3rd Steering Committee session

Performed Measures

During 6 months from July to December 2007, different measures have been taken in different fields, but the main task was BRD trial by artisanal shrimp trawlers in Hormozgan waters. Below all measures are listed:

- Holding three training sessions for fishermen in Hormozgan and Boushehr provinces.
- Producing Extensional program to broadcast from local media.
- Distribution and Installation of Grid 80 device on 11 Industrial trawl vessels. These devices fabricated in 2006 and distributed for shrimp harvest season in Hormozgan and Boushehr. A team consists of 6 experts during shrimp harvest season were onboard for Installation, Training and supervision purposes.
- BRD fabrication and Net making – 6 trawl nets (3 for Boushehr vessels and 3 for Hormozgan vessels) and 10 JTED's (5 for Hormozgan vessels and 5 for Boushehr vessels). It is notable that all primary works had been done to perform experiments in Boushehr, but due to delay in fund release approval for vessels contract, the trials program shifted to Hormozgan province vessels. Fabricated devices could be utilized for shrimp harvest season 2008.
- Purchasing essential needs for project progress such as: Laptop computers, Scales, Biometry devices, personal needs for onboard personnel.
- Producing a documentary movie from all trials step in English.
- Producing an Extensional movie to introduce BRD's and to increase rate of acceptance in Farsi language.
- Printing Promotional items specifically: Posters, Banners, and Stands.
- for BRD promotion in fishing harbours and fishing vessels.
- Forming teams consist of experienced experts to execute trials properly.
- Holding frequent sessions for experts for experiments superior performance. *Most of mentioned steps have been done for trial execution by artisanal shrimp trawlers.*

Experiment implementation on Artisanal shrimp trawlers in Hormozgan province waters in a 29 days period. Regarding importance of this project step, it is described separately. This experiment, has been performed for the purpose of different Bycatch Reduction Devices comparison, in Artisanal trawlers, within Hormozgan province fishing grounds (contains: Sirak, Kuhestak, Dar Sorkh, Aab Shirin Kon, Keshti-e-Sukhte, Tula) during 29 days shrimp harvest season (from 8 October, till 13 November, 2007) by two trial and blank vessels which harvested simultaneously.

Two different types of devices namely; JTED (for juvenile fish reduction) and Modified ground gear (from horizontal to parallel for seabed destruction reduction) examined based on a pre determined schedule. Data related to each harvest operation, has been recorded separately in specific forms contain some information e.g. vessel speed, harvesting time, longitude and latitude, fishing ground information, Sea conditions, discard level, juvenile fish level lower than LM50(Length at which 50 percents of the individuals fish, matured), large fish harvest amount, shrimp harvest rate, etc. Results obtained from 91 times fishing, showed that by applying JTED in 44 times fishing turns, small shrimp weight and large shrimp weight have been reduced 16.5% and 43%, respectively. However commercial fish species have been increased by 0.5% and discard reduced by 38.6%.

Applying JTED equipped with guiding panel 28 times fishing turns, small size shrimp and large size shrimp reduced by 31% and 18.5% respectively. However commercial fish species increased by 6.7% and discard rate reduced by 45%.

Applying parallel chain ground gear in 15 fishing turns, demonstrated; small size and large size shrimp reduction, 38.9 and 20.7%, respectively. Commercial fish species and discard amount also decreased by 26% and 3.3%, respectively.

Consequently, shrimp reduction in both JTED with guiding panel and without guiding panel, observed. But the shrimp reduction amount in JTED with guiding panel is lower; In the meantime Bycatch reduction percentage in this device is higher. Therefore JTED with guiding panel is more efficient.

As we observe in parallel chain ground gear results; shrimp reduction amount is similar to other experimented devices and Bycatch reduction rate is extremely low (3.3%) and could be considered sufficient only for commercial fish species.

Ultimately it is concluded that; comparing these 3 devices shows that; according project objectives, JTED with guiding panel is more sufficient in comparison with 2 other devices.

Vessels Technical specification:

Two dhows (Artisanal vessel) used in trials with below specification:
Rostami (3/9749) – Fiberglass
Length: 21 Meters
Width: 6 Meters
Engine Power : 300 Horsepower
Yaar(3/7304) – Wooden
Length: 19.2 Meters
Width : 6.8 Meters
Engine Power : 320 Horsepower
Navigation system for both vessels is GPS – Wireless set

Fishing Gear Technical specification:

Otter Board: wooden with metal frame Weight : 85 Kg, Dimensions: 180 * 90
Ground Gear : Chain No.8 , Weight : 75 Kg , Length : 53 Meters
Float : EVA , No.10 , Quantity : 21
Net:
Mesh size in main body : 45→ 210D/24Ply/45mm STR/100MD/200y
Mesh size in Cod end : 20 → 210D/30Ply/20mm STR/100MD/100y
Net material : Poly amide

Treatments

After Technical committee assembly and holding expert sessions in Hormozgan province, it was decided; following treatments to be done: JTED;(aiming juvenile fish reduction) 2 situation ; with and without Guiding panel

Ground Gear Modification from horizontal to parallel position (aiming avoiding seabed destruction and stingray catch reduction)

JTED Device specification

Material: Metal frame and rope net
Weight: 13.5 Kg
4 Buoys, No.10 EVA
Dimension: 3 sections each : 40*50 cm
Grid bar spacing : 4 cm

Grid angle : 45º
Grid bindings : 40 cm
Angle fitting by chain

Modified Chain specification

Weight: 75 Kg
Quantity: 131
Chain height: 40 cm
Chain spacing: 28 cm
Links number for each chain: 16 & 17 links

Trial fishing Implementation

BRD test project for shrimp Artisanal trawlers in Hormozgan province started October 8, 2007 and completed; November 13, 2007.(totally 29 working days onboard) 91 harvests, each one took long 2 hours, by 2 vessels simultaneously, being parallel, have been completed. One vessel as blank (ordinary net), another one as trial equipped with BRD harvested, at the same time. Catch statistics, recorded precisely in particular forms. Three treatments were done, in this trial fishing period which in treatment 1 to 3; with 44, 28 and 15 times harvesting, respectively.

Table 1. Treatment 1 (Traditional Net + JTED). Number of Tows= 44.

Large Shrimp kg		Small Shrimp kg		Commercial Fish kg		Discards kg	
Control	Trial	Control	Trial	Control	Trial	Control	Trial
1159	657	322	268	353	354	8564	5240
43% reduction		16.5% reduction		0.5% increase		38.6% redcution	

Table 2. Treatment 2 (Traditional net +JTED with cover). Number of Tows = 28.

Large Shrimp kg		Small Shrimp kg		Commercial Fish kg		Discards kg	
Control	Trial	Control	Trial	Control	Trial	Control	Trial
156.6	127.6	124.2	85.4	132.5	141.5	2218.5	1217.6
18.5% reduction		31% reduction		6.7% increase		45% reduction	

Table 3. Treatment 3 (Traditional net +parallel chain). Number of Tows = 15.

Large Shrimp kg		Small Shrimp kg		Commercial Fish kg		Discards kg	
Control	Trial	Control	Trial	Control	Trial	Control	Trial
939	744	208.5	127	77.5	57.2	2218.5	1217.6
20.7% reduction		38.9% reduction		26% reduction		3.3% reduction	

Funds and Costs

The total fund for project is 375000 USD, which, roughly 84423.86 USD of this amount was spent till end of 2007. Due to some problems have occurred, some costs have been cancelled and replaced with other items. Namely Purchasing Vehicles mentioned in (40000USD) and Dhow leasing, both funds will be used in Fish trawling Workshop regarding a mutual agreement between National coordinator and Mr. Fogelgren. According to our commitments for performing rest of project phases, following task has been remained: Almost 12000 USD for Documentary Movie

Almost 6000USD for Statistics program (Regarding completed Bid-Offer) Almost 10000USD for Farsi version of Bycatch reduction manual (translation and print) – Bid process is underway. Almost 6500USD for Kids Drawing book – Bid process is underway for Costs of Trawl Management Regional Workshop, Trials and International consultants are roughly 70000USD as mentioned in TOR.

Results and Outcomes

Results obtained from 91 times fishing, showed that by applying JTED in 44 times fishing turns, small shrimp weight and large shrimp weight have been reduced 16.5% and 43%, respectively. However commercial fish species have been increased by 0.5% and discard reduced by 38.6%. Applying JTED equipped with guiding panel 28 times fishing turns, small size shrimp and large size shrimp reduced by 31% and 18.5% respectively. However commercial fish species increased by 6.7% and discard rate reduced by 45%. Applying parallel chain groundgears in 15 fishing turns, demonstrated; small size and large size shrimp reduction, 38.9 and 20.7%, respectively. Commercial fish species and discard amount also decreased by 26% and 3.3%, respectively. Shrimp reduction in both JTED with guiding panel and without guiding panel, observed. But the shrimp reduction amount in JTED with guiding panel is lower; In the meantime Bycatch reduction percentage in this device is higher. Therefore JTED with guiding panel is more efficient. As we observe in parallel chain ground gear results; shrimp reduction amount is similar to other experimented devices and Bycatch reduction rate is extremely low (3.3%) and could be considered sufficient only for commercial fish species. Ultimately it is concluded that; comparing these 3 devices shows that; according project objectives, JTED with guiding panel is more sufficient in comparison with 2 other devices.

