Fisheries Technology Committee **ICES CM 1998/B:3**

REPORT OF THE

WORKING GROUP ON FISHING TECHNOLOGY AND FISH BEHAVIOUR

La Coruña, Spain
20 - 23 April 1998

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

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1 INTRODUCTION

1.1 Terms of Reference

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Venue: La Coruña
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In accordance with ICES C.Res. 1997/2:13 the Working Group on Fishing Technology and Fish Behaviour [WGFTFB] (Chairman: Arill Engås, Norway) will meet in La Coruña, Spain from 20-23 April 1998 to:

a) review and evaluate recent selectivity studies of both mobile and static gear from the area of the North Sea;
b) review the report of the SGGRID;
c) consider related research in fishing technology and fish behaviour.

WGFTFB will report to the Fisheries Technology Committee at the 1998 Annual Science Conference.

Justification:

a) Selectivity studies of both mobile and static gears from the area of the North Sea will be the main theme of the meeting. In the last decade many researchers from various ICES member countries have been involved in a wide variety of selectivity studies in the North Sea area. It is time for a major review of the progress and the omissions in the research and the successes of implementation of this work into technical measures developed for North Sea Fishery management. Such a thorough review should identify the gaps in research and help plan the direction of future research in the North Sea.

b) The Study Group will report on this item. Since some countries have introduced regulations requiring the use of grids to reduce fishing mortality, there is a need to collect together the existing selectivity data to make it easily accessible.

c) Research is proceeding in member countries on fish behaviour, survey trawls, static gear, unaccounted mortality of fish and similar important topics which have been reviewed by the working group in recent years. New developments and progress reports on these themes are valued as indicators of change in the priorities for research.

Suggested works items for the FTFB Working Group

In addition to the above Fish Capture recommendations, the FTFB Working Group also made the following suggestions for work to be initiated prior to the next meeting in April 1998:

a) define the contents of a methods manual for use in selectivity studies of static gear (Action: T. Moth-Poulsen, Denmark)

b) report on progress of setting up a technical workshop for FTFB instrument users (Action: G. Bavouzet, France)

c) finalise the setting up of a FTFB webpage (Action: N. Lowry, Denmark and S. Walsh, Canada)

d) report on the progress of setting up an ICES database on commercial trawl selectivity (Action: B. van Marlen, the Netherlands)

e) report on progress of recent research addressing the unaccounted fisheries mortality issue (Action: A. Fréchet, Canada) and

f) investigate the feasibility of compilation of a survival database (Action: M. Breen, United Kingdom)

2 SPECIAL TOPIC: SELECTIVITY STUDIES, NORTH SEA

Keynote speaker: Norman Graham - A review of selectivity studies conducted in the North Sea. Oral presentation

Key points of the review: the North Sea and its fisheries, the principal gear types and target species, gear-related problems, discard levels, size selectivity, species selectivity, and adoption of selective gears by the fishing industry.

The North Sea is one of the most-studied seas in the world, also one of the most heavily exploited in all manner of ways, e.g., fishing, dredging for sand and gravel, and oil exploration and production. Cod, haddock, whiting, and saithe dominate roundfish landings, plaice and sole are the dominant flatfish species, although plaice landings have been declining in last decade. Herring and mackerel are the most important pelagic species.

Principal gear types: mobile gears include bottom trawls, Scottish seines, beam trawls, dredges, and pelagic trawls. Surrounding gears include purse seines and Danish seines. Static gears include gillnets, trammel nets, tangle nets, creels and pots, and longlines.

Gear-related problems are similar to those encountered elsewhere. Many problems have to do with the fact that these are all multi-species fisheries, with single gears built and regulated to a single standard harvesting multiple species with varying morphologies, behaviour, and biological parameters, leading to size and age discards and species discards. Environmental impacts include substrate impacts, impacts on the benthic community, and ghost fishing. It is also necessary to consider such politically sensitive issues as impacts on marine mammals and birds.

Discarding of undersized individuals of commercially important species is a serious issue. Officially reported haddock discards in the last ten years are around 40% of the total haddock catch by weight, and much greater if expressed in numbers. Statistics for whiting discards are even worse. The principal causes of such discards include the difficulty of choosing a single optimal codend mesh size in a mixed-species fishery such as this. In the case of whiting, the gear retains virtually all the legal fish but also retains even higher quantities of sublegals that must be discarded, while the survival of escaping sublegals remains controversial.

Various technical measures have been identified for improving the size selectivity of trawls, and some of these have been legislated: increase mesh sizes, improve mesh geometry, reduce twine diameter, and reduce codend circumference in terms of the number of meshes. Seasonal effects and catch effects are also important, but lie beyond human control.

L50s for various gears can be related to minimum landing size (MLS), and in many cases legislated gillnet mesh sizes have been more effectively matched to MLS than codend mesh sizes.

Numerous selectivity devices and other technical measures for towed gears have been examined with varying success. Separator trawls show potential for hake, grids for *Crangon* and pandalid shrimp, square mesh and escapee panels for *Nephrops* and roundfish, and veil nets for *Crangon*.

Why have selectivity measures not been more widely adopted and/or accepted, and what can we do to improve this? From the fishermen's viewpoint there is no perceived benefit to the individual operator. Most selectivity devices are expensive themselves or increase operating costs. There are potential gear rigging complexities or the gear is rendered less efficient. There may be handling problems or reduced fishing time. Inevitably there is some reduction in landings of marketable catch leading to lost revenue. In summary from the fisherman's viewpoint there is no incentive to use them; they all cost time, money, or both. It is easier to discard from the deck.

How can such measures be implemented? Legislative measures can be used, backed up by enforcement efforts. In practice, most simple measures achieve reasonable compliance. More complex measures require more complex legal and enforcement efforts. Sea-going enforcement is expensive, the risk of detection of non-compliance is low, and even if the measures are used their function is easy to defeat if the users are unwilling.

Another approach is to emphasise the benefits. Do selective measures lead to improved catch quality, thus better prices? Access to fisheries can be made conditional on use of selectivity devices; this is the dominant approach in the Barents Sea but has largely not been tried in the North Sea. Potential increases in future catches are a benefit. Do the laws of supply and demand help offset initially reduced landings? Better species selectivity could lead to more rational exploitation and management of mixed fisheries. "Greening" the industry has political advantages. Reducing discards leads to better knowledge of exploitation rates.

It is easier to conclude with questions than with answers. Can we achieve specific reductions in mortality solely by technical measures? Are complex gears realistically going to be used by the industry? Should we consider economic impacts of technical measures? Should we adopt a more multidisciplinary approach including the biological and financial implications of discards?

Finally, we must have more involvement from the fishing industry.

Comments and discussion: Discards are considered in the assessments, but are not subtracted from the quotas. "Ownership" management approaches such as individual quotas could also be beneficial. Poor linkages exist among minimum mesh sizes, minimum landing sizes, and actual biological parameters. Consumer linkages are potentially important such as pressure for environmentally-acceptable fisheries, but means for establishing and implementing such linkages are challenging and not obvious. At present, fish discards are not high on the Green agenda in Europe, but this could change. It was pointed out that these same issues have been raised many times over many years, but there seems to be little progress. There is a need for a forum where industry, scientists, and fisheries managers can come together for effective dialogue leading to change.

Erdmann Dahm – Measurements of codend selectivity for North Sea saithe by the covered codend and divided trawl methods. Written contribution and oral presentation.

Aims of the investigation: The North Sea saithe stock is heavily exploited. Landings have recently declined and are only now starting to respond to limited quotas. There is potential for technical measures to help improve the situation, but the knowledge needed to implement them on a scientific basis is limited and must be augmented by research.

Diamond mesh and square mesh selectivity were evaluated in two ways: covered codend and divided trawl. Selectivity parameters were virtually identical for diamond and square mesh codends of the same mesh size. Use of a large-mesh strengthening bag outside the codend did not reduce selectivity in either diamond or square mesh codends, even when the outer bag's circumference was reduced. Selectivity parameters were higher for divided trawls.

This independence between mesh shape and selectivity suggests a vigorous fish that will actively exploit escapee opportunities. It is felt that the differing selectivity results obtained with the two methods (covered codend vs. divided trawl) may be due to differences in catch composition within the codend, that selectivity will be impaired with more small fish and bycatch organisms present.

Hans Polet –Cod-end and whole trawl selectivity of shrimp beam trawls. Written contribution and oral presentation.

The study found high variability in both L50 and selection range for *Crangon* shrimp. Only sea state, catch volume, and clogging by hydrozooans had significant impacts on L50, only clogging on selection range. Selectivity for finfish was quite poor. Whole-trawl selectivity was also measured and showed that 10% of all shrimp escaped below the footrope. Most undersized shrimp escaped through the body of the trawl, followed by the codend. 80% of the marketable shrimp arrived in the codend, with only minor escape rates through the codend or the body netting. When a grid was installed, codend catches were smaller and cleaner resulting in better selection.

It appears that high sea states increased selectivity by inducing surges in the codend either on the bottom or at the surface thus washing the shrimp out. There was a comment that the small-mesh pockets used to measure whole-trawl selectivity may have biased the results.

Kurt Kvalsvik, Ole Arve Misund, Kjell Gamst, Roar Skeide, Ingvar Svellingen, Håkon Vetrhus – Size selectivity experiment using sorting grid in pelagic mackerel (*Scomber scombrus*) trawl. Written contribution and oral presentation.

A high exploitation rate makes it necessary to use size-selective fishing gear to maximise the growth potential of the resource. There is also a strong price differential according to fish size that also favours the selective harvest of larger fish, especially fish weighing 600 gm or more. Experiments were carried out on the west coast of Norway with a single grid installed in a pelagic trawl. The grid was 3 m long by 2 m wide with an aluminium frame and GRP bars spaced 42 mm apart. A guiding ramp was installed in front of the grid, which was held at a 30-degree angle within the extension piece. The grid was attached at its leading edge to the tope of the extension and sloped down and aft. with a gap between its bottom edge and the floor of the extension allowing passage of retained fish into the codend. Towing speeds were around 4.5 kn. and flows through the grid were about the same except when there were large fish concentrations in the grid section. The first trials yielded 48% selection, with smaller fish escaping through the grid were about the same except when there were large fish concentrations in the grid section. The first trials yielded 48% selection, with smaller fish escaping through the grid into a collection bag. In the second trial 40% of the fish were selected out, again with reasonable size selection- The L50's in both trials were about 37 cm, with a wider selection range on the first trial where more small fish were encountered. It appears that reductions in the bar spacing may be needed in order to optimise selectivity. A Scanmar grid sensor proved useful for detecting when fish were passing through the grid and indicated when fish were schooling too heavily in front of it. No escapee survival studies were carried out, but results from tests on survival of mackerel escaping from a purse seine through a grid suggest that survival should be high. The grid was large relative to the deck space typically available on this class of vessel, causing some handling problems. A new version has been developed, articulated in four sections to roll up on the net drum and employing 38-mm bar spacing, but no trials have been carried out yet.

Unlike other studies with similar gear and species, no cases were observed with very large pulses of fish accumulating in front of the grid and blowing out the trawl before they could pass through the grid. There are no plans at the present time for focused escapee survival studies, but video observations during upcoming experiments should indicate likelihood of injury rates. High catch rates in this fishery are problematic for present survival research methodologies.

Comments and discussion – The presence of a cover has affected mackerel behaviour in other grid experiments. Grid sensors can be used to detect high concentrations accumulating before the grid to allow tactical adjustments in the fishing operation. Mackerel swam through the grid headfirst. There may be interest in the industry to use such grids to high-grade fish. Fish were heterogeneous in size because these tows were made through layers of scattered fish and small schools rather than large dense homogeneous schools. It was felt that using relatively large diameter bars in the grid should lead to lower injury levels.

Hans Polet –Experiments with sorting grids in the Belgium brown shrimp (*Crangon crangon)* fishery. Written summary and oral presentation.

Tests were done on a research vessel, then replicated on a commercial vessel. On the research vessel a cover was installed over the grid outlet, but on the commercial vessel an 80-mm outer codend was used surrounding the entire codend as well as the outlet to permit retention of marketable fish. Small shrimp were excluded by the grid, apparently entrained in the water flow. Small flatfish also seemed to be carried out the outlet, especially on the commercial vessel perhaps due to improved flow. Other bycatch species also seemed to be substantially excluded. Large numbers of starfish caused severe clogging, resulting in high shrimp loss. Plans are underway to develop means to pre-sort starfish. Apparent advantages of grid use: cleaner catch, exclude small shrimp, conservation of pre-recruit finfish for other fisheries, and less impact on habitat. However, to the individual fisherman there are losses of marketable catch. Also, juveniles of species preying on shrimp will be conserved, and perhaps lower discards of fish will reduce a food resource for shrimp.

Comments and discussion – The grid bar blockage ratio is about 25%. The grid was installed just behind the trawl body, about 5 m from the end of the codend. No flapper or guiding funnel was used. When the grid was not used, most small shrimp escaping through the body netting escaped through the bottom panel, but with the grid installed most small shrimp escapes were through the upper panel suggesting a change in water flow patterns throughout the trawl body. Codend mesh selectivity seemed to increase substantially when the grid was installed.

Dick Ferro – Recent Scottish data on demersal fish selectivity. Oral presentation.

What is the overall fleet selectivity for the Scottish fleet fishing in the North Sea, allowing for wide ranges in environmental variables, gear, etc? Ignoring haul-to-haul variability, is it possible to detect significant effects due to gear design, the sorts of things we can design and legislate?

The data set was obtained from selectivity experiments conducted on commercial vessels in 1991 and 1992. There were 14 experimental cruises in all, 2 on pair trawlers, 10 on single boat trawlers, and 2 pair seine cruises. The covered codend method was used, and 58 different codends were examined. Most of the data were on cod and haddock but so far only haddock data have been analysed. The study variables included codend mesh sizes ranging from 67 to 117 mm, different codend circumferences ranging from 54 to 134 meshes around, twine thickness from 2.9 to 6.3 mm (double), season, and gear type. There could be confounding between vessel effects and gear type effects in the pair trawling and pair seining studies due to the low numbers of observations.

The analytical approach calculated a mean selectivity curve incorporating between haul variations on mainly unraised data, using the log-link model for L50 and log(SR). Data were weighted inversely to the variance.

Focusing on the relationship between mesh size and codend circumference, holding constant such variables as twine thickness but not gear type or season, a plane of predicted L50 values was produced, from which departures of observed values could be observed. The sensitivity of L50 to study variables was examined, showing that mesh size had strongest influence, followed by codend circumference, and finally twine thickness.

What are the impacts of legislative changes on these variables? If only one variable is changed then it is easy to adjust the other factors to compensate and hold L50 constant or even depress it. For example, increases in codend mesh size or reductions in circumference can easily be compensated for by increases in twine diameter.

Conclusions: even allowing for all other variables there is a significant effect of codend design across the whole fleet, and there is probably a seasonal effect. There may be a gear type effect but if so it appears to be weak relative to the codend design variables. Accordingly, legislation may be worthwhile, but its real-world is effectiveness is problematic if there is reluctance.

Necessary additional work: Windows? A larger data set. More fish behaviour studies could point to new gear design and facilitate effective contributions from gear manufacturers.

Comments and discussion – More sophisticated analysis could assess potential confounding of vessel and/or cruise effects with other effects. There did not seem to be a significant net effect within gear types. There were no significant effects on selection range across this study; selection range was quite stable. Twine thickness is only one of the considerations, twine stiffness could also be manipulated to reduce selectivity factors. The catch sizes were typical of commercial sizes, up to several tons. Surprise was expressed that gear type showed so little effect since the characteristics of the fish entering the different gear types should be quite different.

Erdmann Dahm, Barry O'Neill, John W. Valdemarsen, Charles W. West, Harald Wienbeck – Factors affecting the variability of cod-end selectivity: the effect of towing speed and gear size. Written contribution and oral presentation.

If selectivity varies with vessel size, the fishing mortality exerted by a fishing fleet may be influenced by changes in the vessel size structure of the fleet. This may easily happen due to modernisation or legislative controls on fishing opportunities related to vessel size. The mechanisms by which vessel size are likely to affect selectivity are thought to be either differences in towing speed or in fishing gear size. Towing speed on the one hand will determine the flow of water through the codend and related to this geometry. The total size of the gear on the other hand could possibly determine the total size of the catch or the catchrate (catch in standard time).