Cuba

Luis Font Chávez, Fishery Ministry, Havana, Cuba, jfont@cip.telemar.cu

Abstract

Constructive characteristics of trawl nets used in tropical shrimp fisheries, present a marked negative effect on benthic populations and bottom species, constituting a threat for conservation of biological diversity and marine environment. Nevertheless and taking into account that the catch of this resource represents an important economic and social source, it is necessary to promote the use of lower impact catch technologies and that their introduction in the fishery be technical and economically feasible. Results reached up to present in the project have been aimed to the design, construction and test at experimental and commercial level, in Santa Cruz del Sur Fishing Enterprise, of a less harmful fishing technology to environment, being verified important advantages as: to allow an escape of near 25% of bycatch, thus reducing the negative effect on fish populations and specially juvenile stages of Lane snapper (*Lutjanus synagris)* and also increasing the fishing gear selectivity to the catch of Pink shrimp *(Farfantepenaeus notialis)*, with no detriment of the present observed levels and consequently an increase in the catch exportable value. At the same time, regulatory measures on the fishery have been dictated which substantially contribute to the protection of shrimp populations and species composing bycatch. Other foreseen results are related to the reduction of net constructive costs and fuel consumption. Project execution has been characterized by the active participation of managers, technical personnel of the Enterprise, as well as captains and fishermen of shrimp vessels, who have contributed with valuable experiences and practical execution in

the project development by participating in cruises, conferences, workshops, and advanced qualifying courses for the personnel dedicated to net construction. The new fishing system will be introduced in Santa Cruz del Sur Fishing Enterprise at the end of ban in the 2008–2009 seasons.

RESULTS

WORK AREA

Investigation was conducted in Santa Cruz del Sur Industrial Fishing Enterprise operation area, Province of Camagüey, located in Cuba's southeastern zone.

Design, construction and test of net prototypes

The new design of shrimp twin net used is the denominated Prototype E3 (10.4/10.0 m), with a fish escape device "fish eye"- type. Design of net Prototype E3 is the result of previous development of 6 experimental cruises with 154 hauls, which allowed to improve both prototypes (E1 and E2) initially used. Traditional net is the denominated shrimp net 9.0/9.8 m, currently employed in vessels operating in the Enterprise fishing zone. In Table 1 the main characteristics and calculated technical parameters are presented, that define the hydrodynamics quality of both fishing gears.

Table 1. Characteristics and technical parameters of the Traditional and E3 net.

Parameter	Traditional Net	E3 Net
Upper rope length, m	9.0	10.4
Area of net mesh part, m^2.	155.0	129.6
Area of net mouth, m^2	9.8	10.0
Horizontal opening, m	6, 3	7.3
Vertical opening, m	1,9	1,6
Net weight without codend, kg	7,4	5.9
Resistance to trawl, Newton	1609.4	1415.3

These modifications mainly influence in the increase of horizontal opening and decrease of vertical's, contributing to the reduction of fish catch of the system, taking into account the distribution habits in the water column of the species that compose bycatch. On the other hand, differences in mesh surface area, net weight and hydrodynamics resistance, directly influence in a lower effort of main engine and a slight reduction in materials and fuel consumption.

A fish escape device was added to the net, constructed of stainless steel bars of 8 mm diameter and consists in an ellipse-shaped ring with a larger diameter of 50 cm and a smaller one of 25 cm, with a 50 cm total length, which is fixed to a piece of mesh added between the net body and the codend and in the upper central line of the net

To verify the fishing and economic efficiency of the new fishing system under commercial regime, 3 cruises were conducted, with a total of 99 hauls with an average duration of 2½ hours, on board Vessels FC-24 and Plástico 1, of 21 meters of overall length and constructed of ferrocement and fibreglass respectively and equipped with traditional nets in a side and Prototype nets E3 with " Fish-eye"- type escape device in the other. Nets were alternated in their location, considering operational characteristics of trawls in the fishing zone, which generally make turns that increase the

trawled area by starboard side, which slightly influences in catch increase of nets located in this side of the vessel.

Effects of the new fishing system on shrimp catch

Catch and size composition

In the three commercial cruises performed, with a total of 99 hauls, catches obtained by both fishing gears were similar, with slight increases in net E3, although statistically no significant differences were observed among them. Nevertheless, the retention of greater sizes in net under study resulted evident. Processing of the observed size composition from measurement obtained in the 3 commercial cruises, with a total of 8 580 individuals in the case of the experimental net and 8 473 in the traditional one, indicated that sizes lower than 8.2 cm are retained in a greater extent in the latest, while for sizes higher than 8.7 cm the result is inverse. Mean values for the traditional and modified net were of 8.6 cm and 8.8 cm respectively.

Economic assessment determined by the gear effect on shrimp catch

The increase of gear selectivity favourably influences the escape of small individuals, which are likely to be caught later at a greater size. Additionally, if taken into account the volumes of shrimp catch in both fishing systems, the economic result of the fishing operation is higher for the same operation level.

Calculated value of the catch is presented in Table 2, observed by type of fishing gear in the three commercial cruises, evaluating the levels of catch by exportable category to the current prices of the international market, (Exporter CARIBEX February/2008) and applied to the marine shrimp export categories, for 1 ton of catch. Results indicate an increase of USD 343.35 by ton, according to the size composition retained by each net.

Table 2. Catch value by type of net.

Categories	Price/kg USD	Traditional Net	E3 Net
		Income/ton USD	Income/ton USD
100/120	4,65	1081,60	906,98
80/100	5,91	549,65	508,74
58/80	6,23	883,00	895,70
43/52	6,88	1193,55	1174,69
34/43	7,18	611,90	627,97
28/34	10,80	1430,24	1561,99
22/28	12,07	996,41	1218,00
13/21	15,80	931,81	1127,44
Total		7678.16	8021.51
Increase in catch value/ton			343.55

Incidence of the new fishing system on fish catches reduction

Bycatch of shrimp fishery in our country is constituted by a large amount of marine organisms, in which fish predominate with values near to 75–80% of the total caught. Levels of presence in catches depend on multiple factors, among which can be mainly cited: fishing time, trawl depth, season of the year, geographic location, as well as

those caused due to the design of the net used, deficiencies in calibration of trawl doors, excess of weight in the footrope and trawl speed.

In Cuban fisheries, the bycatch/shrimp rate ranges between 3.2 and 6.3 values, being likely to reach higher levels in hauls performed in areas where sponges, sea urchins *(Moyra sp)* or jellyfish *(Aurelia aurita)* are abundant according to the life cycle of these species.

Analysis of species composition by commercial and sampling cruises over the last five years, for Ana Maria and Guacanayabo Gulfs, showed that there are 11 fish species representing near 90% of the catch and from them: Yellow fin mojarra *(Gerres spp).*

Lane snapper (Lutjanus synagris), Mojarra (*Diapterus* sp), Atlantic bumper (*Chloroscombrus chrysurus*) and Tomtate grunt (*Haemulon aerolineatum*), integrates near 75%. The Ground croaker (*Micropogonias* sp), Searobin (*Prionotus punctatus*), Sand seabass (*Diplectrum formosum*) and the Blackedge cusk-eel (*Lepophidium graëllsi*), present incidence levels in the order of 5 to 3%.

A noticeable variation in species compositions is observed from the beginning of the 90´s of last century, reported by several national authors. Such a variation is due, among other factors, to overexploitation of bycatch components, mainly fish, by the null selectivity of the shrimp fishing gear. This has determined that predominant species at present catches, are of low commercial value and others like lane snapper, sand sea bass and the blackedge cusk-eel, are caught in juvenile stages and show a considerable reduction in current catch volumes, regarding the above mentioned period.

Effect of the new system on fish catches

Results obtained in experimental cruises and corroborated in those conducted under commercial fishing conditions, indicate a reduction near 25% of fish catches, including a 4.1% of lane snapper juveniles, thus decreasing the negative effect of the current shrimp gear on the sustainability of fish resources in the fleet operation zone.

On the other hand, as previously indicated, fish escape by the use of escape device contributes to the quality of shrimp caught, because the resource suffers a lower mechanical damage taking into account that cleaner catches are obtained, being reduced, additionally, time employed in catch processing on board the vessel.

Fishing management measures adopted:

Regulation measures, constitute a valuable tool for the protection of shrimp resources and bycatch in general, especially those directed to the application of total closures and by areas, diminishing of fleet capacity and the increase of the selectivity of the fishing gear. In Cuba, in recent years the following resolutions have been established.

INCREASE OF TOTAL BAN PERIOD

Resolution 180/2003 July 15- October 15 3 months
Resolution 158/2004 July 15- November 15 4 months
Resolution 112/2005 July 15- November 30 4 ½ months
Resolution 155/2006 July 15- November 30 4 ½ months
(Resolution 078/2007 April 1st/07- February 1st /2008 10 months)

OTHER PROVISIONS – Resolutions 158/2004 and 155/2006.

PROTECTION OF NURSERY AREA

- Shrimp trawl prohibition to less than one nautical mile from coast.

LIMITATION OF FISHING EFFORT LEVEL

- Limitation of number of vessels allowed operating in the fishing zone to 50 units.

INCREASE IN NET SELECTIVITY

- Increase in mesh size of shrimp nets.
- Prohibition the use of a second codend and establishment the covering the bottom half of the codend with a protecting net sheet.

RECRUITMENT PROTECTION

- Suspension of fishing in zones of high abundance of small size shrimps and stages of molt (small and damaged shrimp) superior to 25%.

Present status of investigation

As a conclusion of the experimental phase and verification of results in commercial cruises, it was arranged with the direction of Santa Cruz del Sur Fishing Enterprise to rig 3 vessels with the new system, which would begin to operate at the end of current ban (February, 2008). At present time, 2 vessels are operating with this fishing gear, with results that corroborate those obtained in the experimental phase. The third vessel should begin to work next month of March, when the new gears are available. These activities are aimed to gradually introduce the system and to acquire the practical experience by the captains and crew.

On the other hand, Santa Cruz del Sur Fishing Enterprise and PESCACUBA Enterprise Group is providing knowledge and support for the execution and conclusion of the project, due to their active participation in the development and exchange of experiences with vessel captains, being also pointed out in addition, that personnel for construction of new nets is available, who was qualified through theoretical-practical courses.

Introduction of the Net E3 with escape device in Santa Cruz del Sur Fishing Enterprise

According to the planned chronogram, the new fishing system will be introduced in shrimp vessels of Santa Cruz del Sur Fishing Enterprise, at the 2008–2009 seasons, being dictated the legal provisions required for its fulfilment.

Trinidad and Tobago

Suzuette Soomai Fisheries Division, Ministry of Agriculture, Land and Marine Resources, St. Clair Circle, St Clair, Port of Spain, Trinidad and Tobago

Abstract

Three periods of gear trials were conducted over 2006 and 2007 in the artisanal fleet and one period in 2007 in the semi-industrial and industrial fleets, overall covering an estimated 25% of the national trawl fleet. Gear trials involved modifying the existing trawl net, testing of two bycatch reduction devices (BRDs) namely the fisheye and square mesh panel, and testing of a new monofilament trawl net received from Mexico and aimed at reducing the level of discards of bycatch caught in the artisanal shrimp trawl fishery. Overall results are insufficient to determine the effectiveness of each BRD in reducing discards. Modifications to the existing net and the new monofilament net however showed favourable results with regard to making fishing operations more efficient. Joint gear testing between the Fisheries Department and the fishing industry has been beneficial in educating fishers and promoting co-management of the trawl fishery. Technical assistance from the National Fisheries Institute of Mexico and from the FAO was instrumental in technology transfer and enhancing fisheries research in Trinidad and Tobago. Gear testing allowed for collaboration with Venezuela on joint research in the Gulf of Paria and the Columbus Channel where the shrimp and groundfish resources are shared.

Introduction

The shrimp trawl fishery of Trinidad and Tobago targets five penaeid shrimp species (*Litopenaeus schmitti*, *Farfantepenaeus subtilis*, *F. notialis*, *F. brasiliensis*, *Xiphopenaeus kroyeri)*. Groundfish bycatch of commercial importance is the sciaenids (*Cynoscion* spp, *Macrodon ancylodon*, *Micropogonias furnieri*), gerreids (*Diapterus* spp.), lutjanids (*Lutjanus* spp., *Rhomboplites aurorubens*), haemulids (*Haemulon* spp., *Genyatremus luteus*, *Orthopristis* spp.) and ariids (*Bagre* spp, *Arius* spp) (Kuruvilla *et al*., 2001). In Trinidad, the resources are exploited by an artisanal, semi-industrial and industrial trawl fleet. The shrimp and groundfish resources in the main trawling grounds in the Gulf of Paria and Columbus Channel are considered to be shared stocks exploited by the fleets of both Trinidad and Tobago and Venezuela.

The high levels of bycatch and discards is of great concern since only a small portion of the bycatch is retained and landed and most is discarded at sea. An estimated 90% of the bycatch of artisanal vessels, and 71% of the bycatch of the semi-industrial fleet, is discarded and most are juvenile fish of other important coastal fisheries (Kuruvilla *et al*., 2000). This is one of the main sources of conflict between the trawl fishery and other fisheries such as the artisanal gillnets and lines. In a 1994 local knowledge survey fishers noted a decline in catches and the general perception was that trawling was responsible for destruction of the seafloor and juvenile fish (Ramjohn, 1995).

The high level of bycatch and subsequent discarding is due to two main factors. Firstly, the shrimp trawl fishery is a tropical multi-species coastal fishery targeted by a gear that is relatively unselective. Secondly, the vessel used for trawling have a limited hold capacity and to maintain net profits only the target shrimp species and bycatch for which there is commercial value is landed.

Methods

Artisanal Fleet

The artisanal fleet targets mainly *Litopenaeus schmitti* and *Xiphopenaeus kroyerii*. The net currently in use by the fleet consists of a flat trawl net made of multifilament twine with a head rope length of 34 feet and mesh size of 1 ¼ inches. In November 2006 a double foot rope was introduced into the design of the traditional net. The second foot rope was made of chain and was separated from the main foot rope by nylon twine strings. Steel triangles were also used to obtain the desired separation along the whole length of both foot ropes. Trawls were made at an average depth of 1.4 m and towing speed from 2.5 to 3.2 knots (Soomai and Seefoo, 2006).

In May 2007, a fisheye was installed in the artisanal trawl net between the last panel of the trawl body and the codend. Separate experiments were conducted using a square mesh panel in place of the fisheye. Paired trawls were conducted using two vessels and the experimental gear from above (Net 1) and the control net (Net 2) where:

- Net 1: Flat trawl net with head rope length - 34 feet, mesh size - 1 ½ inches;
- Net 2: Flat trawl net with head rope length - 34 feet, mesh size - 1 ¼ inches.

Trawl doors were used in all of the trials. (Soomai, 2007).

In October - November 2007, gear trials commenced on a new prototype monofilament trawl net received from the INP, Mexico. The new net was rigged, tested and modified, to ensure that it was fishing well in local conditions (Soomai, 2008). Head rope length was 46.5 feet with 3/8 inch diameter nylon rope and monofilament net of 8 -10 twine gauge. The new gear was tested against the previously modified multifilament net (control net) and with the fisheye and square mesh panel installed.

Semi-industrial fleet

The semi-industrial trawl fleet targets *Farfantepenaeus notialis* and *F. subtilis*. The main characteristics of the trawl system were:

Head rope length: 34 feet

Foot rope length: 38 feet

Tickle chain length: 35 feet

Mesh size: 1 ¾ inch

Otter boards: wood and steel, 6 feet long, 34 inches high, an angle of attack of approximately 24°.

Bridles: 20 fathoms long made of 7/16 inch diameter steel wire.

To install the fisheye in the experimental net, a netting extension of 30 by 100 meshes of 1 5/8 inches was prepared and inserted between the last panel of the trawl body and the codend. A second foot rope made of chain was installed in this net and was separated from the main foot rope by nylon twine strings 8 inches long. Paired trawls were conducted at depths of 6 - 9 fathoms in the Gulf of Paria and average trawling time was 3 hours/haul at a towing speed of 3.0 knots (Soomai, 2007).

Industrial Fleet

The industrial fleet targets *Farfantepenaeus notialis* and *F. subtilis*. The industrial trawl fishing gear and its rigging (otter boards, bridles, tickle chain) was slightly bigger in

dimensions to those of the semi-industrial vessels, except in the case of the former, because of the outriggers; two equal nets are towed at each side.

Sea trials were conducted in the Gulf of Paria at depths of 3 – 8 fathoms and average trawling time was three hours/set. Fisheye and square mesh BRDs were tested in separate sets. The same fish eye and netting extension used in the semi-industrial trawler was installed in the starboard trawl net. A square mesh panel was inserted in a netting extension of 30 by 120 meshes of 1–5/8 inches and was also installed in the starboard trawl net. Due to the difference in catches and operational dimensions observed between the trawls, the square mesh panel was also tested in the port side trawl net (Soomai, 2007).

Results

Artisanal Fleet - Multifilament Net

Results were inconclusive in determining the effectiveness of the gear modification. Overall, analysis of the data collected was inconclusive in determining the effectiveness of the fisheye and the square mesh panel in terms of bycatch reduction. There was a 50% reduction in shrimp catch in the experimental net and the level of retained fish did not increase in the experimental net compared with the control net.

Artisanal Fleet - Monofilament Net

There was a reduction in the capture of unwanted bycatch in the new monofilament net with a 13% decrease in discarded bycatch to retained bycatch ratio and a 27% decrease in the discarded bycatch to total catch ratio. Larger shrimp catches were recorded however smaller sized shrimp were caught in the monofilament net. The monofilament net was able to operate efficiently in a variety of water conditions and at the speeds of 2.5–3.0 knots. Trawling with the monofilament net was more fuel efficient.

Semi-industrial Fleet

The species composition was generally the same in the both the experimental (fish eye installed) and control nets. The data collected was insufficient to determine the effectiveness of the fish eye in bycatch reduction. The double foot rope was discontinued since it was stirring up too much sediment as a result of the shallow area of trawling operations.

Industrial Fleet

There was a 32% reduction in the average weight of the total catch in the experimental net (fisheye or square mesh installed) and the shrimp to retained bycatch ratio was estimated at 1:1. However it was estimated that 90% of the bycatch was discarded from both the control net and from the experimental net. Overall the data was unable to provide a definite indication that the BRD was effective in reducing discarded bycatch.

Lessons Learnt

The high discard levels from trawlers put the fishing industry at risk of being the target of environmental groups making themselves vulnerable to attack and possible closure of the fishery. Fishers need to become more responsible for their role in contributing to reduction of resources and take part in research into more environmentally friendly practices.

Technical assistance from Mexico and the FAO was integral in conducting gear trials. Trinidad and Tobago needs to enhance its technical capabilities with regard to fishing gear technology in order to effectively support the fishing industry through future testing and introduction of more efficient trawl gear.

The formation of the National Steering Committee (NSC), comprising trawl fishers and vessels owners, was the first formal exercise to involve the participation of the fishing industry in co-management of fisheries resources. Involvement of fishers in research in collaboration with the government was an initial attempt at participatory management. There is an increase in awareness and commitment within the trawl community towards future cooperation with fisheries authorities.

Data collection under Project EP/GLO/201/GEF helped to fill data gaps in the industrial trawl fishery. National stock assessments for whitemouth croaker (*Micropogonias furnieri*) and lane snapper (*Lutjanus synagris*) were completed and showed the stocks to be fully to over-exploited (Soomai and Porch 2006; Yanagawa et al 2006). A study on the importance of bycatch and discards to the social and economic wellbeing of associated fishing communities was also completed (Hutchinson *et al*., 2007). The trawl industry plays a significant social role in maintaining livelihoods in these rural communities.