Selectivity data from the same codend and the same area were collected in April 1995 by the FRV "Solea" and the FS "Marandi". Due to bad weather conditions only the effect of towing speed could be investigated during this period. The effect of gear size was tested during a cruise of FRV "Solea" in April 1997. The same cod-end was attached to two trawls of similar design but different size (444 and 528 meshes around fishing circle).

The analysis of the 1995 data revealed a moderate increase of 50% retention length with speed in the data of "Marandi" whereas the data from "Solea" proved the opposite. In contrary, catch size proved to be an important source for the variability of selectivity parameters on both ships. Up to a catch of 800 kg the 50% retention length steadily increased.

The 1997 data from "Solea" prove neither an influence of catch size nor of gear size. The restricted range of catch sizes obtained during this cruise, however, forbids extrapolation of these data.

Towing speed may have a certain effect on the selectivity of a given cod-end but this effect, apparently, may easily be affected by other aspects of the fishing operation as the hauling procedure or the vessel motion during fishing. Any evidence that gear size significantly affects the selectivity of the same codend in a ceteris paribus experiment is not existing.

Comments and discussion – It was pointed out that L50 increased with increasing catch size up to around 800 kg, but after that it flattened out or declined.

Nicholas Lowry, David Wileman and Dick Ferro –Factors affecting the variability of cod-end selectivity. Written contribution and oral presentation.

Data were obtained from 6 vessels participating in 9 experimental cruises engaged in a co-ordinated study of codend mesh selectivity. 99 hauls yielded usable selectivity data for haddock, 61 for cod. The analytical model focused on L50. The model showed L50 increasing with catch for both species up to about 600 kg; for haddock it then apparently declined, for cod it stabilised but with much scatter. Continuing the analysis by breaking the data set into hauls below and above the inflexion point of around 600 kg catch size, L50 increased with increasing sea state, L50 was lowest with post-spawning fish and was highest in late summer. The experimental method proved to be a strong factor: L50 was highest for trouser trawl studied and lowest for covered codend studies. However, this effect could be an artefact since the only vessel on which the trouser trawl technique was employed was a side trawler while all other work was carried out on stern trawlers.

Comments and discussion –The sea state effect could be due to either washing fish out of the codend at the surface during haulback, or due to the codend pulsing during the tow. This is an important point since the implications for escapee survival are quite different depending on whether fish escape at the fishing depth versus being strained out at the surface.

B. Bertelsen, A. Engås, T. Jørgensen and O.A. Misund – Trials with grid in the commercial trawl fishery for saithe in the northern North Sea. Written contribution and oral presentation.

In connection with the proposed introduction of a new minimum legal size at capture of 40 cm for saithe (*Pollachius virens*) in the Norwegian EEC south of 62°N and proposed new regulations prescribing use of grids in the industrial saithe fishery, experiments were carried out to determine the appropriate grid bar spacing required to achieve this target. The fishing trials were carried out along the western slope of the Norwegian Deeps and a total of 45 hauls were taken. A codend mesh size of 100 mm (the minimum legal commercial mesh size) was used. Some hauls were also made with an inside blinder of 52 mm mesh size. Sort-X grids with bar distances of 45 and 50 mm were used. The catch comprised mainly of saithe, haddock (*Melanogrammus aeglefinus*) and cod (*Gadus morhua*). The 50 mm bar spacing corresponded with a 50% retention length of 55.7 cm and resulted in considerable loss of saithe above 40 cm. A bar distance of 45 mm gave mean retention length of 48 cm for saithe, the selection range 8.4. Overall, 5% of the catch was below 40 cm when the 45 mm grid was used with a codend mesh size of 100 mm. Retention lengths for cod and haddock were estimated at 44.0 and 38.1 cm, respectively.

Comments and discussion – Retention of undersized saithe was low with the best grid and codend configuration, and losses of marketable fish were low.

Norman Graham – Bycatch reduction in the brown shrimp fishery using a separating grid. Oral presentation.

The trials were carried out on *Crangon* grounds on English east coast, which are also important finfish nursery grounds. Most *Crangon* vessels now use twin beam trawls. About 40% of the fleet already use veil nets to sort out small fish, but there is interest in grids. After some alternatives were examined, an inexpensive plastic grid was designed and tested in one side of the twin beam trawl system. This yielded about 75% reduction in whiting bycatch, about 40 to 50% for plaice. There was a positive relationship between fish length and escape probability. There was a mean shrimp loss of

9% with the grids. However, accumulations of weed, starfish, and other debris could cause substantial shrimp losses of up to 30%.

Comments and discussion – Bycatches per tow were substantial but estimates by weight or proportion are unavailable. Grids offer potential advantages in bycatch reduction over veil nets.

Ingvar Huse – Trawl grid selection of industrial fish in the North Sea. Oral presentation.

The Norwegian industrial fishery in the North Sea targets sandeel and Norway pout, with some bycatch of important foodfish species. In order to reduce this, efforts were made to introduce grids. The grid tested was based on shrimp-type grids employing a leading net to guide the fish towards the lower part of the upwards-slanting grid. The best results were obtained with the leading panel directly in front of the grid, forcing the fish to swim through a narrow passage between a netting panel and the grid. Behavioural differences between the pout and the foodfish, particularly juvenile haddock, facilitated separation up to 57% for haddock with about 20% loss of Norway pout. However, blue whiting and argentines proved more difficult to sort out, with escape rates of around 30% and 40% respectively. In summary, grids offer some potential but further strategies are necessary such as time and area closures.

Discussion of special topic

Bycatch is a special problem in the North Sea fisheries. It is a particularly challenging area in which to work because of the large number of multispecies fisheries, and because management must be on a multinational basis. Stock assessment biologists have made it clear that fishing mortality must be reduced, and improving selectivity through technical measures can be part of the solution since many of the important North Sea species are sensitive to bycatch and will respond to successful discard and bycatch reduction measures.

Are we able to go fishing for specific species and size groups, and if not, why? What more information do we need?

There are three major areas in which various members of the Working Group can and do contribute:

Provide selectivity data for stock assessment biologists;

Help achieve bycatch reduction through gear improvements or development of new gears and methods; and

Develop useful models of selectivity processes.

One consistent problem is that by the time one identifies a problem, develops a research program, and carries it through to a conclusive result (in the best case), the situation may have evolved such that the results are no longer relevant to the end users. It is necessary to both accelerate the process and to involve biologists, economists, and fishermen throughout the process from planning, through the research and development phase, to the conclusion. These are multidisciplinary problems with many different interests involved and it is seldom productive to work on aspects of it in isolation.

If strategic issues such as those described above can be accommodated, a potentially effective approach for developing useful technical measures is to start with species selection, then perform further selection on the separated species if necessary. However it is extremely difficult to achieve perfect, or sometimes even satisfactory, species selection by technical measures alone. It is often necessary to apply a combination of technical measures and management measures such as time and area closures.

It was reiterated that the biological and economic dimensions must be considered, that this is key to establishing the sort of motivation among stakeholders that is necessary to ensure adoption. Legislation is only one dimension of this, albeit an important one. There is a consistent failure to demonstrate to the fishermen the short and long-term benefits that they will individually receive by improving selectivity. Again, more involvement by all stakeholders is needed. It is necessary to develop rational management schemes that reward selective fishing practices.

While bio-economic issues are important, albeit neglected, there is a trend of increasing pressure from the environmental and conservation community which can override other considerations. In the face of this, any efforts to reduce bycatch can be useful almost irrespective of the biological and economic issues.

Bycatch and discard problems are much less serious with static gears. However they have received a great deal of public attention, perhaps out of realistic proportion, due to public attention to charismatic species. A comment was made that in some regions the selectivity of static gears is not adequate.

It was pointed out that estimating fleet selectivity is different from developing and introducing selective gears, and that considerable success has been achieved, albeit slowly, in moving towards credible measures of fleet selectivity.

A proposal was made to mention the potential for modelling selectivity. However, while this has value in terms of improving our understanding of the process and guiding our research, it may not necessarily take us much closer to quantitative measures of whole-fleet selectivity here and now, the sort of information sought by assessment biologists and fisheries managers.

A group comprising Peter Stewart, Ronald Fonteyne, Norman Graham, Erdmann Dahm, Dick Ferro, Ingvar Huse, Bjørnar Isaksen, Bob van Marlen was selected and charged with the task of producing a response to the Fishing Technology Committee's request for a review of the selectivity of fishing gears used in the North Sea. This group met on 23 April, 1998 and subsequently reported to a full meeting of the Working Group, at which time the following remarks were reviewed, amended, and adopted:

Mobile gears

Size selectivity

It is important to distinguish between factors influencing selectivity that vary from haul to haul and those that do not vary. These between-haul variables should not be considered in analyses of fleet selectivity, and include such factors as catch size, sea state, time of day, water depth, and other variables.

Fleet selectivity should be considered in terms of mesh size, codend circumference in meshes, twine thickness, gear type, the type of selectivity device (if any) employed, and seasonal effects.

Techniques exist for maintaining and analysing large data sets, and these could be used to derive estimates of fleet selectivity. However, to do so a strong and comprehensive database on selectivity is a necessary prerequisite, and no suitable database presently exists that draws on the many selectivity studies carried out by various national establishments.

While the range of important species covered in these scattered data sets is incomplete, sufficient data are available to permit estimates of fleet selectivity for the following species: haddock, whiting, saithe, plaice, sole, and *Nephrops*.

The latest summary and review of selectivity data was produced by Wileman (1995?).

A monitoring programme is required for tracking whole fleet selectivity for all important commercial species. The frequency of such monitoring efforts depends on changes in gear design and operations in the fleets and the implementation of new technical measures, but should be carried out at a rate of at least once every five years.

Species selectivity

Data have been collected on the performance of divided trawls, square mesh panels, and grids in various North Sea fisheries. However, industrial fisheries have not been sufficiently studied.

Some species-selectivity methods have been acknowledged as generally successful in commercial fisheries, including:

- grids (although not yet applied in North Sea fisheries); and
- square mesh panels in *Nephrops* trawls.

Despite their positive performance in research settings divided or separator trawls are not being used in commercial fisheries.

Static gears

- More research is needed to reduce bycatches of marine mammals and seabirds.
- More research is needed on specific fisheries that have not yet been investigated.

Two tables were prepared characterising our present knowledge on various means for manipulating the selectivity of towed gears. In both tables, "Complexity" refers to the difficulty in terms of time, money, or effort that commercial fishermen might be expected to experience in implementing the technique while "Effectiveness" means the potential effectiveness based on research findings and recognizing that full effectiveness may not necessarily be realised in actual commercial fishing conditions. "Target species" are coded as follows: "DR" for demersal roundfish, "DF" for flatfish, "SH" for shellfish, and "PR" for pelagic roundfish.

Table 1. Technical measures for influencing size selectivity

Technique	Complexity	Target species	Effectiveness
Codend mesh size	Low	DR, DF	Good
		SH	Moderate
Codend circumference	Low	DR, SH	Moderate
		DF	Poor
Twine thickness	Low	DR, SH	Good
		DF	Moderate
Square mesh codends	Moderate	DR, SH	Good
		DF	Moderate
Square mesh panels	Moderate	DR	Moderate
		DF, SH	Poor
Baltic panels	Moderate	DR	Moderate
		SH	Moderate (?)
		DR	Poor
Grids	Moderate/High	DR	Good
		PR	Good (?)
		DF, SH	Moderate
Modified groundgear		DR	Good

Table 2. Technical measures for influencing species selectivity

Technique	Complexity	Target species	Effectivenes
Codend mesh size	Low	Mixed	Good
Codend circumference	Not applicable or no data		
Twine thickness	Not applicable or no data		
Square mesh codends	Moderate	DR, DF	Good
Square mesh panels	Moderate	DR, DF, SH	Moderate/Good
Baltic panels	Not applicable or no data		
Grids	Moderate/High	DR, DF, SH	Good
Modified groundgear	Moderate	DR, DF	Moderate

3 THE ICES FIVE-YEAR PLAN

(Peter Stewart)

There is new emphasis on communicating with other ICES committees, co-ordinating overlapping research activities. There is increasing interest in the environmental impacts of fishing operations, and this may be a good time to respond with increased research effort. Concern was expressed that the activities of FTFB and FAST not be too rigidly demarcated, Behaviour is an important issue for both Working Groups, but there has been a lull in such research in recent years. Direct assessment of fisheries is increasingly important, and this group is particularly competent to offer advice on improving these methodologies. (See also new business).

4 SURVEY GEAR STUDIES

David Somerton and Peter Munro – Estimating the efficiency of a flatfish trawl. Written contribution and oral presentation.

Groundfish and crab populations in the eastern Bering Sea are assessed annually with a bottom trawl survey using the 83–112 eastern trawl. The net efficiency of this trawl, or the proportion of animals between the trawl wings that are captured, has been assumed to be unity. However, recent studies using low light video cameras demonstrated that even large crabs and flatfish can often escape under the footrope. Such observations prompted us to experimentally estimate net efficiency with an auxiliary bag attached beneath the trawl to capture fish and crabs escaping under the footrope. Unlike the trawls previously examined in escapement studies, the 83–112 trawl lacks bobbins or rollers on the footrope and instead has a footrope consisting of a simple, rubber-wrapped cable. This difference in trawl design required several distinct differences in the design of the auxiliary bag, including the elimination of the upper panel and the addition of a heavy chain footrope.

Net efficiency for three species of flatfish examined was quite high. For rock sole (*Lepidopsetta bilineata*) and flathead sole (*Hippoglossoides elassodon*), efficiency was invariant with fish length and averaged > 0.90 over the entire size range. For yellowfin sole (*Limanda aspera*), efficiency increased with length, reaching the asymptotic limit of 0.75 at about 25 cm. For Pacific cod (*Gadus macrocephalus*), efficiency was 1.00 over the entire size range. Net efficiency for two crab species, snow crab (*Chionoecetes opilio*) and Tanner crab (*C. Bairdi*), was high at the smallest sizes, declined to a minimum at about 50 mm carapace width and then increased asymptotically at larger sizes. The reasons for the apparent increase in efficiency at small sizes is unknown, but we believe that small crabs may pass under the trawl footrope and enter the trawl by passing vertically through the belly meshes. If this does occur, the important question is whether this is a usual feature of the trawl or an experimental artifact.

The attachment of the underbag to the trawl resulted in two problems: 1) a decrease in wing spread, presumably from increased drag on the bottom and 2) a high catch of benthic epifauna. Average wing spread for hauls with standard 55 m bridles was 14.3 m, considerably less than the 17.0 m mean width of the standard net. Shortening the bridles to 28 m increased average wing spread to 15.4 m. The underbag rapidly filled with epibenthic fauna, especially brittle stars, resulting in a progressive narrowing of the net by as much as 3 m over the duration of a haul. After 7 attempts at trawling in the initial study area, we were forced to locate a new study area with a lower abundance of brittle stars.

Comments and discussion – This study looked at footrope efficiency alone, but to get the gear to function it was necessary to vary the rigging, which may have affected herding and other aspects of whole-gear efficiency.

Derek Galbraith – Underwater video of the deep-water species in trawl codend west of Scotland. Video and oral presentation.

Comments and discussion – This was a preliminary effort aimed at evaluating potential sampling gears for an upcoming survey. Some behavioural observations of indigenous species were also made.

Discussion – survey gear

Much work has focused on footrope efficiency and trawl efficiency, but how do we go forward with estimates of sweep efficiency and other elements of whole-gear efficiency? Whole-gear efficiency, including reactions to the ship and otherwise in front of the gear, is the necessary parameter in order to develop absolute abundance estimates from trawl catches, and absolute abundance is an essential input for ecosystem and other multispecies models. Studies of fish behaviour in front of the gear show that it is highly variable.

5 STUDIES OF UNACCOUNTED MORTALITY

M. Ulmestrand and D. Valentinsson, G.I. Sangster, D. Bova, R.J. Kynoch, M. Breen, G.N. Graham, A.V. Soldal, O. Cruickshank, T. Moth-Poulsen and N. Lowry – *Nephrops* survival after escape from commercial fishing gear or discarded from deck. Written contribution and oral presentation.

The experiment described in this paper is a part of a joint Scottish/Danish/Norwegian/Swedish EC Fair Project CT-95–0753 "Roundfish and *Nephrops* Survival After Escape from Commercial Fishing Gear". The sea trials were carried out by a Scottish prawn trawler during July-August in 1996–97 in North West of Scotland. New design of *Nephrops* holding pens with 96 compartments each were placed on the sea bottom and used for indicidually separation of *Nephrops*. After

trawling, *Nephrops* from the cod-end cover and sorting deck were randomly collected and held in individual perforated plastic tubes submerged in seawater deck tanks. A diving team transferred the *Nephrops* to the sea bed pens and monitored the mortality daily for at least 11 days.