Knowledge gained through the Project was used in the development of revised marine policy and fisheries legislation in 2006. Issues related to bycatch and discards and the use of environmentally sensitive gear are listed as implementation strategies under the government's draft policy objectives to maintain ecosystem health and sustainable fisheries for the future.

Future Plans

- Conduct additional testing of the monofilament net, fisheye and square mesh panel BRDs to determine their effectiveness in reducing discards.
- Conduct tests on the semi-industrial and industrial fleets using new nets made of Dyneema netting and new otter boards as the experimental gear.
- Urgent consideration will be given to implementing management measures such as enforcing areas of operation as prescribed under national regulations, since the artisanal fleet is operating in very shallow waters. Movement to deeper waters is expected to reduce the catch of juveniles, in the absence of a BRD.
- Trinidad and Tobago will continue to participate in global and regional initiatives aimed at reducing discards from the trawl fishery.

References

Hutchinson, S., Seepersad, G., Singh, R., Rankine, L. 2007. Study on the Socio-Economic Importance of Bycatch in the Demersal Trawl Fishery for Shrimp in Trinidad and Tobago. Department of Agricultural Economics and Extension, Faculty of Science and Agriculture, The University of the West Indies, St. Augustine, Trinidad and Tobago.

Kuruvilla, S., Ferreira, L., Soomai, S., and Jacque, A. 2000. Economic performance and technological features of marine capture fisheries: the trawl fishery of Trinidad and Tobago. Regional Workshop on the Effects of Globalization and Deregulation on Fisheries in the Caribbean. Castries, St. Lucia, 4 December, 2000. Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.

Kuruvilla, S., Ferreira, L., and Soomai, S. 2001. National Report of Trinidad and Tobago. In Tropical shrimp fisheries and their impact on living resources. Shrimp fisheries in Asia:

Bangladesh, Indonesia and the Philippines; in the Near East: Bahrain and Iran; in Africa: Cameroon, Nigeria and the United Republic of Tanzania; in Latin America: Colombia, Costa Rica, Cuba, Trinidad and Tobago, and Venezuela. FITT/C974. Food and Agriculture Organization, Rome.

Ramjohn, D. 1995. Results of fisheries local knowledge survey in the Gulf of Paria. FAO/UNDP Project FI:DP/INT/91/007 "Integrated Coastal Fisheries Management". Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.

Soomai, S., and Porch, C. 2006. The status of lane snapper (*Lutjanus synagris*) resources in Trinidad and Tobago. In Technical Report of the Caribbean Regional Fisheries Mechanism (CRFM) 2nd Scientific Meeting, Port of Spain Trinidad, March 2006.

Soomai, S., and Seefoo, A. 2006. Report of Gear Trials conducted by the Fisheries Division, Ministry of Agriculture, Land and Marine Resources (MALMR) in collaboration with the National Fisheries Institute (INP), Mexico, November 12 – 25, 2006. Project EP/GLO/201/GEF "Reduction of Environmental Impact from Tropical Shrimp Trawling, through the Implementation of Bycatch Reduction Technologies and Change of Management.". Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.

Soomai, S. 2007. Report of Gear Trials conducted by the Fisheries Division, Ministry of Agriculture, Land and Marine Resources (MALMR) in collaboration with the National Fisheries Institute (INP), Mexico, May 21 – 31, 2007. Project EP/GLO/201/GEF"Reduction of Environmental Impact from Tropical Shrimp Trawling, through the Implementation of Bycatch Reduction Technologies and Change of Management.". Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.

Soomai, S. 2008. Report of Trawl Gear Trials, 4 October – 28 November, 2007. Project EP/GLO/201/GEF "Reduction of Environmental Impact from Tropical Shrimp Trawling, through the Implementation of Bycatch Reduction Technologies and Change of Management." Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.

Yanagawa, H., Ferreira, L., Martin, L., and Soomai, S. 2006. Preliminary data analysis of two fish species in Trinidad using the SPR (Spawning stock biomass Per Recruit) method.: 1. Whitemouth croaker (Cro-cro), Micropogonias furnieri; 2. Lane Snapper, Lutjanus synagris. Produced for the Project for the Promotion of Sustainable Marine Fisheries Resource Utilisation, JICA. Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.

Columbia

Maria Rueda and Farit Rico, Instituto de Investigaciones Marinas y Cosetras

ABSTRACT

Quantification of the tropical shrimp trawling impact and mechanics to reduce it on both Caribbean and Pacific coasts were evaluated. The methodological approach included census of the fishing technology, monitoring, workshops, trials and fishing experiments. The census revealed that vessels and net designs are 30 years old. Fishing monitoring showed the following catch composition: shrimp 8%, incidental catch 27% and discards 65% for the Caribbean; while for the Pacific shrimp is 5%, incidental catch is 43% and discards is 52%. In this sense new trawl nets were designed, introducing new netting materials and BRDs (fisheye and TED). 12 Trawl nets prototype were manufactured during 2 workshops, where 60 fishers were trained in fishing trials. These trawl nets were used in fishing experiments comparing catches of an experimental vessel (using prototype nets) with those of a control vessel (using traditional nets) to test reduction of bycatch and fuel consumption if possible. For the

Caribbean 80 hauls paired showed that the bycatch was reduced as follows 20% (fisheye), 41% (TED), 54 (fisheye + TED); while for the Pacific 240 hauls showed reductions of 28% (fisheye), 23% (TED) and 57% (fisheye + TED). In the Caribbean the fuel saved was 17%, whereas on the Pacific the save was 25%. Current decrease of the shrimps stocks and high fuel prices, are part of the issues that the fishery management agency in Colombia faces to change of management.

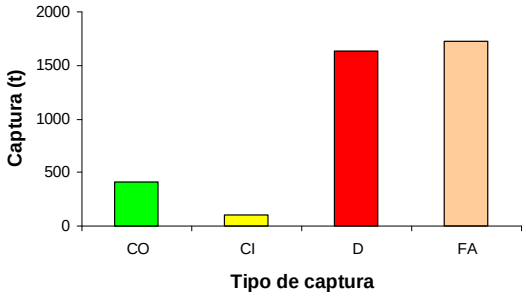


Figura 1. Composición de la captura total (t) en la flota camaronera de aguas profundas del Pacífico colombiano.

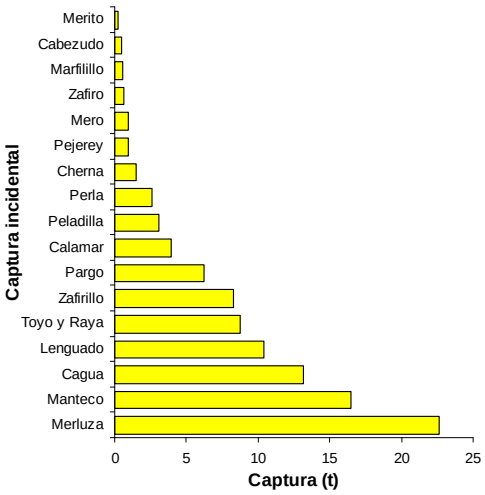


Figura 2. Composición por productos de la captura incidental (t) desembarcada por la flota camaronera de aguas profundas del Pacífico colombiano.

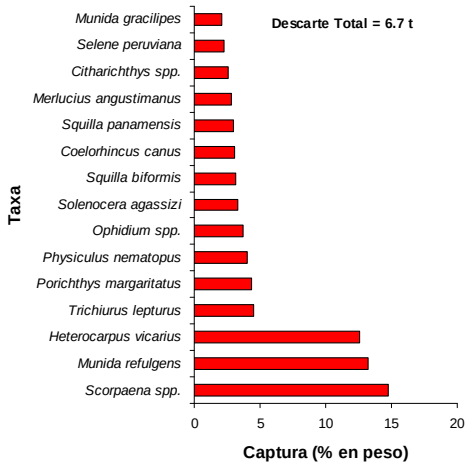


Figura 3. Principales taxa del descarte en la flota camaronera de aguas profundas del Pacífico colombiano.

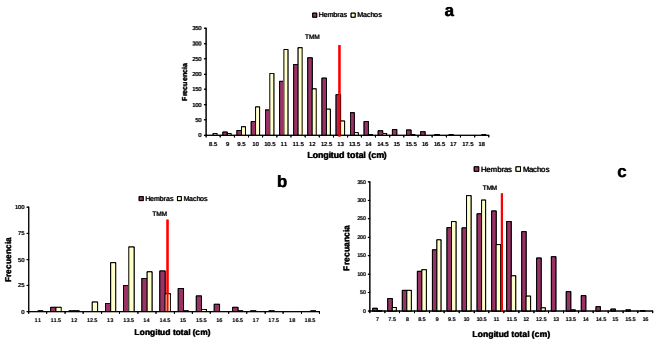


Figura 4. Distribuciones de frecuencias por sexo indicando la TMM. a) Farfantepenaeus brevirostris; b) F. californiensis y c) Solenocera agassizi.

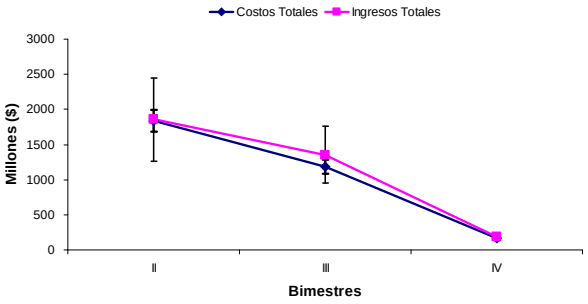


Figura 5. Comportamiento bimensual de los costos y los ingresos totales de la flota camaronera de aguas profundas en el Pacífico colombiano. El área entre las líneas representa la renta económica.