Results from triplicated cage experiments are presented on mortality rates of *Nephrops* that have escaped through three different codend meshes or being discarded from the vessel's deck. Creel caught *Nephrops* were used as control group.

Significant differences in mortality were found between discards, escapes and controls. The estimated mortality rates were 69%, 19%, 1% for discarded, escaped and controls respectively. No significant differences were found in mortality between the different cod-ends. Mortality was not size dependent.

The results on significantly higher survival for escapes than for discards support the aims towards more selective gear.

Nephrops were caught in one of three different codends: 70-mm diamond mesh, 100-mm diamond mesh, and 60-mm square mesh. "Discarded" and "escaped" *Nephrops* were placed in seabed cages and their survival evaluated. Control animals were caught in traps and subjected to the same cage and observation treatment. Tow durations were 1–2 hours for escape observations, 3–4 hours for discard experiments. Cage observation periods varied from 11 to 25 days, but nearly all mortalities were observed within 7 days. Mortality rates for discards were very high (ca. 70%), substantially lower (10–20%) for escapees, and nil for controls. There was no codend effect for either escapees or discards. There was no effect of Nephrops size. It is likely that discard mortality rates in commercial fisheries are higher, conversely this experiment probably overestimates escapee mortality. This supports the use of selective trawl gear.

Dan Erickson, Ellen Pikitch, Petri Suuronen, Esa Lehtonen, Christopher Bublitz and Christopher Mitchell – Selectivity and mortality of walleye pollock escaping from the codend and intermediate section of a pelagic trawl: results of a pilot study. Written contribution, brief video, and oral presentation.

This paper summarises results of an at-sea fisheries experiment conducted in the Gulf of Alaska during June 1997. The purpose of this research was to qualitatively evaluate escapement of walleye pollock (*Theragra chalcogramma*) passing through codend and intermediate (= extension) meshes of a pelagic trawl and to test the applicability of a caging method for measuring escape mortality for this species.

Although walley pollock escaped through a square-mesh window placed in the tope panel of a codend, these meshes became increasingly blocked as catch volume increased. Pollock actively escaped through a square mesh window sewn into the top panel of the intermediate (as far as 18 m head of the catch bulge). We concluded that catch of undersized pollock can be reduced in the North Pacific pelagic trawl fishery if square-mesh panels are placed in the codend and the intermediate.

A caging method developed by Finnish Game and Fisheries Research Institute was improved and applied to a pelagic trawl to measure mortality of pollock escaping codend and intermediate meshes. Escaping fish were herded to the caging system either by a top-panel cover or by a full codend cover. This caging system is unique in that samples of escaping fish can be collected at any desired moment of the tow.

Control specimens were caught by seine and subsequently handled in the same manner as trawl escapees. Size distributions of seine-caught pollock were similar to sizes of pollock that escaped through trawl meshes. All seine-caught pollock were alive and in good condition after approximately a 64 hour holding period in the collection cage.

Comments and discussion – Filled cages were towed at ca. 1 kn to the staging area for about 1 ½ hours. A suggestion was made that the cages be put into a container to protect the fish during this towing period. The point was made that this low-speed towing is probably less injurious than the exposure the collected fish get while they are being collected during fishing operations.

Henry Milliken, H. Arnold Carr, Marianne Farrington, Emily Lent – Survival of longline Caught Sub-Legal Cod and the Results of the Catch Comparison Between 11/0 and 15/0 Hooks. Written contribution and oral presentation.

Longline fishing bas been touted as a clean, low impacting fishing method. However, some longline fishermen and biologists have expressed concern that there is a high mortality rate for cod and haddock that pass trough and de-hooking device aptly called the "crucifier" before they are released. This device is usually two parallel steel cylinders placed vertically on the gunwale and used to remove the hook from the mouth of the unwanted fish. The hooked fish on

the longline encounters the crucifier during the hauling of the gir and the hook is pulled from the fish. This may result in severe injuries to the mouth of the fish.

Two separate studies were conducted to determine: 1. The survival of sub-legal cod caught in the longline fishery using 11/0 circle hooks; And 2. To determine the length frequencies of cod caught on Mustad 11/0 vs. A modified Mustad 15/0 circle hooks. The modified hook was constructed of 11/0 hook gauge wire, yet had a 15/0 size. The focus of the research was to assess the longline fishery and the impact on the sublegal catch. Results from the study show there is a high mortality associated with capture using the 11/0 circle hook and that the catch of sublegal cod can be significantly reduced when a modified 15/0 circle hook in fished in lieu of an 11/0 hook.

Comments and discussion – Fish were observed at the surface after release, and about 1/3 seemed to have the potential to survive. The caging period was 72 hrs, with no observations between the time of cage placement and cage recovery. Cage mortalities were high even for control fish, and the comment was made that in caged sablefish studies there is very little mortality within the first 48 hrs, with sudden onset of almost complete mortality within the next 24 hrs of cage confinement. There was mention that in Danish studies there is a consistent difference in condition between hook-caught and gillnet-caught fish, so it is not safe to assume that fish caught in one manner for a control will have the same fate as fish caught another way for the study.

Henry Milliken– The physical response of juvenile Atlantic cod (*Gadus morhua*) to longline capture. Poster (Authors: Marianne Farrington, Emily Lent, Arne Carr, and Henry Milliken.) and oral presentation.

The relationship between the stress response and the survival rate of juvenile bycaught cod was assessed. Blood parameters, including sodium, potassium, chloride, osmolality, glucose, cortisol, lactate, and proteins were analysed for juvenile cod caught in the longline fishery in the Northwest Atlantic. Animals were subjected to one of two injury levels: (1) wounded by mechanical hook removal or (2) minimal injury due to manual removal (TLC). Blood parameters were assessed for two groups of fish, those bled immediately after removal from the gear, and those allowed to recover for 72 hours. These values were compared to jig-caught fish treated in the same manner which served as normal and control fish, respectively. The survival rate for the TLC fish was approximately equal to that of the control fish, and was greater than that of the wounded fish. Fish bled immediately after removal from the longline, both wounded and TLC, showed dramatic increases in cortisol (14 x normal levels), lactate (5 x), and glucose (2 x). Proteins, hematocrit, and osmolality showed slight increases immediately after removal, while sodium and chloride showed no change. Potassium was slightly elevated in TLC fish and slightly depressed in wounded fish after removal from the gear. After 72 hours of recovery most parameters had recovered to near normal values. Those that differed from normal (proteins, cortisol, lactate, sodium, and chloride) approximated values found for the control fish and may be indicative of effects of the cage. The depression of potassium levels in wounded fish was worsened during the recovery period, while in TLC fish it returned to normal levels. The role of potassium in survival remains unclear.

Phillip MacMullen – FANTARED: Lost net studies in shallow water areas of Portugal, Spain, and the UK. Oral presentation.

Objectives: to quantify the extent of loss of gillnets and determine factors leading to net loss; to determine typical patterns in the physical evolution and movement of lost nets; and to assess the extent and duration of the fishing mortality resulting from lost gillnets at a number of field sites.

A survey was performed among fishermen to identify the extent of net loss, factors leading to net losses, and the likelihood of recovery. The survey covered fishing areas, target species, mode of operation, circumstances of loss, and other factors. Losses were usually due to weather and encounters with towed gears.

At four study areas off Spain, Portugal, and the U.K., experiments were conducted with experimentally "lost" nets to characterise their fate and ghost-fishing properties. The nets were systematically examined by divers, who recorded data on their physical condition and catching performance. The nets deteriorated very quickly as soon as there were any instances of bad weather. Catch rates also decayed quickly within a matter of a few weeks.

Various factors determined how long a ghost net could "survive": water depth and associated strength of water movements, exposure to weather, seabed characteristics, the presence of crabs in the area, light and temperature levels, interaction with towed gears, and various combinations and interactions of these factors.

In conclusion, gillnets lost in inshore areas stop fishing very quickly, but ghost nets in deeper water could be more troublesome due to the relative absence or weakness of the factors that make nets lost in shallow waters deteriorate.

Comments and discussion – Biodegradable twines have long been discussed but there has been no implementation. Further studies will be conducted in deeper water. Fishermen support such research once they are made aware of the potential economic losses due to ghost fishing, but oppose it as long as they only sense a threat from environmental organisations.

Andy Revill – The biological and economic impacts of discarding in the UK (East Coast) brown shrimp fishing fleet (paper). Written contribution and oral presentation.

Crangon grounds also are usually nursery areas for finfish. *Crancon* are mostly fished with beam trawls with 20-mm mesh sizes. Juvenile finfish bycatches are quite high, commonly around 50%. Typically the vessels are small, 300 HP or less. There are many more vessels involved in this fishery in Germany and the Netherlands than in France, Denmark and the UK. Studies showed large numbers of finfish discards, but no evaluations had been made on the biological or economic significance of these discards.

Revill applied various models to evaluate this for the UK fleet. He estimated discard reductions attributable to grids and sieve (veil) nets, converted to reductions at age for the finfish species, then used these as input values in various biological and economic models. The models also included discards by other fleets, natural mortality and economic value.

Results showed that for UK fleet the present level of finfish discards in the *Crangon* fleet has a value of 2 million pounds. Estimated total value of additional landings if the whole fleet used sieve nets would be nearly 1 million pounds, and this should be bit higher if grids are used instead of sieve nets. The model shows that it is important to look at final biological and economic parameters, not just initial discard quantities. The model did not consider such economic costs of using selectivity devices as loss of target species, which seem to be around 10%. Revill also pointed out that economic benefits (e.g., increased value of plaice catches) will not necessarily fall to the *Crangon* vessels operators who incur the costs of reducing bycatch. Since these were single-species models, effects of ecosystem responses could not be evaluated.

Comments and discussion – Confidence intervals about the estimates are about ± 25%. Sensitivity analyses are underway on the various model components. It was mentioned that discard rates can vary substantially from one year to another. There was considerable discussion of the economic, social, and political implications of work of this nature, but it was pointed out that economic characterisations are more easily understood by a broader audience than technical descriptions of bycatch and discard rates.

Mike Breen, Graham Sangster and Aud Vold Soldal – Evidence of Cover Induced Mortality in Fish Survival Experiments – A Cautionary Note. Poster.

Most experiments investigating the survival of fish escaping from trawl cod-ends have used cod-end covers to capture/sample any escaping fish. In the cover fish can be exposed to a continuous flow of water for up to 50 minutes and it has been suspected that their use may cause injury and fatalities among fish caught in them Recent technological developments have permitted the cover to be closed and released remotely. This has enabled researchers to sample fish at any phase during a tow and for any length of time. This paper describes analysis of survival data for haddock and whiting using simple multiple-linear regression with explanatory variables including mesh size, cover exposure and experimental year. Evidence is presented to suggest that the survival of individual fish, following escape from a cod-end, may be affected by the length of time spent in the cover, exposed to a continuous flow of water. However, it is also possible that survival is dependent upon the time during the haul when escape occurs.

Discussion of unaccounted mortality issues

It is important to improve our understanding of causes of unaccounted mortalities. In fact, improved methodologies for escapee survival studies have shown sharp declines in escapee mortality.

6 STUDY AND SUB-GROUP REPORTS

P.O. Larsson - Report of the 2nd workshop on standard trawls for Baltic international fish surveys. Written contribution.

A report was distributed, time was given to read it, and it was discussed by the Working Group.

Comments and discussion – Vessel horsepower ratings range from 100 to 3000 HP, with a cluster around 400 HP and another around 1,000 HP. Towing speed will be set at 3 kn, and it was emphasised that this should be precisely specified, e.g., ship's speed over the ground, vs. the trawl's speed through the water. Tow duration and scope ratios will also be specified. A recommendation was made that external funding be vigorously pursued to help meet training and material needs. Tests of gear efficiency (e.g., escapes under the footrope) were recommended. It was pointed out that allowing the use of different types of doors, as is endorsed in the report, may introduce additional inter-vessel bias and variability due to the different herding and bottom-tending characteristics of different door designs, even when spreads are held constant.

Bjørnar Isaksen – Report of the Study Group on grid (grate) sorting systems in trawls, beam trawls, and seine nets.

A draft of the study group's report was distributed, time was given to read it, and it was discussed by the Working Group.

Comments and discussion – Structure of the report...should the minutes be treated as an appendix rather than put in the body? A table of grid usage should be put into the main body of the report. The final report will feature an introduction and Table of Contents. The introduction might also mention that grids started out as species-selective devices and only later evolved into size-selective devices, might specifically explain what advantages grids offer over mesh size manipulation, and should indicate data sources substantiating claims of improved bycatch performance. There is interest in extending mandatory grid usage into the North Sea shrimp fisheries conducted by Norwegian vessels, but composition of the bycatch has not made this a compelling issue at this time. The fishery for silver hake in New England should be added to the table of grid usage. Is there a need to develop methodologies for comparing selectivity parameters for gears with and without grids installed? It was also pointed out that the Bibliography lacks citations for the Australian and U.S. Gulf of Mexico grid efforts. The report should include or refer to the Nordic Research Council's project on the Greenland shrimp fishery. Two more examples of areas where grids offer potential benefits include the North Sea mixed finfish fishery and various fisheries in Southeast Asia where discarding is high. It was pointed out that any time that numbers are used their source should be cited and their accuracy checked, and that referring to monetary values associated with bycatch reduction may not be appropriate. A suggestion was made that twin trawling is one methodology with high potential for evaluating selectivity with and without grids. The section on potential impacts of use should include some remarks on practicality and acceptability. It was noted that the Bibliography includes references to grids in purse seines, which are not among the gears studied by the group.

David Somerton - Description of a study group on the use of selectivity and effort measurement in stock assessment.

Objectives: to consider case histories of stock assessments with long time series, then to apply known values of selectivity and efficiency for survey gears to these time series and see what improvements, if any, result. The motivation is to determine what experiments on selectivity and efficiency can productively contribute to the process. Comments from the group suggest that there may be differing views about the objectives and present direction of this study group.

7 SELECTIVITY AND EFFICIENCY OF STATIC AND MOBILE GEARS

Svein Løkkeborg – The use of hook timers to determine time of capture and escape rate in longlining. Written contribution and oral presentation.

The time at capture in longlining is a factor of interest for a better understanding of the capture process. A device that detects movements was attached to longline snoods. When subjected to movements, this hook timer counts the number of motions every full minute throughout the soaking period. A behaviour study using a test line with two hooks and hook timers attached to a camera frame was conducted to investigate if fish and bait scavengers behaved differently when striking a baited hook and thus caused different hook motion patterns. Ling (*Molva molva*) and tusk (*Brosme brosme*) caused motions of much higher intensity than hagfish and crab, and hook timer recordings of fish and scavengers were easily distinguishable. A longline fishing experiment for cod (*Gadus morhua*) with hook timers attached to snoods at intervals of every tenth snood was also conducted. The hook timer recordings showed that the mean time elapsed from the baited hooks reached the sea bed to the first bait attack caused by fish was 35 min indicating that the majority of the catch was taken in the first part of the soaking period. An uncertain estimate of escape rate during hauling is given, and an improved method of using hook timers to determine escape rate and competition for baits is suggested.

Comments and discussion – The timers were relatively small and light, and did not apparently affect catch rates.

Jesper Boje, R. Holst and A. Woll – Selectivity of longlines in the fishery for Greenland halibut. Written contribution and oral presentation.

A trial fishery with longlines for Greenland halibut was conducted in East Greenland August 1997, using different hook sizes (12/0 and 14/0). A total of 58.000 hooks were set and 4.000 Greenland halibut were caught. Using the SELECT approach expected proportions were fitted to the observed proportions for five different models. All models resulted in almost identical fits. In the analyses bell-shaped selectivity curves are assumed following the principle of geometrical similarity (Baranov 1948). The absence of non-selective data requires the choice of selectivity curve to be based on specific knowledge on the capture process. Since the selectivity curves cannot be determined unambiguously, none of the applied curves can be preferred.

In conclusion, it is difficult to evaluate size-selective properties of these different hook types, and this could be facilitated by testing more than two hook sizes. It was not possible to distinguish what selection curve best modelled the data. The difficulty of determining size composition in the absence of independent data was acknowledged.

David Wileman, Thomas Moth-Poulsen, Niels Madsen, Vesa Tschernij, P.O. Larsson and René Holst – Size selectivity and relative fishing power of Baltic cod gill nets. Written contribution and oral presentation.

The two specific objectives for this study were:

To measure the effect of gill net design parameters upon the size selectivity and relative fishing power of Baltic cod gill nets.

To produce a statistical model describing these changes in selectivity which can be used in simulations of possible fisheries management scenarios.

Comments and discussion – The estimated relative size structure of the study population(s) was a good fit with population age structure estimates from VPA analyses. One implication of these findings is that it offers another technique, independent of trawls, for taking measures of population size (age) structure. The bimodal catch size distribution reflects two capture modes: classic gilling is indicated by the primary mode, while the second peak encompasses entanglement and other catch mechanisms.

Magnus Wahlberg, Sven-Gunnar Lunneryd and Håkon Westerberg – Visual and acoustic observation of rainbow trout behaviour around a modified salmon trap. Written contribution and oral presentation.

The behaviour of rainbow trout *(Salmo gairdneri)* around a modified salmon trap was studied with two video cameras, a scanning sonar (Mesotech MS 900, 675 kHz) and a splitbeam echosounder (Simrad EY500, 120 kHz). The trap was situated in an about 10000 m^2 large net enclosure where 60–80 rainbow trouts were held. The aims of the study were: 1) testing whether a seal exclusion device (such as a grate, a net cone or a net with large meshes) put into the entrance to the fish bag, would influence the fishing efficiency, and 2) understanding the function and efficiency of the leader net. All the various seal exclusion devices tested had a decreasing effect on the fishing efficiency. Comparing how many fishes that finally went into the fish bag with the number that entered into the middle chamber, a decrease in the capture rate from 61% without devices to as low as 7% with devices was observed. However, the rate of escapes from the fish bag into the middle chamber was almost zero with a device installed, compared to up to one third without the device. This may indicate that the net fishing rate could be acceptable with proper adjustment of the seal exclusion devices. The study at the leader net showed that only 20% (out of a total of 50 trackings) of the traced fish were actually lead towards the fishing gear. The other fish showed a broad variety of reactions towards the leader net. There was no clear difference in the behaviour of the fish during day and night, respectively. In two traces made during night-time it was concluded that the fish reacted to the leader at a distance of several meters, raising the question of which senses were used by the fish to detect the gear.

Comments and discussion – Given the limited abundance of many salmon stocks around the world relative to the high competition among user groups, in many places there may be resistance to efforts to improve the efficiency of salmon traps. It was pointed out that many of the salmon in the Baltic are planted by commercial fishermen's organisations. The scanning sonar employed in the project proved quite valuable for observing fish behaviour at relatively short range although there was a significant learning curve. While seals will quite willingly bite through netting, the netting employed in this study resisted such attacks and the seal grids proved to be an effective barrier. Seal predation is a

serious challenge to the viability of the Baltic salmon fisheries and motivates continued efforts. Other researchers have found fixed cameras to be a useful tool for fixed gear research.

Henry Milliken – Multispecies groundfish, Stellwagen Bank: bycatch reduction. (Authors: Chris Glass, Henry Milliken, Arne Carr, Benedetta Sarno, Gregg Morris.) Oral presentation.

A series of preliminary investigations have been completed that compare three different codend configurations in the Northeast multispecies groundfish fishery. All trials were conducted using a two seam trouser trawl that was first tested to determine that the two sides were catching equal numbers and had similar selectivity for all the predominant species. The studies evaluated two composite six-inch codends (square mesh on the upper one-third and diamond mesh on the lower two-thirds vs. square mesh on the top half and diamond mesh on the lower half) and a seven-inch square mesh codend. The control codend was a standard six-inch square mesh as is required by local regulations. The treatment and the control codends were switched from port to starboard using the ABBA protocol. The preliminary results show that the number of yellowtail flounder caught were significantly reduced using all three treatment codends. There was a significant decrease in the number of winter flounder caught using the ½ square (top) ½ square diamond (bottom) and a seven-inch square mesh codend. When the data from the yellowtail and winter flounder were pooled, there was a significant reduction in both the numbers and weight of individuals caught with each treatment. Cod showed no significant decrease in numbers or weight, yet did show a significant difference in a comparison of the length frequencies for the ½ square (top) ½ square diamond (bottom)) and a seven-inch square mesh codend.

Comments and discussion – The "ABBA" methodology refers to the sequence in which the control and experimental codends were switched from one side of the trouser trawl to the other. It was observed that the length frequency results showed that the experimental codends reduced efficiency across all sizes rather than changing the size selectivity properties of the codend, i.e., catches of all sizes seemed to be reduced roughly equally. Could a masking effect from the chafing gear have affected size selectivity? Could the hanging ratios between the diamond and square mesh panels have affected selectivity? Video observations of flatfish escape behaviour in other areas often show that escape attempts may be directed upwards. Video observations made in this study showed that the trawl was performing to expectations, that the chafing gear did not induce distortions or twisting. The point was made that if fishermen will vigorously resist efforts to deny them the use of chafing gear then there is little point in conducting experiments on gear without such gear installed.

Bjørnar Isaksen, Kjell Gamst, Kurt Kvalsvik and Bjørn Axelsen – Comparison of selectivity and user properties between Sort-X and single grid for two-panel bottom trawl for cod (*Gadus morhua*). Written contribution and oral presentation.

Comments and discussion – The selectivity data were fitted to both the C-log-log and logit models, but the C-log-log model (asymmetric) was the best fit. Cost of the single grid was about half that of the Sort-X. There has been discussion of a hinged version that can go onto a drum. The grids showed clear advantages in terms of reducing catch of undersized fish relative to conventional codends.

Daniel Prior – Estimation of net mesh opening in the cod-end by using a numerical model. Written contribution and oral presentation.

The calculation of net shape is made by using a numerical model based on finite element method. The net is split in several triangular elements for calculating the forces on the net in a first step. In a second step the co-ordinates of each vertex are calculated. At the equilibrium point, the forces acting on the net are equilibrated. At equilibrium, the position of vertices gives the shape of the net and also the opening of net meshes.

The model is validated after tests conducted on a mock-up. The cod-end is tested under gravity and partially filled with bags of water.

The net mesh opening is estimated after a trawl (GOV) filled with 1 m^3 of fish.

Comments and discussion – Does the numerical model use a linear relation between strain and stress, when we know that twines are elastic so the relationship is non-linear? It seems that the model is not too sensitive to this factor. The model applies a drag component to each twine element. Flow in the codend is particularly important in terms of defining shape and conditions confronting fish, and this is complex, varying in different parts of the net. However, this model can only consider one-dimensional homogeneous flow.

Discussion of selectivity and efficiency of static and mobile gears

When large fish are present small fish are not as likely to be caught by longlines, but will be caught if the large fish are not present. This is in contrast to a trawl, which can never catch the small fish whether large ones are present or not. Gillnet trials in Germany showed that there was a shift in the mode of catch length distribution from one lake to another, and the suspicion is that this was related to differing size compositions among the lakes. Bait size affects size selectivity in longlining but not hook size. If fish stratify vertically according to size, then density can affect the size composition of the catch in a gillnet or on a longline.

8 REPORTS FROM PROJECTS AND MEETINGS

John Willy Valdemarsen – FAO activities aimed to reduce bycatch/discard in world fisheries to comply with the Code of Conduct for Responsible Fisheries, and – Report on an international initiative to reduce incidental bycatch of seabirds in longline fisheries. Written contribution and oral presentation.

Comments and discussion – It is very difficult to generalise about the ease of implementing such measures in different regions or cultures. The comment was made that a weakness of efforts like this is that they are too often established and dominated by specialists, when often generalists and multidisciplinary approaches are needed to achieve successful implementation.

Ronald Fonteyne – EU-project: evaluation of mesh measurement methodologies for fisheries inspection and research (fair ct96.1452). Oral presentation.

Requests from fisheries inspectors and enforcement authorities led to initiation of a concerted action involving experts in a review of present techniques for measuring mesh size and consideration of needs and potentials for innovative techniques. The state of the art was reviewed for both fisheries enforcement and fisheries research, and the strengths and weaknesses of existing instruments and techniques assessed. The many shortcomings and inconsistencies associated with the wedge gauge were acknowledged, but without rejecting the technique out of hand. Mesh measurement is most controversial in countries and fisheries where small changes in mesh size can make a big difference in catch quantity and composition. Fishermen objected that the present EU wedge gauge does not guarantee an objective, repeatable measurement and may not be suitable for some materials. The ICES gauge was recognised by all as a more objective instrument but its fragility and need for calibration were concerns. The netting industry would prefer measures averaging several rows and/or allow for variability in manufacturing tolerances. The needs of scientists and enforcement personnel are similar but their different motivations and circumstances may influence the appropriate choice of technique. Characteristics of an ideal mesh gauge were defined, and these go well beyond the capabilities of either wedge gauges or the ICES gauge and will require a considerable research and development effort. Draft specifications were also developed for a rationalised, standardised set of wedge gauges and measurement procedures for the near term.

Comments and discussion – Abrasive netting or grit-laden netting may quickly wear away painted or printed markings.

P. Suuronen, E. Lehtonen, S. Kuikka, P.-O. Larsson, V. Tschernij, T. Moth-Poulsen, N. Madsen and R. Holst. Improving Technical Management in Baltic Cod fisher (BACOMA) - Objectives and Progess. Written contribution and oral presentation.

BACOMA is a three-year research project that is partly funded by the EC. The objectives and the main achievements during the first year (1997) of the project are presented in this paper.

Flume-tank tests showed that it is possible to construct a codend cover with a sufficient cross section area without using any hoops. Full-scale sea trials with the 'hoopless' cover are now under way.

A new technique was developed that allows collection of fish escaping trawl codend during any moment of a haul so that survival can be assessed for short and long tows and for small and large catch quantities. A significant reduction of cod under the minimum landing size was found when the Danish exit windows were moved from the position currently specified (i.e., where they terminate in front of the lifting becket) to one where they terminate just in front of the codline. A further improvement in selectivity was obtained when a single big top-panel window was used in the aftmost part of the codend. These results, however, must be regarded with caution because of the sparse catches. In the survival experiments conducted in August-September, codend catch exceeded 1000 kg in several tows. No clear relationship between the survival rate and codend catch size could be observed. The exceptionally high (> 18°C) water temperature experienced during the first two periods of the survival experiments clearly represents difficult conditions for escapees.

When taking this into consideration, the fairly high average survival (82%) observed is encouraging. It is notable that in those experiments, where the water temperature was near normal, the survival of escapees was almost 100% (but codend catches were low too). Further data are needed of escape-survival in various fishing conditions. The first simulations on biological impacts of increased selectivity indicated that a larger minimum allowed mesh size would remarkably increase Baltic cod catches and would make the management system more information robust. An essential task in the next step of this analysis will be the inclusion of selectivity and survival uncertainty in the model.

Comments and discussion - Each cage in the survival study contained from 100 to 400 fish, using underwater TV to control when to start and stop collecting. The selectivity work showed that when the escape windows were taken further aft, there was some loss of marketable fish, but this was partially offset by actual increases in the catch of the largest fish so income losses were mitigated.

9 SUGGESTED WORK ITEMS

Thomas Moth-Poulsen – Define the contents of a methods manual for use in selectivity studies of static gear. Written contribution and oral presentation.

Comments and discussion – Knowledge exists on ways to manipulate some aspects of the selectivity of shellfish traps, but the issues are complex. No manuals exist for some of these static gear types (e.g., traps) so any effort in this direction will constitute progress. Concern was expressed regarding the possibility that our present knowledge is insufficient to prepare a manual of methods, in which case it might be more appropriate to treat these issues with reviews. It was pointed out that in the course of trying to draft a manual it will become clearer whether or not the necessary knowledge is available in all areas, especially since there will be extensive peer review as an integral part of the drafting process. Methods for conducting comparative fishing experiments should be included.

Gerard Bavouzet – Report on progress of setting up a technical workshop for FTFB instruments users. Meeting announcement and oral presentation.

An international workshop on Fishing Gear Measurement and Observation Devices was announced for 30 November through 4 December, 1998 in Lorient, France. The meeting is intended for users of these devices rather than design engineers or manufacturers.

Barry McCallum – Report of the creation of an FTFB webpage and maintenance of an FTFB server. Written summary, video demonstration, and oral presentation. (See Appendix 1).

Comments and discussion – The webpage will also support the mailboard for the group. Is there some way that an official FTFB page like this can support a list of interested participants who are not current official members of the Working Group? This must be explored. It was pointed out that Working Group reports are not readily available for general public access, and access to Working Group presentations can be sensitive as well. It will be necessary to co-ordinate these and related issues with ICES communications policy.

B. van Marlen - Report on the progress of setting up an ICES database on commercial trawl selectivity. Written summary and oral presentation.

The EU-Concerted Action Selectivity database (SELDAT - FAIR-CT96–1531) has just been finalised with the draft final report. The background idea is that selectivity data are used in mesh assessments by assessment biologists. Needed are estimates of whole fleet, whole gear selectivity to calculate fishing mortality rate at age. The objective of this feasibility study was to define the specifications and conditions for creation, use and maintenance of a database containing fishing gear selectivity information. The project was split into 16 tasks, including three plenary discussion meetings, an inventory of needs with potential users, an inventory of available computer facilities and software, an inventory of available selectivity data, and cost estimates for creating and implementing the database as well as entering the data. A total of 20 persons participated in the SELDAT-project. Database types considered were: an on-line catalogue only; an on-line catalogue with an exchange format; an on-line catalogue with a user data screening program; a central store of ASCII files with on-line catalogue (web site) and extract bunch of data; a hosted database with an on-line catalogue (web site) and extract sub-set of data. The various types were scored against a set of criteria involving: quality, availability, security, ease of management, relevance, ease of use, data extensibility, function extensibility, effort for data provider, and turn-around time after which the database-type hosted database with an on-line catalogue (web site) and extract sub-set of data was judged to offer the best value for money. The group also produced draft lists of

variables at experiment level and at haul level with field specifications, and thoroughly discussed a follow-up project proposal.

Project proposal FAIR-PL98–4044 was sent to DG-XIV in January 1998. Experts in fishing gear technology and selectivity, stock assessment, information technology, and database technology from fourteen organisations (CEFAS from the UK added to the existing list) in The Netherlands, Scotland, Denmark, Belgium, Sweden, Norway, Portugal, Greece, Germany and France are nominated to co-operate in three small teams to define a detailed requirements specification for the selectivity database and acceptance tests for the database. Access, security, and data integrity issues must be resolved. A consultant will be contracted to carry out the physical design, implementation, and testing procedures, and development of a data entry program which will be used by the participating institutes to enter data. The database will be demonstrated to users in a workshop at the end of the project. An international Steering Group will be established with leading fishing gear and stock assessment scientists to give guidance on the management of the project, to advise on the database development process, to give approval to major decisions within the project, and to ensure that the end product fulfils the defined specification. The suggested project duration is twenty-eight months.

Comments and discussion – Access to the database will be restricted, but issues remain to be resolved regarding who will have access. Funding and other support including a database host will be required to carry out the project but these are not yet in hand.

Mike Breen – The feasibility of compiling an unaccounted mortality database. Written summary and oral presentation.

Aims of the proposed database:

To provide a regularly updated overview on the current knowledge on unaccounted mortality to aid identification of future research priorities; and to collect the required data to allow the calculation of F_y (for the relevant unaccounted mortality sub-components) for use in fisheries management.

Possible database format options:

1. Comprehensive "Unaccounted Mortality" database...all details of all experiments related to unaccounted mortality.
2. "Survival Probability" database...all details of all survival experiments.
3. "Unaccounted Mortality" review summary...summary details of all experiments related to unaccounted mortality.

Option 3 was recommended due to data gaps that make it difficult to support Options 1 and 2. Further, While Option 3 is simple in structure it still satisfies the aims of the database and a prototype has been developed and tested.

Summary of recommended actions:

That the FTFB Working Group propose a suggested work item to initiate a pilot study to set up an unaccounted mortality database and review, and appoint two co-ordinators (Alain Fréchet and one other) to manage the pilot study.

That the database co-ordinators:

1. identify reviewers in different areas of unaccounted mortality research, particularly in discard mortality (F_d), escape mortality (F_e), and ghost fishing mortality (F_g);
2. set up the database structure on a suitable computer system;
3. define a standardised unaccounted mortality data format;
4. establish further dialogue with the Stock Assessment Working Groups to define the most appropriate format for data to be compiled;
5. begin a dialogue with the Stock Assessment Working Groups and other institutes to co-ordinate the collection of appropriate stock assessment data (i.e., in terms of explanatory variables); and
6. investigate the feasibility of co-ordinating and exchanging information with other relevant databases.