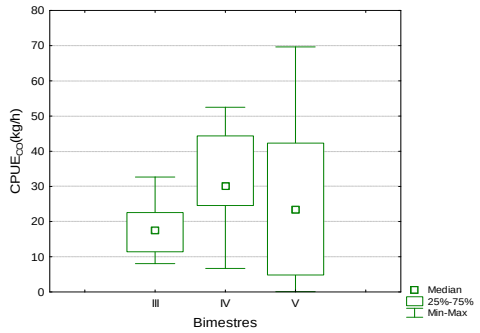


Figura 6. Abundancias por bimestres de captura objetivo CO.

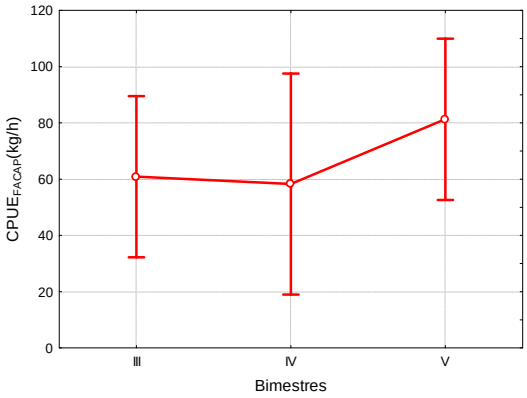


Figura 7. Abundancias por bimestres de la fauna acompañante del camarón de aguas profundas (FACAP). Las barras de error denotan intervalos de confianza del 95%.

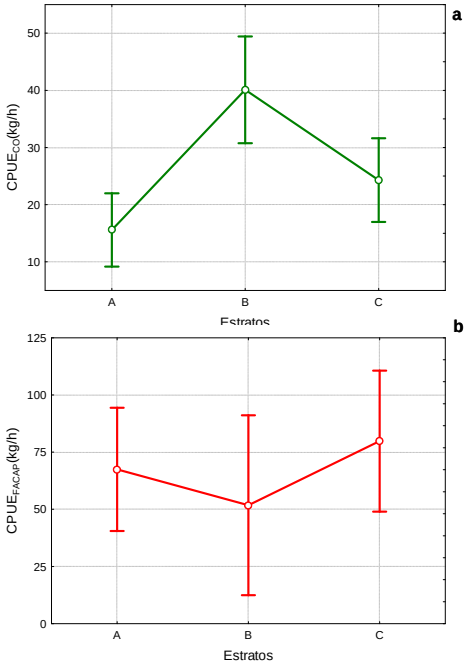


Figura 8. Abundancias por estrato de profundidad de a) captura objetivo (CO) y b) fauna acompañante del camarón de aguas profundas (FACAP). Las barras de error denotan intervalos de confianza del 95%.

References

Alverson, D., M.H. Freeberg, S.A. Murawski y J.G. Pope. 1994. A global assessment de fisheries bycatch and discards. FAO Fish Tech. Pap. 339, Rome, 233 p.

Andrade, R. 2000. Evaluación de captura, esfuerzo y algunos parámetros poblacionales de los camarones café (*Farfantepenaeus californiensis*) y rojo (*Penaeus brevirostris*) en el Pacífico colombiano. Tesis Universidad del Valle. 65 p.

Conapesca, 2005. Noticias Sagarpa. Disponible en Internet. URL: http://www.conapesca.sagarpa.gov.mx

De la Pava, M.L. y C. Mosquera. 2001. Diagnostico Regional de la Cadena Camarón de Pesca en el Pacífico Colombiano. Documento Técnico presentado al Ministerio de Agricultura y Desarrollo Rural. ACODIARPE, Buenaventura, 41 p.

Eayrs, S. 2007. Guía para Reducir la Captura Incidental (bycatch) en las Pesquerías por Arrastre de Camarón Tropical. Edición revisada. FAO. Roma, 108 p.

EJF. 2003. Squandering the seas: How shrimp trawling is threatening ecological integrity and food security around the world. Environmental Justice Foundation, London, 45 p.

FAO. 1995. Código de conducta para la pesca responsable. FAO. Roma, 46 p.

Fischer, W., F. Krupp., W. Schneider., C. Sommer., K.E. Carpenter y V.H. Niem. 1995. Guía FAO para la identificación de las especies para los fines de la pesca. Pacífico centro-oriental. Vol. I-III. FAO. Roma, 1813 p.

Garcia, S.M. 1996. The precautionary to fisheries and its implication to fisheries research, technology and management: an updated review. En "Precautionary Approach to Fisheries". Part 2. FAO Fisheries Technical Paper No. (350/2), 1–76.

INCODER. 2007. Resolución N° 2852 del 22 de diciembre de 2006. INCODER. Bogotá, 7 p.

Kelleher, K. 2005. Discards in the World's Marine Fisheries. An Update. FAO Fish. Tech. Pap. 470, Rome, 131 p.

Lewison, R.L., L.B. Crowder, A.J. Read y S.A. Freeman. 2004. Understanding impacts of fisheries bycatch on marine megafauna. TREE, 19: 598–604.

Madrid, N y W. Angulo. 2002. Evaluación biológico-pesquera del recurso Camarón de Aguas Profundas en el Pacífico Colombiano. Marzo 2001 – Febrero 2002. Informe Técnico. Agropesquera Bahía Cupica Ltda. Buenaventura, 70 p.

Madrid, N y M. Rueda. 2007. Análisis para la estimación de cuotas de pesca del camarón de aguas profundas en el Pacífico colombiano basado en registros históricos. Informe Técnico. INVEMAR. Santa Marta, 17 p.

Morgan, L.E y R. Chuenpagdee. 2003. Shifting Gears. Addressing the Collateral Impacto de Fishing Methods in U.S. Waters. Pew science series on conservation and the environmental, Washington, 42 p.

Pauly, D y G.I. Murphy. 1982. Theory and management of tropical fisheries. ICLARM/CSIRO, Manila.

Pineda, F.H. 1995. Biología del camarón de aguas someras Penaeus occidentalis, P. stylirostris, y P. vannamei, en la Costa Pacífica colombiana. Documento Técnico del INPA. Buenaventura, 60 p.

Puentes, V., N. Madrid y L. Zapata. 2007. Catch composition of the deep sea shrimp fishery (Solenocera agassizi Faxon, 1893; Farfantepenaeus californiensis Holmes, 1900 and Farfantepenaeus brevirostris Kingsley, 1878) in the colombian Pacific ocean. Gayana. 71 (1): 84–95.

Robertson, D.R y G.R. Allen. 2002. Peces costeros del Pacífico oriental tropical: Un sistema de información. Institutto Smithsonian de Investigaciones Tropicales, Balboa, República de Panamá.

Rueda, M., J.A. Angulo, N. Madrid, F. Rico y A. Girón. 2006. La pesca industrial de arrastre de camarón en aguas someras del Pacífico colombiano: su evolución, problemática y perspectivas hacia una pesca responsable. Instituto de Investigaciones Marinas y Costeras "José Benito Vives De Andréis" - INVEMAR. Santa Marta, 60 p.

Sagarpa. 2003. Informe del taller Nacional sobre selectividad de sistemas de pesca de arrastre para camarón. Implicaciones para el ordenamiento pesquero. Sagarpa-Conapesca-INP. Mazatlán, Sinaloa, 32 p.

Seijo, J.C., O. Defeo y S. Salas. 1998. Fisheries bioeconomics. Theory, modelling and management. FAO Fish. Tech. Pap. 368, Rome, 176 p.

Zapata, L.A., G. Rodríguez, B. Beltrán, G. Gómez, A. Cediel, R. Avila y C. Hernández. 1999. Evaluación de recursos demersales por el método de área de barrida en el Pacífico colombiano. Bol. Cient. Del INPA, No. 6: 177–226.

Venezuela

Luis Maracano and Jose Alio, Instituto Nacional de Investigaciones Agricola Edif. (INIA), lmarcano@inia.gob.ve and Jalio@inia.gob.ve

Abstract

Discarded by catch of the industrial shrimp fleet in Venezuela is about 60% and is considered a major environmental impact in the country. Tests were conducted to reduce discards in the industrial and artisanal shrimp fleets. The industrial shrimp fishing is performed by 260 Florida type vessels, targeting shrimp and fish. The use of TED is mandatory. Testing of bycatch reductions devices (BRD) like fish eye showed a significant reduction in discards but also severe losses of commercial catch. The square mesh panel did not provide significant reductions of discards. The lower or lifted lower rope rendered an average 25% reduction in discards and no significant loss of commercial catch. The artisanal shrimp fishing is done with small trawls and beach seines. The former was modified with Nordmore grid, square panel and fish eye. Better results were obtained with the fish eye, which showed a reduction in discards close to 70%, but a 30% shrimp loss was confronted. Tests of BRDs will continue after FAO-GEF project ends in 2008, organizing workshops with fishers to show construction and use of the devices, and sharing of results with researchers and fishers of countries in the region is to be promoted.

Introduction

Discarded by catch in the Venezuelan fisheries has been assessed only in the shrimp (Marcano *et al.* 2001) and tuna long line fisheries, although preliminary results suggest that there could be significant amounts of discards in some artisanal and industrial purse seine tuna fisheries. The high proportion of bycatch in the trawl fisheries gives evidence of a large environmental impact by this sector and casts a wrong image of the fishing industry to the general public. This could have induced drastic political measures recently taken by the Venezuelan Government with respect to trawling in the country. Since late 80's there have been trials to promote selectivity in the trawl fisheries. The assistance of the FAO-GEF project on shrimp gear modification and the technical support from consultants, allowed a fast testing of different alternatives of gear modifications or the introduction of gears from other parts of the world on the local shrimp fishing, which improved significantly the efficiency of the shrimp fishing sector and reduced its environmental impact.