That the reviewers:

1. identify all available references and data on relevant survival experiments and models;
2. identify all available references and data on the magnitude of encounter related to any identified survival references;
3. calculate estimates of F_y where appropriate data are available; and

4. identify the necessary parameters for standardised data formats for unaccounted mortality and the extension of the unaccounted mortality database.

Once sufficient data have been identified by the unaccounted mortality review, a Study Group would be organised to review and report on all available data concerning Unaccounted Mortality in Fisheries and to assess the feasibility of expanding the Unaccounted Mortality database to include all data and experimental details.

Comments and discussion – The database structure that was recommended in this feasibility study depends heavily on reviewers who will screen and characterise the data to be used, which is a heavy task for them and potentially controversial. No requests for such an unaccounted mortality database have come from other ICES groups to date, but this can be addressed in discussions at the Statutory Meeting if it is proposed as a Special Topic.

10 NEW BUSINESS

Comments were offered on the potential activities of the Fisheries Technology Committee 1998–2003 (FTC Five Year Plan), as follows:

- Assessment of factors determining codend size selectivity
- Assembly of database on codend selectivity measurements
- Development and comparison of gear techniques for reducing fishing mortality
- Monitoring effectiveness of existing technical conservation measures for fishing gears
- Investigation of unaccounted mortality due to fishing
- Investigation of selectivity of static gears
- Environmental impacts of fishing gears
- Gear-related aspects of economic effects of reducing fishing mortality
- Assessment of selectivity of mobile and static survey gears
- Integration of codend selectivity data into stock assessments
- Catchability coefficients of survey gears
- Reduction of sampling variance of survey gears
- Incorporation of experimental data on survey catchability into population assessment models
- Observation and quantification of fish behaviour in relation to catching processes
- Whole gear selectivity
- Modelling fish capture processes
- Assessment of methods for defining fishing effort

11 RECOMMENDATIONS FOR THE 1999 FTFB WORKING GROUP MEETING

The FTFB Working Group has been invited to hold its next meeting in St. John's, Newfoundland, Canada, between 17 and 25 April 1999 allowing four days for the meeting of the Working Group (from 19–22 April) plus time for meetings of Study Groups (17 and 18 April).

Access will be provided to the Marine Institute's flume tank and testing facilities so participants can bring models and other materials for display and testing.

Special topics:

1) **Physical and biological impacts of fishing operations, with a Keynote Speaker.** Proposed by Bob van Marlen

A proposal was put forward for a Special Topic for the 1999 meeting of the WG/FTFB to consider possible technical modifications to fishing gears and fishing operations to reduce their immediate and long-term physical and biological impacts, and to review and consider recently developed methodologies to study impacts on benthos and benthic substrates. This should include ghost fishing by lost gear.

Justification:

Recent international research concerning both towed and static gears indicate that they cause measurable impacts on the ecosystem. In some fisheries there is a need to reduce these effects and investigate technical and operational measures

for achieving this. The activities of this proposed Study Group will support and complement those of the Working Group on ecosystem effects and not duplicate them.

2) Review recent research on fish behaviour, evaluate implications for assessment surveys, and assess possibilities for quantitative modelling. Proposed by Geoffrey Arnold.

A proposal was put forward for a Special Topic for the 1999 meeting of the WG/FTFB to review recent research on fish behaviour, evaluate the implications for assessment surveys, and assess the possibilities for quantitative modelling.

Justification:

There have been many studies of cod-end selectivity and net efficiency but only limited work on the combined overall efficiency of the survey vessel and survey gear. Investigations of the behaviour of identified fish can provide a great deal of information on horizontal and vertical distribution and reactions to vessels and fishing gear. These topics directly affect accessibility and availability of fish to survey gear and vulnerability to capture. The catching performance of the gear in turn affects estimates of population abundance and similar considerations apply to acoustic surveys. Several ICES countries are conducting or have recently completed significant studies in this area and the subject would benefit from a review of progress, an exchange of experience, and an evaluation of objectives.

Study Group:

1. **Manual of methods for measuring the selectivity of static gear experiments.** Proposed by Thomas Moth-Poulsen

The Working Group on Fishing Technology and Fish Behaviour recommends that a Study Group be established to:

a) write a manual of methods for measuring the selectivity of static gear experiments; and
b) review selectivity studies on fish traps, fyke nets, and pots to determine whether the information on techniques for studying the selectivity of these gears is sufficient to include them in the methods manual.

Under the chairmanship of (to be named) the Study Group will work by correspondence and will meet in St. John's, Newfoundland at a time convenient to the meeting of the WG/FTFB in 2000. The Study Group will report to WG/FTFB and FTC.

Justification:

Through several inter-European co-operative projects on gillnet selectivity, accurate procedures for planning, preparing for, and conducting gillnet selectivity experiments have been developed. Robust statistical procedures based on the SELECT model have been developed that can produce reliable gillnet selectivity parameters, supporting the use of results from selectivity studies in stock assessment and management, and for comparisons between gears. Patterns of longline (hook) selectivity follow to some extent those of gillnets and several size selectivity studies have been conducted using similar methodologies.

However, the mechanisms affecting selectivity in traps and fyke nets are different and it is not clear how many controlled selectivity experiments have been conducted for these gears nor if any recognised methodologies have emerged. Selectivity processes for baited pots are thought to be even more complicated although some selection experiments have been conducted in Europe, the USA, and Canada.

No updated ICES methods manual exists for passive gears.

The work of this Study Group will be extensive and will require at least one additional meeting in 2001.

Suggested Work Items:

In addition, the FTFB working group also made the following suggestions for work to be initiated prior to next meeting April 1999:

1. Steve Walsh and Barry McCallum recommend that a small group of 2–3 persons be set up to investigate the development of techniques to quantify fish behaviour from underwater videos and still photographs. In studying the

selectivity of commercial and scientific fishing gears, many institutes use underwater video and still cameras attached to either an ROV or the gear itself. There exist great sources of video data on fish behaviour in many institutes but there has been little use of such observations for quantitative analysis of fish behaviour. Commercial software packages such as Noldus are available that are specifically designed to automate the analysis of behavioural experiments while they are underway. What is lacking is software for post-experiment analysis. The FTFB Working Group should investigate whether such software can or has been developed to the mutual benefit of many institutes. We suggest that a scientist from the Aberdeen Marine Laboratory or other such institute that has extensive background in the use of video observations should lead this group and report the findings at the 1999 FTFB Working Group meeting. It was recommended that Barry McCallum, Dick Ferro, and Ingvar Huse constitute this group.

2. Norman Graham proposed as a work item that a review be conducted of the methods of implementation of technical conservation measures (TCMs), specifically those relating to fishing gear construction and operation that have been applied in member states; and to identify the cases where implementation has been successful with particular attention to the related significant biological, technical, and economic factors that may have contributed to that success.

12 SUGGESTED SPECIAL TOPIC FOR THE 2000 FTFB WORKING GROUP MEETING

To review recent research on unaccounted mortality and identify modifications to existing gears and fishing practices which could reduce unaccounted mortality. Proposed by Dick Ferro.

Justification:

In the past five years much new information has become available on the survival of fish escaping from codends and on other sources of unaccounted mortality. The importance of these data for stock assessment are now recognised. The techniques have improved and data on a wider range of fisheries are available. The FAO Code of Conduct for Responsible Fisheries makes a recommendation on unaccounted mortality.

13 ANNUAL SCIENCE CONFERENCE YEAR 2000

Suggested topic for a Theme Session for the Annual Science Conference for the Year 2000:

Passive fishing gears. (Action: Peter Stewart)

Close of meeting.

14 NATIONAL COUNTRY REPORTS

Belgium (R. Fonteyne and H. Polet)

Selectivity and discards reduction

The study on the development of environment friendly fishing methods for brown shrimp (*Crangon crangon*) in the Belgian coastal waters was continued. The main aim of this study is to develop a shrimp trawl that (a) fishes in a species and length selective way, (b) reduces the unwanted by-catches, (c) thus reducing the impact of this coastal fishery on the environment and (d) improves the quality of the catches. The selectivity experiments going on in the margin of this study were continued. Cod-end as well as whole trawl selectivity was studied. The experiments with a sorting grid were partially successful. Significant reductions of benthic organisms, undersized shrimps, flat- and roundfishes in the catches were recorded on condition that low numbers of starfish were caught. If starfish were abundant in the catches, clogging of the grid caused large losses of commercial shrimp catches. Alternative grid configurations were tried out and are planned for 1998. A new project was started to use electrical pulses as an alternative stimulation in the shrimp beam trawl. This project aims at the development of a shrimp trawl with increased species and length selectivity in the front part of the gear. In the first project year only lab experiments are carried out to study the behaviour and survival of all organisms that occur in the commercial catches of the shrimp fishery.

The EU-project "Economic consequences of discarding in the Crangon fisheries" to determine the biological and economic impacts of the discarding of juvenile round- and flatfish in the *Crangon* fisheries in EU-waters was started. It runs in co-operation with the University of Lincolnshire and Humberside (co-ordinator) (Grimsby), the Danish Institute for Fishery Research (Charlottenlund) and CEFAS (Lowestoft).

Co-operation was given to the EU-project FAIR-CT96–1531 "Selectivity Database" which was a desk study to explore the possibilities to develop a database containing results of selectivity research. In this project 13 European institutes were involved.

Ecological effects of fishing activities

In the framework of the EU-project "IMPACT II - The effects of different types of fisheries on North Sea and Irish Sea benthic ecosystems" (contract AIR2–94–1664) the studies on the impact of fishing gear on the sea bottom and the benthos populations were terminated. This project ran in collaboration with fisheries research institutes and universities in the Netherlands (co-ordinator), Belgium, Germany, Ireland and the UK. In this study the Sea Fisheries Department concentrated on the physical impact of beam trawls.

The EU-project FAIR PL97–3809 "Reduction of adverse environmental impact of demersal trawls" was started and runs in co-operation with the Martin Ryan Marine Science Institute (Galway; co-ordinator), the Rijksinstituut voor Visserij Onderzoek (IJmuiden), the Nederlands Instituut voor Onderzoek van de Zee (Texel), Rijkswaterstaat Directie Noordzee (Den Haag) and the Bundesforschungsanstalt für Fisherei (Hamburg). The main objective is to assess methods to reduce the adverse impact of demersal trawls on benthic marine organisms through changes in net design and alternative methods of stimulation.

The penetration depth of towed gears as well as the physical changes in the superficial sediments are studied in the European study "Trawl penetration in the seabed". Other partners in the project are the University of Rostock (co-ordinator), RIVO (IJmuiden) and the Netherlands Institute for Applied Geo-sciences (Haarlem). Side-scan sonar and RoxAnn surveys have been made to study the disturbance of the sea bottom by beam trawls towed by beamers of 300 and 1200 hp.

Fishing gear research

In the frame of national and regional fishery projects *Nephrops* beam trawls were tested and introduced and the possibilities to develop a *Spisula* fishery in the Belgian coastal waters and a jigging fishery were studied.

A Concerted Action "Evaluation of mesh measurement methodologies for fisheries inspection and research" sponsored by the EU (contract FAIR CT96.1452) will end in June 1998. 14 research institutes and 14 fisheries inspectorates representing all EU fishing nations plus Norway collaborate in this project. The industry is represented by EUROPECHE and EUROCORD for respectively the fisheries organisations and the netting manufacturers. The

objective of the project is to evaluate the present mesh measurement procedures, to identify the problems related to these measurements and to define the requirements for a model mesh gauge suitable for both inspection and science.

Canada (S. Walsh)

Dept. Fisheries and Oceans, Science Branch, Northwest Atlantic Fisheries Centre St. John's, Newfoundland Canada

Fish Behaviour: Year II of Experimental work to study natural behaviour, vessel noise induced and bottom trawl induced behaviour in cod and American plaice using acoustic tags was completed with 2 cruises. The two year study is testing the null hypothesis that temperature has no significant effect on natural and vessel/trawl fish behaviours. Final analysis of complementary laboratory work on the effect of temperature on swimming speeds and endurance on cod and American plaice with Memorial University Fisheries and Marine Institute was completed. *Survey gears*: Experimental video trials were carried out to measure the effect of sweepline herding in cod and American plaice using either a 35 mm still camera or a CCD video camera suspended off the top bridle. Additional bottom trawl door restrictor rope trials were carried out in shallow water to measure trawl performance and the effect on selectivity of groundfish. Contact person: Dr Stephen J. Walsh, Northwest Atlantic Fisheries Center, P. O. Box. 5667, St. John's, Newfoundland, Canada A1C-5X1, Tel. +1–709–722–5478, Fax +1–709–772–4188, e-mail walsh@athena.nwafc.nf.ca

Dept. Fisheries and Oceans, Science Branch, Northwest Atlantic Fisheries Centre St. John's, Newfoundland Canada

Codtrap selectivity: Projects to improve the size and species selectivity of cod traps were carried out at three sites in NAFO Divisions 3Ps, 4R, and 3L. In Division 3Ps, a rigid grate system was fitted into the drying twine of a Japanese cod trap to allow cod under 45 cm to escape. In Division 4R, square mesh panels with mesh sizes of 102 mm and 117 mm square were tested by ten cod trap crews in an effort to reduce the catch of cod under 43 cm. To reduce salmon by-catches the leaders for six traps were sunk and deflectors were added to four others. In Division 3L, panels with mesh sizes of 102 mm and 114 mm hung at 72% were compared to traps with drying twine constructed completely of 92 mm. Retainer bags were used on all traps to catch the escaping fish and to quantify results. *Gillnet selectivity*: Length measurements of cod were collected from 22 gillnetters in NAFO Division 4R using mesh sizes of 140 mm, 152 mm and 165 mm. The objective of the experiments was to determine appropriate mesh sizes for gillnets to ensure that the catch of cod < 43 cm does not exceed 15%. *Otter trawl selectivity*: Five selectivity devices were tested during experimental fishing trials on 10 groundfish otter trawlers in NAFO Division 4R. The devices tested were (1) Rigid grate system with 55 mm bar spacing; (2) Rigid grate system with 60 mm bar spacing; (3) Codend with 155 mm diamond mesh in the top and bottom panels and 145 mm mesh in the side panels. (4) Codend with 145 mm diamond mesh in the top and bottom panels and 145 mm square mesh in the side panels; (5) Codend with 145 mm square mesh throughout. *Reducing catches of small shrimp and by-catch in shrimp trawls*: Square mesh codends with 55 mm and 45 mm mesh and a shrimp size sorting grate with bar spacings of 12 mm were compared to a regular 40 mm diamond mesh codend during three trips on a 65 feet shrimp twin trawler in NAFO Division 3K. Nordmøre grates with 28 mm bar spacings were used in both trawls during the three trips. A fourth trip was used to compare a Nordmøre grate with bar spacings of 22 mm in one trawl to a grate with 28 mm in the second trawl. Shrimp samples for length were taken from all valid sets during each trip. In addition catch weights and numbers of turbot and catch weights of lanternfish were recorded for each set. Contact person: Gerald Brothers, Coordinator-Conservation Technology, Program and Co-ordination Division, Fisheries Management Branch, Department of Fisheries and Oceans, P.O. B. 5667, St. Johns, Newfoundland, Canada, A1C-5X1. Telephone +1709 772–4438, Fax +1 709 772–2110, e-mail: brothers@dfo-mpo.gc.ca

Canadian Centre for Fisheries Innovation, St. John's Newfoundland, Canada

Over the past year, 1997–98, the Canadian Centre for Fisheries Innovation has worked with the Fishing Technology Unit of the Memorial University Fisheries and Marine Institute in St. John's on a number of fishing gear research projects. Four projects have attempted to improve selectivity of existing gear, and one aimed at development of technology to reduce ghostfishing by lost gear. All of the Center's projects are carried out in partnership with industry. The industry partners are identified in the list: 1) Development and Testing of a Trap for use in the Salmon Fishery of Juan de Fuca Straits with the T'sou-ke First Nation of British Columbia. (Contact: Cathie Horan, CCFI, P.O. Box 4920, St. John's, NF, A1C 5R3;tel: 709–778–0515; Fax: 709–778–0516; e-mail: choran@gill.ifmt.nf.ca). 2) Investigation and Evaluation of a Gear Locating System, with Notus Electronics. (Contact: Glenn Blackwood, CCFI, Address and fax as above; Tel: 709–778–0542; e-mail: gblackwo@gill.ifmt.nf.ca). 3) Cod Trap Selectivity Experiments in Lawn and Petty Harbour, NF, with the Fisheries Resource Centre (FRC), St. John's, and Tom Best and Associates (TBA) of Petty Harbour. Funding contributed also by CAFID. (Contact: Glenn Blackwood) 4) Gear Modification to Reduce By-catch of Turbot in Shrimp Fishery with shrimp harvester Ben Foley.(Contact: Glenn Blackwood). 5) Development and Testing of Offshore Cod Pots with Fishery Products International, St. John's (Contact: Glenn Blackwood)

Fisheries and Marine Institute, Memorial University of Newfoundland St. John's, Newfoundland, Canada

Underwater observations of salmon behaviour near a large scale salmon trap was continued on the west coast of Canada. Cod trap selectivity and post-selection survivability were conducted on two sites around Newfoundland. A deep-sea groundfish trapping system was designed and tested in the flume tank in partnership with an industrial client. Sea trials were conducted on a shrimp trawl rigged with longer toggle chains to reduce bycatch of turbot. A twine trawl for harvesting shrimps in the Gulf of St. Lawrence was tested in the flume tank and at sea. A gear finding/locating device was tested in laboratory and at sea in co-operation with a local instrumentation manufacturer. Testing of various selectivity devices for shrimp and fish trawls in the flume tank was continued. An inshore survey trawl, scaled down from Campelen 1800 shrimp trawl, was designed and manufactured for the Institute's 45' research vessel "Mares". An industrial training course on responsible fisheries was developed and is to be delivered to fishers in the Atlantic Canada. Contact: Pingguo He, phe@gill.ifmt.nf.ca. *Fish Behaviour*: Final analysis of complementary laboratory work with the Northwest Atlantic Fisheries Centre on the effect of temperature on swimming speeds and endurance on cod and American plaice Contact person: Paul Winger, Fisheries and Marine Institute, Memorial University of Newfoundland, St. John's, Newfoundland, Canada.

Germany (Erdmann Dahm)

1. *Factors affecting codend selectivity - Gear size*

In the frame of the EU-project VARSEL finished in 1997 a research cruise investigating the influence of gear size on selectivity was carried out. Two trawls were compared in a ceteris paribus experiment One gear was a commonly used standard trawl of the ship, one a scaled down version (30%) of it. The comparison yielded no proof for the existence of any gear related difference in selectivity. With both trawls similar selectivity parameters were obtained both for cod and haddock.

2. *Bycatch reduction and losses of commercial sized shrimp in the fishery for brown shrimp*

The profitable beamtrawl fishery for brown shrimp is relatively unselective due to the small meshes used in the codend. In account of this the EU plans the mandatory use of so called sievenets or of sorting grids in these trawls from 2000 on. Sievenets have already been used on a voluntary basis by the fishermen because they separate young fish and jelly fish out of the net. Their use, however, implies the loss of marketable shrimp. Trials undertaken in 1997 aim at a more precise definition of an optimum mesh size for the sievenets and try to investigate the potential of sorting grids of the Nordmöre type for the same purpose. 84 hauls from 17 days of charter yielded a large number of samples from the different stages of catch processing. Their evaluation is under way but requires a considerable effort of manpower.

3. *Selectivity investigations in the trawl fishery for eel*

Investigations on the potential of the use of sorting grids for the separation of eel and unwanted bycatch in trawls have been continued but have been stopped because 50% of the eel were not separated but escaped through the fish escape hole. In the following the effort was concentrated on the adaptation of a semi automatic longline system to the conditions of eel fishing. It is hoped that a combination of trawl fishery for cod and longlining for eel will improve the economic situation of small scale fishing enterprises.

4. *Selectivity and efficiency of gillnets in the cod fishery*

A detailed analysis of the catching process in cod gillnetting showed that the bell shaped selectivity curve of gillnets originates from a number of superimposed different catch modes. Six different modes could be distinguished. Under special conditions a single catch mode may be predominant. Thus, in the autumn of 1997 when a bright year class of young undersized cod appeared on the fishing ground most of them were caught by hooking with teeth at a bar and subsequent entangling. A dependency on mesh size for this phenomenon is assumed but not yet statistically proven.

5. *Unwanted bycatches in the gillnet and longline fishery for cod in the Baltic*

The unwanted bycatches of ducks on certain shallow fishing grounds off the German coast in the Baltic were by far less severe than in previous years and experiments. A presently ongoing evaluation tries to find out whether this is natural variation or the effect of changes in gear construction A quantitative assessment of bycatches of the same birds on longlines set on the same fishing grounds demonstrated the minor importance of duck bycatches for this fishing method.

6. *Roller gear elements with shifted axis: first operation in the commercial brown shrimp fishery*

Roller bobbins with shifted axis have the advantage of keeping better bottom contact even close to the trawlheads and of reduced stirring up of debris. In fishing trials with this new ground gear a catch increase of 10% was observed.

7. *A measurement instrument for the inspection of the propulsive power of fishing vessels at sea*

After trials to transfer a method of horse power measurement which is successfully used in mining and steel production onto fishing boats had failed due to the unexpected bearing clearance of the shaft a new attempt was made with torsion measuring sensors. Their compensation is achieved via interface on a PC. The new method, however, requires more conscientiousness and longer training of the technical personal involved.

8. *Alternative stimulation of bottom fixed flat fish:*

It is thought among benthologists that the rows of heavy tickler chains running before the groundrope of sole beam trawls have a generally negative influence onto the bottom ecology. First trials from the previous year to replace these by a hydraulic jet pump assumed to have the same chasing effect without destructing the seabed structure have been continued to achieve optimum technical performance. In an EU- project starting from 1998 (REDUCE)the comparative investigation of the biological effects of both gears is planned

9. *Measurement of economic impacts of fishery management decisions.*

A further EU project was started with the aim to investigate the economical impacts of quota, fishing effort, costs and earnings. Scientists from Germany, Spain and the Netherlands are involved in this project. The German contribution in 1997 consisted of the selection of an appropriate sample of 22 ships mostly catching cod and saithe willing to provide information on fishing effort and earnings and the establishment of contacts to selected fishermen from the federal country of Mecklenburg-Vorpommern willing to contribute similar data. Further on statistical data available in the Institute for Sea Fisheries were scrutinised to find out the average relation between fishing effort and catch on different fishing grounds. The results were used to verify a tentative model.

10. *Mechanised longlining in the cod fishery of the Baltic:*

A new purchased random baiter was fitted to the existing mechanised longline system and adapted to the deck layout onboard FRV „ Clupea". Shooting of the gear and operation of the random baiting machine now can be done by one man only.

11. *Further development of hydroacoustical methods:*

Hydroacoustic assessments in shallow waters are seriously biased by chasing effects of the research ship. This can be overcome by towing the transducer on a towed body sideways from the ship. Its performance could be improved by the introduction of a diving depth dependent control which gives a more stable performance independent on the length of the cable

The videoimage processing system Khoros was connected to the BI500 package commonly used in Germany to evaluate EQ500 data. It helps to develop and apply flexible evaluation algorithms

12. *A towed body for the wireless transmission of video signals in underwater observations:*

A special underwater observation technique was developed in collaboration with a German firm to make underwater observation and measuring techniques also applicable on small fishing boats. A special towed body towed at the water surface provides energy for the sensors used at the fishing gear and broadcasts their signals to the boat. At the end of the tow it is possible to release the body by remote control, to locate it by position signals and to rescue it after hauling of the gear. After the end of the technical development it is intended to test the new equipment during a longer period at sea.

13. *Digital image processing in the measurement of small objects*:

A special software package to speed up the manpower consuming measurement of shrimps was developed in collaboration with the university of Duisburg. The extension of this work with regard to the measurement of sorted out young fish is intended

14. *A measurement instrument for the quick check of girth*:

Girth of fish can be a decisive quantity for the selection of fish by a gear. A quick measurement of this property on a large number of specimen, therefore, can be essential. A device was developed which allows the performance of such measurements at defined force. The fish to be measured is inserted into a double loop one external creating an opening force and a soft internal attached to the external. Both loops are closed by the movement of a handle to the right. On attaining a defined strain in the inner loop the handle is blocked and the value read at the corresponding mark on a scale.

France (Georges Massart, Francois Théret, Daniel Prior)

1. Introduction

Besides the routine duties which consist in supporting the trade --demonstration and perfection gears tested on models in the Boulogne and Lorient flume tanks, supply of drawings on trawls, gillnets, purse seines, along with various appraisement missions -, the fishing gear technology service main activity follows two trends according to the federative scheme dedicated to the "Sustainable management of the fisheries resources":

- studies dedicated to the selectivity of the fishing gears.
- developing methods of numerical simulation of the way the gears operate (trawls and purse seines).

2. Studies achieved

2.1 Gear selectivity

The studies dedicated to the selectivity were almost all conducted as part of either European contracts, or as part of agreements between the nation or the region of Brittany. These studies were turned on the following subjects:

Investigating the influence of the material constituting the net

Conflicting results were obtained, some of them even seeming to be inconsistent...Provided that more precise an analysis be completed, it seems that the volume of the capture may have a significant influence on the selectivity of the cod-end, irrespective of rigidity, diameter, nature of the thread constituting the net.

Investigating the efficiency of square mesh panels

This device was presented in the scope European regulation projects as quite universal a solution to the problems resulting from a lack of selectivity of trawls. It was tested in Norway lobster-hake fisheries, in the Bay of Biscay, to spare hake juveniles. This gave bad results.

Finalising a selective trawl for lophius, ray, hake and cardine

The grid trawl previously developed was successfully tested aboard a professional trawler (60% decrease in discards). A cruise dedicated to the visualisation of the behaviour of the fish facing the grid was successfully completed aboard the r/v gwen-drez. The design of a flexible grid allowing for the cod-end to be hauled on the net drum is in progress. It will be tested at sea in 1998.

Finalising a selective trawl for prawns

The improvement of the actual selective trawler (ASSELIN or similar) requires a better knowledge of the behaviour, and more specially of the vertical distribution of the shrimps and fish (flat fish and gadoids) which juveniles are captured by the shrimp trawl. A cruise was conducted implementing a device consisting of several small size trawls (10 cm vertical

opening) piled up on the same frame. On account of the results, it was possible to build a trawl which improves the selectivity in favour of flat fish. The problem regarding gadoids must be approached in 1998.

Reducing damage and improving the selectivity of bivalves-oriented dredgers

Preliminary tests have been conducted on a dredge without teeth bar, but had a disastrous action on the size of the captures. Further tests will be conducted in 1998.

GILLNET project (European project)

Publication of a brochure providing a summary of the results achieved in the scope of the project, regarding the selectivity of the gillnets and trammels.

These results were subject to a violent contestation on the part of the skippers from Boulogne, Thus, a new study was achieved at the DPMCM's request, with results identical to those obtained for GILLNET project. Though, an analysis bearing on the selectivity of the beam trawls (with the 80 mm prescribed mesh opening) shows that it is comparable to that of trammels with a 90 mm mesh opening (whereas the European Union prescribes a 100 mm opening). On account of these results, the European Union a temporary impairment was conceded to the vessels operating in the western Channel.

RESCUE project (European project)

Drafting of the final report of this study dedicated to the analysis of shrimp fisheries and relevant discards. The project is to be continued without France, to investigate selective systems mainly turned on common shrimp fishery (quite marginal in France).

SELMED project (European project)

Aiming at the knowledge of both the inter- and intra-specific selectivity of the main métiers of gillnets implemented in the Mediterranean, this project is almost completed. It enabled (i) to assess the selectivity of nets as a function of the meshing and mounting; (ii) to observe the behaviour of the nets when implemented; (iii) from these observations, to prepare didactic video tapes.

CETASEL project (European project)

On account of the bad conditions experienced during the latest campaign at sea, the results turned out to be unconvincing. The aim was to test the efficiency of the methods of localisation of dolphins when in the entrance of the trawl and of the systems enabling them to escape. On the other hand, IFREMER's contribution to the final report enabled to produce a synthesis document on the data available of the accidental capture of small cetacea by pelagic trawls.

ESMED project (European project)

The project aimed at a comparison of both the performances and selectivity of MEDITS trawl and the sampling Italian trawls. Thanks to IFREMER's software EROC, it was possible to visualise the way the trawls operate onboard the R/V L'EUROPE and the Italian R/V SALVATORE LO BIANCO.

2.2 Concerted actions with European grant

Involving a fairly great number of partners, these concerted actions enable to compare the studies conducted in the various countries.

IFREMER is involved in the following studies:

MESH: Study of a gauge system enabling a reliable measurement (and control) of the meshing.

SELDAT: Analysis of the conditions of setting up and exploiting a bank of European data on the selectivity of the fishery gears and techniques.

NOVARRAST: Evaluation of the discards (assessment of the existing data). Identification of the fisheries necessitating a decrease in the rejects. Creation of national liaison groups in association with the profession for preparing the proposal of a program dedicated to the selectivity of the fishery techniques, to be submitted to the European Union. This program will be conducted onboard professional vessels. The French liaison group started its activities in 1997.

2.3 Numerical simulation of the devices operation

2.3.1 Calculation of the geometrical and hydrodynamic parameters which rule the selectivity of the cod-ends (European programme PREMECS)

By using the method of numerical calculation of the trawl shape developed previously (CATS project) it is possible to calculate the shape of the mesh in the cod-end when distorted by the tension resulting from the hydrodynamic efforts and the presence of a volume of capture. The work completed during the first year of study enabled to compare three methods of calculation, and to compare some experimental results to the results of the calculations.

2.3.2 Dynamical study of the devices operation

Prepared at the Ecole Centrale de Nantes, a thesis was defended in September 1997. It shows the possibility to simulate transitory phenomena (obstruction, for instance) and integrate the movements of the vessel to analyse the variations of the cod-end shape as a function of the variation of the conditions of its operation.

This study was the opportunity for a former student preparing a thesis at IFREMER – and now working for the French company LE DREZEN – to finalise, with the collaboration of the team based in Lorient, a software dedicated to the simulation of the implementation and operation of purse seines.

The Netherlands (B. van Marlen)

1. Project RESCUE (CFP Study 94/044, Research on Crangon Fisheries Unerring Effect)

This project was finished with the final report being revised. An extended fleet inventory was made of shrimp trawlers (*Crangon crangon* L.) in Belgium, Denmark, United Kingdom, Germany, France, The Netherlands and discards monitored during a range of sea-trips on commercial boats for four quarters in 1996 and the first of 1997. Discard figures of 0-group. 1-group and 2+-group were raised to fleet levels, using the information collected during the discard trips and effort data for the species: bib and poor cod, cod, whiting, gurnards, turbot, brill, flounder, plaice, dab, sole and Crangon. The actual meaning of these figures is still to be determined in relation to natural mortality. The results seem to call for further improvements in the selectivity of shrimp trawls.

2. Project CETASEL (Air3-CT94–2423, Prevention of by-catch of small cetaceans in pelagic trawls by technical means)

Work is still current on the final report. A clear solution to the problem of cetacean by-catch could not be found in the three years duration of the project. Many observations on cetacean encounters were done on various sea trips, but their actual positions in relation to the pelagic trawl could not be monitored by the acoustic equipment. Nevertheless, the equipment did reveal interest of the animals in the trawl in several occasions. An excluder device (ropes leading from the lower panel upward) was designed, but the effectivity not proven. A paper titled "Prevention of by-catch of small cetaceans in pelagic trawl by technical means (project CETASEL)", ICES C.M. 1997/Q:20 was presented at the Annual Science Conference in Baltimore, U.S.A. 1997 in the Theme Session of "By-Catch of Marine Mammals Gear Technology, Behaviour and Kill Rates".

3. Project: Cetacean research "Neeltje Jans 97/98"

Enclosure trials on cetacean behaviour and acoustics were undertaken in CETASEL, and the research will be extended at national expense with Hardewijk Marine Animal Park to determine the detection properties of the sonar of harbour porpoises and the and the effectiveness of acoustic scaring devices (pingers). Other participants are the Hawaii Institute of Marine Biology (U.S.A.), and the University of Odense (DK). The research will focus on the reactions of Atlantic species to deterrents and the measurement of the target strength of several passive gears.

4. Concerted Action SELDAT (FAIR-CT96–1531, Selectivity Database)

This project is currently being finished. The extent of selectivity data was defined, as well as the wishes of potential users investigated. Various types of database were considered with cost options for design, building and maintenance. Rules and conditions for hosting were discussed with ICES. A follow-up proposal (FAIR-PL98–4044) was sent to the EU for actually building, testing, filling and demonstrating the database. The physical design and testing will be tendered out to outside contractors. Depending on support by the EU the database can be built. The new project is scheduled to run between September 1998 and November 2000.