Methods

The study was made in the five most important shrimp fishing grounds in the lower Caribbean Sea: Lake Maracaibo estuary, Gulf of Venezuela, eastern platform, the Gulf of Paria and in front of the Orinoco river delta. Each shrimp fishery was evaluated with respect to: fishing gear in use, operational methods, region of operations, captures, landings, and commercial and discarded by catch. Tests on the industrial shrimp trawling were conducted by trained observers on board of Florida type vessels, which use two nets, one on each side of the boat; one unmodified net served as control. The use of TED is mandatory. Three modifications were tested, fish eye, square mesh panel and double or lifted lower rope. TEDs were not used during experimental trawls. Tests on artisanal shrimp fishing included the modification of a small trawl with an increase mesh size in the sac, or the use of a Nordmore grid, a square mesh panel or the fish eye in the sac. Tests in the artisanal fleet were performed using several vessels operating close by in the same fishing grounds, one group with traditional nets serving as control. The replacement of the traditional beach seine by the Suripera net from Mexico or by the bottom entangling net was also tested.

Results

The fleet of 260 industrial trawlers uses a similar type of net, semi-balloon with two covers, with 20/21 m upper/lower ropes that could go to 30/32 m depending on size of vessel and engine power. There are about 10 stern trawlers targeting fish but were not included in the study. The catch composition of the industrial trawl is about 4% shrimp, 26% fish, molluscs and other crustaceans that are landed, and about 60% discards. Fish eye in the industrial trawl induced reductions in discards of 40%, but also losses close to 50% in average of the commercial catch of fish, which on top of the 45% loss caused by the use of the TED, makes the device unacceptable by the fleet. The square mesh panel rendered only 4% reductions in discards, but there were problems in the rigging of the gear, so no conclusive results could be obtained with this device. The lower double rope gave consistent results with an average 25% reduction in discards while the commercial CPUE was maintained or improved. The artisanal shrimp trawl fishery in the Orinoco river delta and the lower eastern Caribbean Sea operates with discards of nil to 90%. Tests with the Nordmore grid in the artisanal trawl fleet operating in the Orinoco river delta showed a severe clogging of the grid with the large load of debris carried by the river. This device seems to require cleaner waters to be used efficiently. The square mesh panel gave large shrimp losses (beyond 40%) since the fishers leave the net lie slack on the bottom before retrieving it on board after the tow. The fish eye placed at 1,5 m away from the knot in the sac induced reductions of discards close to 70%, although the loss of shrimp could be nil to 30%. Placing the fish eye closer to the end of the sac promoted shrimp loss, and further away from it did not render significant reductions in discards. A backwash panel may have to be used behind the fish eye to prevent the escape of shrimp through the BRD during the retrieval process of the catch. The mandatory use of fish eye in the artisanal trawl and the lower rope in the industrial trawl is suggested and may be included in the fishing regulations. The beach seine used in many artisanal shrimp fisheries is not amenable to structural modifications to reduce discards, because shrimp loss cannot be prevented. There are possibilities to replace it with the Suripera net tested in Lake Maracaibo, Gulf of Venezuela and eastern platform. Only in the former area was the shrimp density large enough to show similar shrimp CPUE values with respect to the traditional beach seine nets (20 kg/h) with 2% discards, while the beach seine has 80% discards. Unless shrimp density if very high, the

CPUE of the Suripera net is too low due to the reduced swept area that is covered by the gear. The bottom entangling net showed discards of 40% and a shrimp CPUE of xx kg/h which also makes it a good system to replace the beach seine.

Lessons learned

There has been a severe lack of motivation by fishers to test modifications of the shrimp trawl gear in general to improve its selectivity during the 50+ years of the shrimp fishery in Venezuela. This attitude could be a consequence of a castrating enforcement of the fishing regulations. In large contrast, there were great changes in the number of vessels (from 200 in 1980 to 450 in 1990, to 260 currently in operation), fishing power, materials for net construction (replacing PA for PE) and use of electronics on board. The FAO-GEF project provided an opportunity for all fishers to get involved in the solution of the common problem of the large discards rate in the shrimp fleet. It was also a means to improve the image of the fishing sector in front of the general public, which may see the fishers as predators and destructors of the marine environment. Fishers seem to be willing to incorporate better fishing practices to their usual operations.

Future plans

- Complete validation tests of gear modification or introduction of new gear in the artisanal shrimp fishing sector.
- Organize workshops with shrimp fisher's communities along the country to show the use of the new technology and demonstrate its use.
- Share results with colleagues and fishers from other countries in the region in order to speed up regional results.

References

Marcano, L.A., Alió, J.J., Novoa, D., Altuve, D.E., Andrade, G., and Álvarez, R.A. 2001. Revisión de la pesca de arrastre en Venezuela. En: Tropical Shrimp Fisheries and their Impact on Living resources. FAO Fisheries Circular 974: 330–378, Roma. http://www.fao.org/docrep/007/y2859e/y2859e13.htm#1

Mexico

Dr Miguel Angel Cisneros Mata, Instituto Nacional de Pesca, Mexico

1. Meetings of the National Steering Committee held:

a) Mazatlan, Sin. August 2007. Shrimp Fishery Technical Working Group.

b) Mazatlán, Sin. September 2007. Committee on Fisheries and Aquaculture for the Pacific coast.

Progress of each national project activity

PACIFIC COAST

A 10 day's cruise onboard commercial vessel at the west coast of Baja California Peninsula face operations problems since there was a huge presence of a crustacean known as "langostilla" (*Pleuroncondes planipes*); trawls sets were rather short and non representative in all shrimp fishing ground areas.

Due to engine brake-down of BIP XI, an 8 days cruise for sea trials in the Upper Gulf of California was made; results confirmed advantages of prototype RS-INP-MEX, in previous trials. Comparison of bycatch reduction and catch efficiency of prototype was possible since a set of traditional trawl nets were tested; all expenses were covered by the Walton Foundation through WWF.

ATLANTIC COAST

Arrangements were made to use commercial trawlers for testing of new net designs and the introduction of BRDs at Tampico, Tamaulipas and Ciudad del Carmen, Campeche. Since the fleet composition and technical characteristic of trawl nets has changed, a survey was carried out in those two ports, for data collection of 30 shrimp trawlers.

Two meetings were held with vessel owners from the Atlantic coast, where the stockholders asked to include testing of new otter boards (High Lift) used in the Pacific phase of the project, in order to achieve further fuel savings.

Due to lack of researchers it was decided that all sea trials were going to have place during the shrimp ban of the Atlantic; cost of testing/fishing operations will be cover by the stockholders, except DSA payment of researchers and new gear and devices.

Research for artisanal shrimp fisheries have started in the Upper Gulf of California in order to reduce the impact of enmeshing shrimp nets on endemic endangered porpoise (*Vaquita*); also, due to mixed presence of juvenile white shrimp (*Litopenaeus setiferus*) while trawling for Sietebarbas shrimp (*Xiphopenaeus kroyeri*), a new project will start in 2008 in the Atlantic coast, to introduce a new trawl net with short front upper panel or no front upper panel.

Workshops, training, or demonstration activities undertaken

During July two joint campaigns were carried out jointly with Cuba and Costa Rica, in order to asses the accomplishments of both countries projects.

CUBA:

Locations: La Habana and Santa Cruz del Sur.

Activities: Meeting with FAO-Cuba representatives; Meeting with Authorities from Fisheries Research Center (CIP) and National Steering Committee; Meeting with directors of the Santa Cruz del Sur Enterprise; Sea trials; report to Authorities from CIP and Steering Committee.

COSTA RICA:

Main activities were meeting with FAO-Costa Rica Representative, construction of devices to facilitate testing of double foot rope and sea trials at Gulf of Nicoya onboard B/M CAPITÁN GERARD.

A total of 12 trawl sets were done to test fish-eye, square mesh panel and double footrope.

SURIPERA WORKSHOP

From 20 – 27 November an international workshop was held at Culiacan, Sinaloa, Mexico, with participants from Colombia (2), Costa Rica (1), Cuba (1), Philippines (2), and Mexico (11). Activities include design, construction, testing and fishing operations with suriperas.

General comments on the current status of the shrimp-trawling industry

Although official statistics of shrimp fishery for 2006 and 2007 are not available yet, a general overview of shrimp production is given in Figure 1 (2005 data is considered still preliminary).

Total shrimp production has increased in the last 10 years, mainly due to the significant raise of shrimp farming production. Apparently industrial and artisanal shrimp fishing is stable over the last 10 years; however there is a slight decrease for the industrial fishing, mainly attributed to the Pacific.

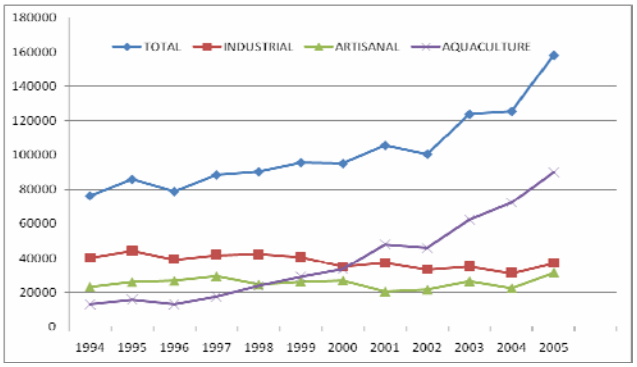


Figure 1. Shrimp production by origin.

Data of shrimp production of industrial, artisanal and shrimp farming from each coast for 2005 are given in Table 1 and 2.

Table 1. Shrimp production by origin in the Pacific Coast.

	Ton	%
Industrial	28,734.0	21.5
Artisanal	17,905.6	13.4
Aquaculture	87,137.7	65.1
Total Pacific	133,777.3	100.0

Table 2. Shrimp production by origin in the Atlantic Coast.