5. Concerted Action MESH (FAIR-CT96–1452, Evaluation of Mesh Measurement Methodologies for Fisheries Inspection and Research)

The second meeting took place in Athens, Greece in December 1997. Critics on the existing mesh measurement regulation were given through many hearings with fishermen and netmakers in Europe. In some countries fishers do not seem to have any problem at all, whilst in others the wish for a more objective method was clearly expressed. Ideas were given to improve the current regulation and also a definition of requirements and specifications for a new measuring method. The last meeting is scheduled for 6–7 May 1998.

6. Project: Separation of mackerel and horse mackerel in pelagic pair trawling

Further trials at sea are planned in the fall of this year on the commercial pair trawlers IJM-203 and SCH-22, after which the project will be rounded off and evaluated. The emphasis will be on the possibility of aimed fishery using more advanced echo-sounder equipment (SIMRAD ES-500).

7. Project: TRAPESE (Study 96/006), Trawl penetration in the sea-bed)

Project "Trawl penetration in the sea-bed (TRAPESE, Study 96/006)" a cooperation between The Netherlands, Germany and Belgium, co-ordinated by the University of Rostock, has begun in June 1997. The first meeting was held in Rostock. Laboratory experiments were undertaken to determine the friction forces and sediment displacement of cable and chain elements running over a simulated sea bed at the University of Rostock. A second meeting is scheduled for May 1998. Literature reviews on the subject are currently being written. The first sea trip was undertaken by RVZ in October 1997 onboard RV "BELGICA" to analyse the penetration depth of beam trawls equipped with chain mats. A sea trip on a Dutch commercial beam trawler is scheduled for the week between 11–15 May this year. The objective is to sample sea bed sediment material before and after passage of a 12 m tickler chain beam trawl to determine the penetration depth. A second trip on a Dutch beam trawler will be done in the fall this year on a different fishing ground.

8. Project: REDUCE (FAIR-CT97–3809, Reduction of adverse environmental impact of demersal trawls)

This project started with a meeting in Galway, Ireland on 12–13 February 1998. The objective is to develop fishing methods that are friendlier to the environment compared to existing demersal gears. After the development phase sea trips will be undertaken to measure the effect on benthic organisms. The working programme was defined in greater detail and plans made for the various sea trips and other activities. Literature reviews are being written. A trip was carried out on RV TRIDENS in March 1998 with an improved version of a 4.5 m waterjet beam trawl with BFAFi-Hamburg. Underwater observations showed that the system worked, but the catches fell short of the standard trawl. Also the effect on the benthos by-catches was analysed. Further experiments are scheduled in October and November this year.

9. Project: Impact reduction (at national expense)

In October 1997 experiments were carried out on RV TRIDENS with modified gears to reduce the by-catch of benthos. Large meshes were tried behind the footrope to release benthic species during trawling, whilst maintaining flatfish catches. Significant success was not achieved so far. Further trials will be done in the fall.

10. Project: Electrical stimulation

A revival of this work was started in the Netherlands some years ago by the private company VERBURG-HOLLAND B.V. at Colijnsplaat in co-operation with the Ministry of Agriculture, Nature Management and Fisheries. In view of the current criticism on the environmental impact of beam trawls the need is expressed to find ways to improve the selectivity on target species and decrease the mortality of benthos in beam trawling. Electrical stimulation has potential

to meet these objectives. The company developed a prototype which is to be tested thoroughly in close co-operation with RIVO-DLO. A first series of trials is scheduled for the first three weeks of June 1998 in close co-operation with the company and the Biological Research Department.

Norway (Ole A. Misund and Dag M. Furevik)

As for the last seven years, the main activity of gear research at the Institute of Marine Research (IMR), Norway, has been conducted through the research programme "Responsible Fishing"; in 1997 lead by the late Arvid Beltestad.

Main topics of research were fish behaviour in relation to baited longline, baited gill-nets and pots with lights. Also fish' reaction to sound has been studied. Using the Vemco positioning system for acoustically marked fish, the behaviour of cod and ling in relation to baited longlines and posts was studied. Attraction depended on current speed and direction was obtained on substantial distance. Capture trials with baited gill-nets on tusk and ling gave varying and insignificant results. Light in baited pots did not increase the catches of cod.

A substantial work has been carried out to enhance the species and size selectivity of trawl gears. Comparative fishing trials with the SORT-V and SORT-X grid systems for bottom trawls in the Barents Sea showed that the simpler and smaller SORT-V grid system had about similar size-selective properties for cod and haddock as had the more complex SOT-X system. Final comparative trials for the two systems are scheduled for August 1998.

Further trials with a horizontal separation panel in bottom trawl for gadoids in the Barents Sea have been conducted. A significant proportion of haddock was found in the upper part of the codend, while most of the cod were found in the lower part.

Sweden (P -O Larsson, Vesa Tschernij and Mats Ulmestrand)

1. Studies on cod trawl selectivity in the Baltic

Further experiments with Baltic cod trawls have been performed within an EU-project, BACOMA, aiming at optimising mesh size, minimum landing size, selectivity, etc. in the management of the Baltic cod stocks. Studies of some sources of variation in selectivity, i.a. vessel type and season, started and will continue in 1998.

2. Survival of escapees from Baltic cod trawls

In cooperation with Finnish colleagues further survival experiments have been done with cod escaping from Baltic cod bottom trawls. The new construction of collecting cages, developed in Finland, was used, collecting escapees during a selected time period in the end of normal commercial hauls (3–4 hours). Experimental fishing was carried out in August during an unusually warm period, resulting in temperatures of 17 - 19 C° at ca 25 m depth, where the cages were anchored. Considering the temperature survival was in most cases surprisingly high.

3. Survival of escapees from Nephrops trawls

Selectivity experiments with Nephrops trawls continued in 1997, mainly with tests of 60 mm square meshes, 70 and 100 mm diamond meshes in the whole codend, with greatly improved selectivity for both Nephrops and roundfish. The EU project on the survival of escapees from such trawls continued. Also survival of discarded Nephrops was studied (excluding possible predation). Their survival was only about 30% as an average, while the escaping Nephrops had very high survival, ca 82%. No conclusive results on roundfish survival have been obtained so far, but the project continues.

4. Development of a selective flatfish trawl

The EU project jointly with DIFTA in Denmark regarding developing a trawl selective for flatfishes was finished in 1997. The main features aiming at reducing bycatch of roundfish are i.a. a low height of the upper panel, the headline extending well down the main of the trawl, large open meshes in parts of the open panels and «Baltic exit windows« with 120 mm meshes in the codend. In the Swedish trials in the Baltic the catch of marketable flounder (> 25 cm) was 48% larger in numbers and 64% in weight with the experimental trawl compared to the catch with the hired commercial vessel´s own trawl, while the catch of undersized flounder was insignificantly lower. The catch of cod decreased with 75% in number and 70% in weight when using the experimental trawl.

5. Selectivity experiments with vendace trawls in the northern Baltic Sea

In the northern Baltic Sea there is a trawl fishery for vendace, exclusively during the spawning season for the commercially very valuable roe. The bycatches of immature, only slightly smaller, vendace has been large and contributed to a severe decrease in stock size. Selectivity and survival experiments continued in 1997. Selectivity data are still not conclusive but survival of escapees proved to be very high, so selectivity experiments will continue.

6. Effects of trawling activities

The effects of shrimp trawling on benthos, fish and Pandalus populations were investigated in the Gullmar fjord on the Swedish west coast. The fjord was closed for commercial trawling in 1990. During 1996 a manipulative experimental study was designed and started. Six sub-areas of the fjord were defined and sampled for macro benthos as untrawled areas in 1996. In three of the six areas trawling was carried out by a commercial vessel during 1997 and fish and shrimp composition in the catches documented. The trawl was equipped with a grid (Nordmøre) to test its effect on bycatches. In 1997 the six areas were resampled for benthos and a comparison was done with the results from 1996, looking for possible differences that might be connected to the trawling activity. No significant differences were found. The reduction of bycatches (85% of fish) with the grid was comparable with Norwegian results.

7. Baltic cod gillnet selectivity and fishing power

Another EU-project started in 1997 regarding gillnets in the Baltic cod fishery. Denmark (DIFTA) and Sweden made surveys of their gillnet fleets and found most of the nets used to have larger meshes than the minimum legal size (105 mm). Experimental fishing was carried out with representative types of net, Danish and Swedish, with six mesh sizes from 70 to 130 mm. Hanging ratio and twine thickness was also studied. No conclusive results were obtained in the hanging ratio experiment, due to low catches with the mesh sizes applied. In the twine thickness experiments the thicker 1.5*6 twine had a relative efficiency of only 0.66 when compared to 1.5*4 twine.

8. Static gear studies

A study of the function of fish traps and other live-catching gear has been initiated by the Institute of Coastal Research, with the aim of improving the efficiency and furthering the use of such gear in the coastal fishery. The basic approach is to study the detailed behaviour of individual fish during the capture process, using acoustic and visual techniques. A large part of the work involves seal protection of static gear.

USA

Massachusetts Division of Marine Fisheries Conservation Engineering Project (H. Arnold Carr, Henry Milliken Dana Morse)

Fluke Study

MDMF researchers studied the mortality on sublegal summer flounder (*Paralichthys dentatus*). This study was a continuation of work performed in 1993. Length of tow time was increased from the 1993 study of one-half hour to one hour. The study was devised to allowed the vessel to conduct "normal" tows for fluke. When the fish were landed, the crew and researchers treated the fish as if it was a normal fishing operation except that all sublegal fish were separated, placed in a holding tank, measured and placed into cages that were placed back on the bottom. Results from Kolmogorov-Smirnov and Mann-Whitney U tests indicated no difference in mortality between larger or smaller sublegal individuals. Survival was generally in the range of 30–45%.

Hook Size

A study investigating the effects of hook size and spacing on the catch of longlined Atlantic cod (*Gadus morhua*), was conducted in the region of the Great South Channel of George's Bank. The study compared a modified Mustad 15/0 circle hook with an 11/0 circle hook. The 15/0 hook was made with 11/0 gauge wire because the fishermen felt that the gauge of wire used in a traditional 15/0 hook was too ?????. The modified 15/0 hook demonstrated a reduction of sublegal cod catch, with no apparent effect on the catch of legal sized fish.

Longline Survival

An effort was made to quantify the mortality of sub-legal longlined cod. Sub-legal cod were either removed from the hook in the normal manner (by encountering the roller device called the 'crucifier'), or carefully released from the hook by hand. Cod were also caught using jigs, as controls. The researchers found an increased mortality associated with the hooking process, but a quantifiable total mortality on fish hooked by the circle hooks and those having the hook removed by the crucifier is less clear. Further, estimates of seagull predation on discards showed roughly 23% eaten by gulls with another 27% of the fish being unable to submerge, and presumed to have been eaten.

Lobster Line Tension

In a preliminary study, the strain placed on buoy and ground lines of lobster trawls during hauling was examined. Three commercial lobster fishermen participated in the study. A load cell was placed between the davit and the hauling block, and the maximum and average loads were recorded. Line loads were calculated, with different estimations made based on varying load angles.

Both floating and sinking lines exhibited similar patterns in their average loads, with tension on the line increasing as water depth increased. Maximum loads also increased with depth, with sinking lines demonstrating spikes of maximum tension much higher than that of floating line. Maximum loads encountered by floating lines were roughly 400 pounds, and those of sinking lines approximately 700 pounds, when calculated at a 45 degree load angle. At a 90 degree load angle, estimates rose to approximately 500 and 900 pounds, respectively. Further fieldwork will include more detailed estimates of line tensions encountered during hauling of lobster trawls, and will contribute to continuing efforts of reducing any possible entanglements with the endangered northern right whale.

Dogfish fishery work

MDMF investigated the use of the raised footrope trawl in an experimental fishery for dogfish (*Squalus acanthias*), off Provincetown, MA in an effort to reduce the bycatch of regulated flatfish species. Eighty-eight paired tows were observed using three commercial vessels, with the experimental trawl being compared to a control trawl using the ABBA method. Catch results indicated no significant loss of dogfish catch, while bycatch of regulated species was significantly reduced. Overall, the raised footrope reduced the catch rate of regulated species ten times, and could provide a viable option for fishermen who wish to participate in this small-mesh fishery.

Whiting fishery

As part of an ongoing effort to keep open the small mesh fishery for whiting in Massachusetts Bay, MDMF created a high-profile qualification and monitoring system for fishermen who wished to participate in the small mesh whiting fishery. Use of the raised footrope trawl was mandatory in the experimental fishery, and MDMF observers made many trips with fishermen, to observe the catch, and to ensure that bycatch of regulated species remained below the 5% level set by NMFS. Cooperation among industry members was very good, and the use of the raised footrope trawl was demonstrated to be an effective method of bycatch reduction.

University of Rhode Island
Fisheries Center

Dr Joseph DeAlteris

1. Evaluation of lobster reefs as a habitat enhancement measure. ***Castro***
2. Development of fish pots for scup and summer flounder, based on behavioral analysis. ***DeAlteris, Williams, and Lipsky.***
3. Analysis of mobile fishing gear disturbance of the sea bed relative to natural processes. - ***DeAlteris***
4. Efficiency of biofilters in seawater recirculating aquaculture systems. ***DeAlteris and Rowan***
5. Differential growth of bivalves by elevation, location and year in Narragansett Bay RI. - ***DeAlteris and Beutel***
6. Estimation of the tractive force of large whales. ***DeAlteris and Fridman.***

Maine Department of Marine Resources

Dan Schick

A double Nordmore grate study in the Gulf of Maine northern shrimp fishery was completed whereby a second grate with smaller bar spacing was placed behind the first grate. In theory, the small shrimp would flow through the bars of the second grate and escape the net, where the market size shrimp would be retained and flow into the cod end through openings at the upper end of the second grate. The study found reasonable reductions of small shrimp in cod end. Size selection needed refining by varying the bar spacing in the second grate.

The second double Nordmore grate study tested 5 bar spacings, 1/4, 5/16, 3/8, 7/16 and 1/2 and found 7/16 to be the best for releasing the most small shrimp without releasing market size shrimp. Second grates are currently being placed with fishermen for commercial trials.

A square mesh cod end study in the northern shrimp fishery is currently under way looking at 1-5/8 and 1-1/2 square mesh compared to the current 1-3/4 diamond mesh. Sea trials are almost completed and the shrimp samples are being measured to produce selectivity curves. A study to compare selectivity curves for shrimp in square mesh cod ends with an 8 inch square mesh chafing gear with shrimp in square mesh cod ends without the chafing gear is to be done this spring. The chafing gear will act as a strengthener for larger nets and the test will be to see if the large mesh chafing gear changes the selectivity curve of the square mesh cod end.

Improvements in the reduction of bycatch in the Gulf of Maine silver hake fishery will be the goal of sea trials of a raised footrope configuration in an otter trawl to be done over irregular bottom this summer. The gear configuration was developed by gear specialists in Massachusetts for use over flat bottom. Success there has warranted trials over irregular bottom and the trials will be conducted cooperatively between Maine and Massachusetts gear groups.

Crangon shrimp gear work is starting this summer and will look at a Nordmore type separator in both an otter trawl and a beam trawl and a descending mesh panel in both gear types.

Manomet Observatory
Bycatch Reduction Project

Dr Chris Glass

Squid Fisheries

Behavioral studies on the reaction of squid (Loligo and Illex sp.) to trawl gears was continued during 1997. Bycatch rates were quantified in inshore and offshore Loligo fisheries and in inshore Illex fisheries. Bycatch rates vary between fisheries but over 30% by weight is discarded at sea by boats targeting Loligo squid in Nantucket Sound. The main bycatch and discard species comprise flatfish, scup and butterfish. Behavioural analysis of squid reactions to trawl gears shows classical herding behaviour and considerable swimming endurance in the forward part of the net. Loligo was also shown to rise when dropping back towards the codend and in some cases to turn and rise on tiring. This behaviour may allow squid to be separated from the main bycatch species. An experimental separator trawl and a raised footrope trawl will be fished on chartered commercial boats during spring 1998 to help assess potential for bycatch reduction in the inshore fishery. Further underwater filming and routine fisheries sampling will be carried out throughout the inshore fleet.