	Ton	%
Industrial	8,300.0	33.9
Artisanal	13,285.3	54.3
Aquaculture	2,903.4	11.9
Total Atlantic	24,488.7	100.0

Number of trawlers in the Pacific coast has a very slight reduction; however, income has been affected from catch reduction or international market price reduction.

In the Atlantic coast, there has been an important reduction of the number of shrimp trawlers, through a government program of buying-out shrimp licenses/trawlers.

Catches per vessel have increase significantly over the last three years, as well as income; although some fishing grounds have been closed, economic impact to stockholders seems not to be important due to increased catches.

Some vessel owners in the Pacific coast that have participated in the project, are applying for certification of "clean shrimp" or "green shrimp", with USA shrimp brokers through some NGOs, in order to get a "bonus" plus prices.

Process to certification of Suripera fishing operations will start during 2008, in order to get a "clean shrimp" label.

Estimation of bycatch reduction:

a) Total Number of shrimp trawlers: Total number of trawlers is in process of actualization since the program to reduce fishing effort by means of buying-out commercial shrimp trawlers is still going on.

b) Number of shrimp-trawlers that used BRDs when the project started: 2 (only research vessels of INP)

c) Number of shrimp-trawlers currently using BRDs: Approximately 140, mainly in the Pacific coast.

Nigeria

James Ogboona, Nigerian Institute For Oceanography And Marine Research (NIOMR), Jamescogbonna@yahoo.com

Introduction

Nigeria is one of the participating countries involved in GEF/UNEP/FAO Shrimp Fisheries Project titled: 'Reduction of Environmental impact from Tropical Shrimp Trawling through the introduction of Bycatch Reduction Technologies and change of management'. The main objective is the reduction of bycatch in shrimp fisheries.

Nigerian Institute for Oceanography and Marine Research, (NIOMR) Lagos is currently implementing 2 complementary research activities in the Eastern Gulf of Guinea sub region of West Africa on the following:

a) The development/adaptation of appropriate bycatch reduction technologies for the shrimp trawlers in Nigeria and Cameroon. This technical part of the project involved the construction of prototype Bycatch Reduction Devices (BRDs) and Turtle Excluder Device (TED) for fleet testing on board conventional shrimp vessels in Nigeria and Cameroon. The awareness created has extended to other States in the sub region including Togo Republic, Republic of Benin, Gabon, Sao Tome & Principe and Equatorial Guinea.

b) The design and conduct of a socio-economic survey of the shrimp trawl fisheries and the trading of their bycatch

The technical development/adaptation of reduction technologies

Turtle Excluder Devices (TEDs) are installed in the codend extension of shrimp trawl nets as a management tool to reduce fishery related sea turtle mortality.

Trawl nets with bycatch reduction devices (BRDs) are also constructed in order to mitigate the problem of juvenile and immature fish bycatch in shrimp trawling.

The duo of TED and BRD in the same trawl net is expected to function perfectly well and complement each other without any drastic reduction in the quantity of shrimps. The data recorded during comparative demonstration trials of trawl nets fitted with TED, BRD codends and the traditional square mesh codend, are shown in Table 1. As shown in Table 2 the results of analysis of variance (ANOVA) indicated that there was no significant variation in the mean values of shrimps caught by the various trawl net codends.

Table 1. Total catch by weight of fish and shrimp in hauls 1 – 4.

Species	TED Only	T90	SMW	Trad
Shrimp	6.2	11.8	9.8	9.5
Com. Fish	109.3	125.3	104.0	109.0
Trash	91.0	70.8	112.0	126.3
Total	206.5	207.9	225.8	244.8

Table 1a. Catch by weight (% of traditional).

Species	TED Only	T90	SMW	Trad
Shrimp	65.0%	120.0%	103.0%	100% (9.5kg)
Com. Fish	100.0%	115.0%	95.4%	100.0% (109.0kg)
Trash	72.0%	56.0%	88.7%	100.0% (126.3kg)
Total	84.4%	84.9%	92.2%	100%

Table 1b. Catch by category within tow (% of total catch per tow).

Species	TED Only	T90	SMW	Trad
Shrimp	3.0%	5.7%	4.4%	3.9%
Com. Fish	52.9%	60.3%	46.0%	44.5%
Trash	44.0%	34.0%	49.6%	51.6%
Total	100%	100%	100%	100%

Table 2. ANOVA Table on shrimps caught by trawl nets fitted with TED, BRD or Traditional diamond mesh codend during demonstration trials.

Variations	Degree of Freedom	SS	F
SSB=8.4675	R-1=3	2.8225	3.071
SSW=11.03	A-R=12	0.9192	
SST=19.4975	15		
F TAB (3,12)	P0.05=3.49	0.01 (3,12) = 5.95	

ANOVA showed no significant difference (P>0.05) between the shrimps caught by the various trawl net codends. This is an indication that there will be no drastic loss of shrimps if the devices are properly installed and operated.

U.S.A. experts inspected the Fishing Companies in Nigeria in September 2007 to determine the degree of TED compliance by the Industrial fishermen as well as the enforcement strategies of the Federal Department of Fisheries. This was undertaken with a view to extend the certificate of TED compliance till 2009.

Workshops on the designs and construction/fabrication of bycatch reduction devices including square mesh windows (SMW), 90° turned (gentle) codend and square mesh codend (SMC) were conducted at the premises of Fishing Companies. The target groups included mainly captains, net makers, deck hands and managers.

The number of participants during the 2-day workshop per company is as follows:

Fishing Companies	Date	No. of participants
Atlantic Shrimpers Ltd	2–23 August 2007	18
Barnarly Fisheries Ltd	24–25 August 2007	16
Honeywell Fisheries	26–27 August 2007	10
United Fisheries Ltd	28–29 August 2007	16
Karflex Fisheries Ltd	4–5 September 2007	12

The workshops conducted earlier at Taraboz Fisheries Ltd and ORC Fisheries included 32 and 18 participants respectively.

The adaptation rate of BRD codends of about 65% was more in favour of square mesh window (SMW). During the period July – December 2007, Atlantic Shrimpers Limited (ASL) completed the construction of a total of about 280 SMW codends i.e. 4 codends per vessel for about 70 shrimp trawlers owned by the industry.

It should be recalled that the recertification of Nigeria for TED compliance and permission to sell all categories of shrimps to USA markets rekindled the interest of the Industrial Fishermen in Cameroon, Gabon and other member states in the sub region in order to enjoy the same opportunity and benefit of higher prices for shrimp exports. Therefore there is the need for technology transfer in terms of capacity building and skills acquisition on the design, construction and operation of TED and BRD by

the participating States in order to achieve this objective and bring about uniform regime of application and enforcement of the relevant fisheries laws and regulations in the sub region. The same issue was highlighted in the draft convention that was reviewed in Douala Cameroon between 19 and 20 December 2007 and at the various meetings that were convened on harmonization of the fisheries laws and regulations and the collaboration on the use of closely coordinated vessels monitoring system (VMS) in the sub-region.

In the light of the above, Dr. B.B. Solarin participated in the Gabon workshop conducted under the auspices of National Oceanographic Atmospheric Administration (NOAA) of the United States. The workshop was convened to share experiences in implementation of TEDs and other management solutions to reduce sea turtle mortality in shrimp trawl nets. There was an oral presentation of the Nigerian experience. The workshop also included practical demonstrations on TED construction as well as demonstration trials at sea to test the performance on board commercial vessel. It created a lot more awareness among the Gabonese industrial fishermen, Managers and Administrators. It was observed that it was important and desirable to maintain an optimum grid angle of 55 degrees in order to improve TED performance.

Cameroon

Oumarou NJIFONJOU, IRAD-SRHOL PMB 77 Limbe, CameroonTel: +237 77 61 91 49; Email: njifonjo@caramail.com

INTRODUCTION

In Africa, the project concerns Nigeria and Cameroon waters. This area has vast fisheries resources, which are critical to the food security of the region, but which are currently severely threatened by over fishing, urban runoff and offshore petroleum exploitation. The project is under the supervision of the Fisheries Department and is implemented in Cameroon by the Fisheries and Oceanography Research Station (SRHOL). The Artisanal shrimp fisheries utilizes more than 1000 fishermen and for the moment the Industrial sub sector has 41 registered shrimp trawlers from Nigeria and 30 based in Douala. Most of these vessels are shrimp trawlers with small mesh sizes and this inevitably results in large quantities of juveniles. Bycatch and trash fish constitute mostly 95% of the products caught and 75% of the finfish landed are juveniles caught before first maturity.

The increase of the shrimp fishing effort over the years, the high level of fish caught by shrimp trawlers, the continue reduction of the sizes of fish landed, the high price of fish on the markets and the political will to conserve and sustain the fisheries resources are the main motivation for the establishment of bycatch reduction legislation/regulations. In the new fisheries Law to be promulgated, BRDs and TEDs utilization has been introduced as one of the basic requirements for the license application.

National Plan of Action for bycatch management and discard reduction

The objectives and activities of the overall national plan of action for bycatch management and discard reduction are here summarized:

Objectives

- Ongoing evolution of the commercial shrimp-trawling fisheries, with estimation of fishing efforts and landings;

- Typical rate of shrimp-catch, bycatch and discards made over an annual cycle by the commercial shrimp-trawling fleet, both before, and after adoption of Bycatch Reduction Devices (BRDs) by the vessels;
- Socioeconomic changes and good governance which may be brought about by the adoption of BRDs in the commercial shrimp-trawling fleets.

Activities

- On-board sampling/Observer program (data collection up to the end of the project);
- Field demonstration of new technologies developed/adapted (workshops);
- Introduction of appropriate BRD and TED technology to shrimp-fishing fleets;
- Establishment of an appropriate database from data collected progressively by observers;
- Dissemination and extension of the results achieved;
- Promulgation of the new fisheries law;
- Management of the vessel Monitoring System (VMS) already installed in the vessels operating in Cameroon;
- The study on socio-economic impact of the By–catch trade in Cameroon should continue particularly data collection and provision of alternative means of livelihood;
- Data analysis and final reporting.

Sea trials demonstration

The sea trips organized during the last workshop (April 07) were undertaken on board the commercial vessel belonging to PGT fishing company based in Douala and freely offered for the occasion (in kind contribution of the private sector). The PGT stern trawler used was a shrimper rigged with four nets, a quad rig, fishing simultaneously as in Nigeria. This permitted comparative testing for the TED and BRD's at the same time. The four traditional trawls were modified from left to right as TED only outside, T 90 codend inside for the Port side, and for the Starboard side, Square mesh window inside and Traditional codend outside, and 3 hauls, each of two hours trawling were made and catches from different codends compared.

It should be noted that the BRD codends tested during the trials were left to the PTG vessel to be tested continuously.

Results of the sea trials

The catch composition included mainly the croakers (Scianidae), sole (Cynoglossidae), thread-fins (Polymenidae), shad, ethmalosa (Clupeidae), silver fish (Trichiuridae), and shrimps (penaeidae) notably *Penaeus notialis, P. kerathurus* and *Parapenaeus atlanticus*. The catch composition was sorted into three major categories: Shrimps, Fish of commercial value, Thrash fish or discards (constituted mainly of juvenile, immature fish species and small pelagic).

The catch composition by weight is shown in Table 1 (first trip) and Table 2 (second trip) below.

Table 1. First trip: Fish composition by weight (kg) of trawl net codend (% of traditional).

Catch by Weight (kg)				
Rig	TED only	T90	Sq Window	Traditional
Shrimp	2.4	2.0	2.0	2.0
Commercial	20.3	0.5	20.0	12.0
Trash	48.0	5.0	43.0	45.0
Total	70.7	7.5	65.0	59.0

Catch by Weight (% of Traditional)				
Rig	TED only	T90	Sq Window	Traditional
Shrimp	120%	100%	100%	2.0
Commercial	169%	4%	166.7%	12.0
Trash	107%	11%	95.6%	45.0
Total	120%	13%	110.2%	59.0

Catch by Category (% of Traditional)				
Rig	TED only	T90	Sq Window	Traditional
Shrimp	3%	27%	3.1%	2.0
Commercial	29%	7%	50%	12.0
Trash	68%	67%	13.9%	45.0
Total			2.1%	59.0

Table 2. Second trip: Fish composition by weight (kg) of trawl net codend.

Catch by Weight (kg)				
Rig	TED only	T90	Sq Window	Traditional
Shrimp	6.2	11.8	9.8	9.5
Commercial	109.3	125.3	104.0	109.0
Trash	91.0	70.8	112.0	126.3
Total	206.5	207.9	225.8	244.8

After analysis of the tables, the following points were observed and discussed:

- The reduction in the shrimp catch in the TED may relate to a problem of the way the TED was deployed – possibly upside down or more likely as mentioned under point 4.. More work on this may improve that catch.
- During the retrieval of the gear, the vessel must maintain some forward speed.
- The square mesh window may require a larger mesh to further reduce the catch of unwanted fish.

- The selvedge line that picks up codends should be extended further as instructed before the trial to compensate for the increased 3 m length in the TED codend.
- Shortening the length of net and placing the TED further forward may improve the stability and reduce any loss of shrimp. However, care should be exercised to not shorten the net too much particularly if the escape opening is faced downward.

2007 – 2008 activities in bycatch management

Two National Steering Committee meeting (NSCM) were held this year in Douala (5 April and 8 September 2007. These meetings were reduced to only key members plus some industrial fishermen because of funding.

The points discussed during the meetings were:

- To prepare the organization of the 4th MCS meeting in Douala;
- To officially discuss the points of collaboration between Cameroon and Nigeria;
- To inform and sensitize the fishing Companies on the new regulation including the use of BRDs/TEDs in Cameroon, and to present to them the need of harmonizing the fisheries laws and regulations in the sub-region;
- To discuss on the future of the project knowing that it is ending in June 2008;
- To present the result of the study carried on the survey of the economic performance indicators of fishing companies;

The National coordinators participated to two MCS meetings organized in Lagos in March and June 2007. A training workshop on BRDs and TEDs also held in Douala 16 to 21 April 2007. Prototypes have been exhibited to the public, their functioning explained and some fishermen trained on how to build the devices. Practical/ Trainings/Demonstrations/Sea-Trials on TEDs and BRDs have been also organized on board a commercial vessel in Limbe. Two kinds of BRDs, the Square mesh window codend and the 90°mesh codend were tested successful, compared to a traditional codend and to the codend equipped with TED.

The 4th MCS meeting on the Harmonization of Fisheries Laws and Regulations within the Southern Gulf of Guinea States held in Douala Cameroon, hosted jointly by the "Caisse de Développement de la pêche maritime" and the Research Centre for Fisheries and Oceanography (SRHOL-IRAD on 19 to 20 December 2007. It is important to recall here that the main purpose of these series of MCS meetings is to establish the framework for the establishment and harmonization of marine fisheries Monitoring, Control and Surveillance (MCS) procedures and enforcement processes within the Southern Gulf of Guinea. The aim is to eliminate all forms of unwholesome fishing practices including Illegal, Unregulated and Unreported (IUU) fishing.

The first three sessions were held in Lagos, while the last one was organized in Douala Cameroon. A total of twenty four participants attended the meeting. This includes twelve (12) official delegates from Benin, Togo, Nigeria, Gabon, Equatorial Guinea and Cameroon, ten (10) observers from MINEPIA and IRAD and 2 FAO officers from Yaoundé and Rome. A draft Convention was also discussed. Participants were committed to carry out the necessary consultations within their States in order to obtain a national consensus on the draft convention under scrutiny. Member States also adopted that the same Argos facilities and equipment currently being used by

the countries within the Initiative that already established their VMS for uniformity and cost effectiveness. A survey of the economic performance indicators of fishing companies has been carried out in on fishing companies and the results presented during the MCS workshop held in Douala.

Lessons learned and future activities

Lessons learned

- Necessity for a close cooperation with Nigeria (from the very beginning of the project and recently on harmonization of fisheries legislation for the whole region started on the initiatives of the two countries.
- The familiarization with TED and BRDs on Nigerian vessels; There is hope now that the collaboration with Nigeria for the implementation of the BRDs and TEDs in the shrimp fishery will help the country organize its fishery sector.
- The creation of the initiative called the Sub-Regional Cooperation in Marine Fisheries Monitoring, Control and Surveillance in the Southern Gulf of Guinea;
- The possibility for Cameroon to export its shrimp products to US. The re-certification of Nigerian fishing products for the US market has naturally trickled an interest from the fishing Industry in Cameroon to also obtain the certification and with this – an opportunity to benefit from higher prices on the shrimp products.

Future activities

- Effective introduction and implementation of BRDs and TEDs in the Cameroon fisheries industry;
- 12 months BRD and TED experimentation, on-board sampling/Observer program (data collection using commercial vessels);
- Study on socio-economic impact of the By–catch trade in Cameroon should continue particularly data collection and provision of alternative means of livelihood;
- Training of Trawler-owners/skippers, technical staff and other stakeholders on BRDs and TEDs Devices building, and fishing gear construction.
- Collaboration of Delegates to engender a uniform approach among member states in the sustainable management of the living marine resources of the Sub-region;
- Organization of the 5th MCS meeting in Gabon. For this purpose FAO should translate the Draft Convention into French with copies sent to member countries before the next meeting, for a better understanding and participation of member countries;

References

Akande, G. 1998. Bycatch Utilization in Nigeria. In: Ivor Clucas (NRI) and Frans Teutscher (FAO): Report and Proceedings of FAO/DFID Expert Consultation on Bycatch Utilization in Tropical Fisheries, Beijing, China, 21–28 September1998; pp 241–251.

Alverson, D.L., Freeberg, M.H., Pope, J.G., and Murawski, S.A. 1994. A global assessment of fisheries bycatch and discards. FAO Fisheries Technical paper, 339, 233.

Bayagbona, E.O., Sagua, V.O., and Afinowi, M.A. 1971. A survey of the shrimp resources of Nigeria. Marine Biology, 11 (2): 178–189.

Clucas, I., and Teutscher, F. 1998. Report and Proceedings of FAO/DFID Expert Consultation on Bycatch Utilization in Tropical Fisheries, Beijing, China, 21–28 September1998; 329p.

Diakite, B. 1998. Bycatch in Marine fisheries in Senegal. In: Ivor Clucas (NRI) and Frans Teutscher (FAO): Report and Proceedings of FAO/DFID Expert Consultation on Bycatch Utilization in Tropical Fisheries, Beijing, China, 21–28 September1998; pp 235–239.

Hall, M.A. 1996. On bycatches. Reviews in Fish Biology and Fisheries, 6; 319–352.

Njifonjou, O. 1998a. The Awasha fishing fleet in the Cameroon coastal area: profitability analysis of the purse seine unit activity. 1998 IIFET Int. Conf. Proc.

Njifonjou, O. 1998b. Dynamique de l'exploitation dans la pêche artisanale des régions de Limbe et de Kribi au Cameroun. Thèse de Doctorat , Université de Bretagne Occidentale, 347p.

Njock, J.C., Njifonjou, O. 2004. L'utilisation des captures accessoires de la pêche crevettière au Cameroun : Rapport de l'atelier international sur la pêche crevettière dans le golfe de Guinée ; Douala, 12–14 février 04.

Legaspi, S., S.A. 1998. Bycatch Utilization in Philippines. In: Ivor Clucas (NRI) and Frans Teutscher (FAO): Report and Proceedings of FAO/DFID Expert Consultation on Bycatch Utilization in Tropical Fisheries, Beijing, China, 21–28 September1998; pp 105–113.