Multispecies Groundfish Fisheries

Experimental fishing trials were carried out on commercial boats on Stellwagen Bank during fall and winter 1997/1998. An experimental trouser trawl was employed to assess the effectiveness of different codend configurations in reducing bycatch and discard of undersized yellowtail flounder. Two composite mesh codends and an experimental 7" square mesh codend were compared against the standard 6" square mesh codend. Composite 1 comprised 6" diamond mesh over the bottom two thirds of the codend with the top third comprised of 6" square mesh. Composite two was made of 6" square mesh covering the top half of the codend, and 6" diamond mesh on the bottom. All three experimental codends showed significant reduction in undersized yellowtail flounder and for flatfish as a whole. There was no significant reduction in catches of cod. Analyses and sea trials are continuing.

Other Projects

Manomet continues to investigate bycatch reduction in Maine herring and whiting fisheries, New York Bight sturgeon fisheries, and Southern New England whiting fisheries. Investigations of an experimental gillnet designed to reflect the acoustic signals of Harbour Porpoises are being undertaken in the Gulf of Maine.

National Marine Fisheries Service
Northeast Fisheries Science Center

Thomas R. Azarovitz
John K. Galbraith

A study was conducted in November, 1997, to compare the spread of six pairs of identical model trawl doors. Two of the pairs had been damaged during annual bottom trawl survey work, and were thought to be no longer useable. The study was conducted aboard the NOAA R/V ALBATROSS IV. A secondary objective of the study was to determine optimal sensor placement for the ship's new Simrad ITI acoustic link trawl mensuration system using two of the Northeast Fisheries Science Center's (NEFSC) standard bottom trawls.

The first phase of the study involved determining optimal configuration for the Simrad sensors on the trawl doors before testing could begin. Wingspread, headrope height and temp/depth sensors were also tried. After a period of adjustment, a position was found for door sensor placement that yielded roughly 80% valid readings. No satisfactory wingspread sensor placement was found; the best data obtained being less than 50% valid readings. Temperature/depth seemed to work fine in most configurations. Headrope height was found to be consistent only on one of the two types of NEFSC trawls. It was observed that the lower profile of the two NEFSC standard bottom trawls (approximate one meter height) yielded the poorest results for headrope height and wingspread sensor readings.

A study area of consistent bottom type and depth was chosen for the testing. In order to account for potential current differences, an octagonal towing pattern was devised for each door pair. Using zero degrees North as a reference point, towing was made in a straight line for each of eight consecutive 45 degree headings. This pattern was performed for each of the six door pairs, using both types of NMFS bottom trawls. Readings were collected at each of the eight headings. The data were still being analysed, but preliminary observations did not show readily discernible differences between any of the door pairs spreads.

A vessel standardisation study was initiated in the Spring '98 field season for the previously calibrated but recently retrofitted NOAA's R/V DELAWARE II. The vessel will be standardised for annual survey bottom trawl studies against the ALBATROSS IV, the primary vessel used in our 35 year time series. Forty four stations of paired simultaneous tows were conducted in the Gulf of Maine, Georges Bank area. More paired towing is planned for the fall '98 bottom trawl season.

SOUTHEAST

NMFS/SEFSC/Mississippi Laboratories
Shrimp Trawl Bycatch Reduction - MARFIN Grant No. 97MFIH04

John W. Watson

Study Objectives: Assist the shrimp industry in the development of new and improved bycatch reduction gear by providing effective gear evaluation techniques and, provide technology transfer to the shrimp industry for adoption and use of approved bycatch reduction gear and techniques.

Methods: New industry developed bycatch reduction gear designs and modifications were evaluated by scuba diver scientist employing trawl evaluation techniques to obtain measurements of water flow characteristics, observe and record operational characteristics, and evaluate fish behavioural reactions. Analyses were conducted to determine the performance of 145 brd designs tested under the regional bycatch BRD evaluation program. Analyses were conducted to determine reduction rate estimates for selected species currently under management plans. Analyses were updated as data bases were updated with new data. Reports were provided to fishery managers and industry constituents to provide current status of BRD development. Technical assistance was provided to fisheries managers, training to law

enforcement personnel, and workshops to commercial fishers and net shops. Artificial reefs were studied for their potential as attractants to conduct BRD evaluations.

Results: Ten new BRD designs were evaluated for bycatch reduction potential and optimum configuration and rigging specifications were determined for the successful Jones/Davis BRD. Designs with the best potential were the modified Jones/Davis and the large mesh BRD with cone modification. Four new soft TED designs were developed and tested which have potential to significantly reduce fish bycatch. The results of analyses of the regional bycatch program BRD evaluation data base were presented in the following reports:

1. Summary report on the status of bycatch reduction device development, Nov., 1996
2. BRD reduction rates for weakfish and Spanish Mackerel, Jan, 1997
3. Report on the results of evaluations of the Jones/Davis BRD, April, 1997
4. Bycatch in the Southeast Shrimp Fishery, June, 1997
5. Report on the status of bycatch reduction device (BRD) development, June, 1997
6. Bycatch Reduction estimates for selected species in the Gulf of Mexico for bycatch reduction devices evaluated under the regional bycatch program, Oct. 1997

BRD technical assistance was provided to fishery managers in developing technical specifications for BRDs approved under management plans. Enforcement training and technical assistance was provided in workshops in Mississippi, Georgia, Texas, Louisiana, and South Carolina. Assistance and BRD instructional materials were provided to individual fishermen and net shops in the South Atlantic States and in Alabama, Mississippi, and Texas. Protocols were developed for certification of new BRD designs. Studies on juvenile snapper habitat preferences and seasonal occurrence, and efficacy of artificial reef designs to increase juvenile red snapper recruitment were conducted off of Mississippi. The results have been published in one manuscript and a second manuscript is in progress.

NMFS / SEFSC / Mississippi Laboratories
TED Technology Transfer
MARFIN Grant No. 97MFIH04

Wilber R. Seidel, John W. Watson, John F. Mitchell

Project Objectives:

1. Provide technical assistance in implementation of new TED regulations.
2. Respond to TED problems and special situations
3. Provide education and training to improve commercial use of TEDs
4. Provide TED technical training for law enforcement agencies
5. Conduct TED certification testing as required by the NMFS Southeast Region Office.

Methods and Materials:

Technology Transfer

Revisions to the TED regulations in December 1996 required an intensive technology transfer and educational effort to insure successful rule implementation and effective operation of the southeast U.S. shrimp industry. With assistance from State Sea Grant and Marine Extension service offices, industry workshops were staged to provide information on TED regulation changes and basic TED tuning. Project personnel also staged rule change and TED enforcement workshops for state and federal fisheries enforcement personnel.

TED Testing

Inconsistent installation of approved soft TED designs resulting in sea turtle captures warranted development and evaluation of soft TED modifications. With participation from industry leaders and soft TED builders NMFS assembled an advisory panel to direct soft TED design improvement. Testing and evaluation of industry designed soft TED improvements was conducted in Panama City, Florida using the juvenile turtle test protocol in June and September of 1997.

Conclusions and Recommendations:

Technology Transfer

A publication detailing TED regulation revisions was produced and distributed. A total of nine (9) industry workshops were held in Texas, Louisiana, Georgia and South Carolina. These workshops presented TED regulation information along with TED skill building techniques. Three (3) TED regulation training workshops were staged for state and federal fisheries enforcement agencies. NMFS gear specialists continued to assist shrimp fishermen and net shops in identifying technical problems associated with TED use through dock side and shop visits. Project personnel assisted NMFS enforcement, State fisheries enforcement units and the U.S. Coast Guard with at-sea TED enforcement in Georgia, Louisiana and Texas.

TED Testing

Project personnel conducted SCUBA diving evaluations and small turtle testing of 21 modified soft TED designs in June and September. Of the 21 designs evaluated, ten were variations of the Andrews soft TED and eleven were variations of the Morrison soft TED. Design problems which prevented the escape of juvenile turtles were identified in 17 of 21 soft TEDs evaluated. Four soft TED designs successfully passed the test protocol. Successful designs included a Morrison 4" x 8" and three Andrews types; 1.) 5" 2.) 6" x 3" x 5" and; 3.) 4" x 8". Components of the modified designs which improved turtle exclusion included a reduction of TED panel wing angle and small mesh webbing in the TED panel wings.

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Jeff Gearhart
Sean McKenna

Bycatch reduction work was conducted in the long haul seine and the penaeid shrimp trawl fisheries. Bycatch monitoring was conducted in the spiny dogfish (*Squalus acanthias*) directed, sink gillnet fishery. The long haul seine and the sink gillnet monitoring studies were funded under a grant from the National Marine Fisheries Service (NMFS) through the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA). The bycatch reduction work in the trawl fishery for penaeid shrimp was completed using state funds.

One new Bycatch Reduction Device (BRD) design, the Jones-Davis BRD, was tested during the 1997 shrimp season. The Jones-Davis BRD, developed by Gulf of Mexico commercial fishermen, is actually a new fish stimulator used in conjunction with a Large Mesh Extended Funnel (LMEF) BRD.

Preliminary testing conducted in the Gulf of Mexico indicated that the addition of the new fish stimulator significantly enhanced the LMEF's rate of fish escapement. This prompted North Carolina to evaluate the performance of this new gear on local fishing grounds. The Jones-Davis BRD and many other BRD combinations utilising the new fish stimulator were tested.

Results of North Carolina fishing trials indicated that the addition of the new fish stimulator hampered fish escapement. Bycatch reduction rates for BRDs that reduced finfish catches by as much as 50% were showing minimal reductions when the stimulator was added. The primary reason for these very different results can be attributed to the differences between species and size compositions of the bycatch encountered in the Gulf of Mexico and inshore waters of North Carolina.

Escape panels were tested in the long haul seine fishery during the 1997 season. The panels tested were constructed of 40 mm (inside diameter) nylon trawl rings connected with plastic wire ties. Two 1.8 meter by 1.2 meter panels were installed in the bunt net (last encircling net in the fishing operation) along the float and lead lines. Twelve samples were collected during the 1996 season and 13 samples during the 1997 season. Reductions of unmarketable fish caught averaged 40% while the loss of marketable fish averaged 6%.

The ocean sink gill net fishery for spiny dogfish, *Squalus acanthus*, was monitored for striped bycatch during the 1997 and 1998 seasons. Commercial vessels fishing along the northern coast of North Carolina were contracted and observers

placed onboard to sample landed and discarded catches. Observers sampled fifty-six trips between January and April in 1997 and forty trips during the 1998 season. Monitoring will continue during the 1999 fishing season.

NORTHWEST

Alaska Fisheries Science Center
National Marine Fisheries Center, Seattle, WA
Research on Survey Trawls 1996–1997

Dave Somerton, Peter Munro, Ken Weinberg

1. Research on escapement under the footrope of survey trawls continued with a focus on the 83–112 eastern, a smooth bottom flatfish trawl with a simple footrope consisting of a rubber wrapped cable. Field experiments on escapement used an undertrawl bag. However, unlike the undertrawl bag design used by Engas, Godo, Walsh and others, the design we used stressed a low profile so that it could fit under but not distort the trawl. For this reason, the bag lacked a separate top panel and instead used the bottom panel of the trawl as a top panel. Preliminary analysis of the experimental data indicated that: 1) escapement of roundfish is quite low even at small sizes, 2) escapement of flatfish generally decreases with increasing size, but in some species escapement again increases at the largest sizes, 3) crabs can enter the trawl after they have escaped under the footrope if they are small enough to passes through the belly meshes.

2. An experiment was conducted to investigate if vessel motion can be transmitted down the towing warps so that it influences trawl performance. Self-recording tension meters were attached simultaneously to the warps at the vessel and at the junction of the tail-chains and lower bridles. Preliminary results in average weather conditions on a smooth bottom indicate that 85% of the changes in tension measured at the bridles could be attributed to vessel motion. However, it is not clear how changes in bridle tension affect herding behaviour nor how bridle tension will correlate with ship motion on rough bottoms.

Alaska Fisheries Science Center
National Marine Fisheries Center

Dr Craig Rose
Fisheries Coordinator

Studies on fish behaviour in fishing gear and bycatch reduction at the Alaska Fisheries Science Center in 1997 have included:

Flexible grates, constructed of Fiberglas rods with neoprene spacers, were tested for effective size selection of pollock and their ability to be used on vessels which employ net reels. A 240 cm long grate was installed in the top panel of the intermediate (extension) which decreased in diameter over the length of the grate. Pollock size separation was achieved over a 10 cm selection range (25% to 75%). The top of this range corresponded to the size of fish whose head width was equal to the bar spacing. The grates wrapped easily over the net reel, suffered no damage, and did not damage the surrounding meshes. Further tests are planned to confirm these initial results and to improve the selection profile.

A minimal otter trawl (30 cm high, 10 m wide)was tested as a tool for harvesting flatfish while avoiding roundfish and halibut bycatch. When fished ahead of a full scale trawl (3.5 m high, 31 m wide) with auxiliary sweeps connected into the sweeps of the main trawl, the minimal trawl retained approximately 50% of the catches of most flatfish. The exceptions to this were halibut (< 20%) and yellowfin sole (21%). Cod catches by the minimal trawl varied between 21 and 35%, while only 10% of the few pollock observed were taken by the minimal trawl. Future work will focus on improving flatfish retention and understanding the variability between flatfish species.

Tests were conducted using the Open Top Intermediate during commercial fishing operations to reduce pollock bycatch during yellowfin sole fisheries. This modification involved removing the top half of the intermediate mesh for a length of approximately 6 meters. Results indicated that approximately a 50% increase in towing time would be necessary to compensate for sole loss, thereby achieving a 50% reduction in pollock bycatch. This was much poorer separation than earlier research tests had indicated. Differences between research and commercial conditions included visibility (the intermediate was in the footrope's sand cloud for most of the commercial tows) and catch rate (higher catch rates during commercial tows).

University of Washington, FRI

Daniel Erickson and Ellen Pikitch

Walleye Pollock Escape: The first of two field seasons was completed during 1997 off Kodiak Island, Alaska to study escapement and escape-mortality of walleye pollock passing through pelagic-trawl meshes. Objectives were (1) qualitatively evaluate escapement of walleye pollock through square meshes installed in the codend and in front of the codend (i.e., the intermediate or extension), and (2) test methods used to collect and hold escapees for estimating post-escape mortality. Codend-meshes became increasingly blocked as catch-volume increased. Rapid, high-volume escapement was observed through intermediate meshes (~ 20 m ahead of the catch bulge). The caging method, designed to collect escapees at any moment during a tow, worked well for this pelagic species. The final field season will take place during May and June 1998 to estimate mortality of fish escaping codend and intermediate meshes at small and large catch sizes. Project Investigators (alphabetically): Chris Bublitz (University of Alaska, Fishery Industrial Technology Center), Dan Erickson (University of Washington, School of Fisheries), Esa Lehtonen and Petri Suuronen (Finnish Game and Fisheries Research Institute), Chris Mitchell (Alaska Fisheries Development Foundation), and Ellen Pikitch (Wildlife Conservation Society, Osborn Laboratory of Marine Sciences).

Discard Mortality of Sablefish: The final of three field seasons will take place during April, 1998 to estimate mortality of sablefish (*Anoplopoma fimbria*) caught by bottom trawl and discarded at sea. Results of the pilot study and the 1997 field season were presented at the 1997 ICES Annual Science Conference. Project Investigators are: Dan Erickson (University of Washington, School of Fisheries), Richard Methot (National Marine Fisheries Service, Fishery Resource Assessment and Monitoring Division), and Ellen Pikitch (Wildlife Conservation Society, Osborn Laboratory of Marine Sciences).

UK (Scotland)

Cod-end selectivity

The effect of twine thickness on cod-end selectivity was studied. Three cod-ends were tested, all nominally 100 mm mesh and 100 open meshes in circumference. A 4 mm double twine was compared with the two maximum thickness twines proposed by the EU Commission of 6 mm double and 8 mm single twine. A significant difference was found in the selectivity of all three cod-ends. The 6 mm double twine was the least selective having a selection factor of approximately 2.8 whereas the 8 mm single and 4 mm double had selection factors of 2.9 and 3.3 respectively.

The large quantity of existing data on Scottish trawl cod-end selectivity (mainly for haddock) has been reanalysed using the latest statistical techniques and will be published at the FTFB Working Group meeting and subsequently in a journal. Significant effects due to mesh size, meshes round the cod-end circumference and twine thickness are revealed. Differences between seasons and gear types are also examined.

The Laboratory collaborated in EU funded projects on factors affecting the variability of cod-end selection, the feasibility of a selectivity database and a review of mesh size measurement methods.

Fishing effort

A new contract in collaboration with fisheries economists aims to study the effectiveness of effort control in the CFP.

Deep water fishing

Eleven fully instrumented hauls were carried out on FRV *Scotia* in September/October 1997 on the continental slope west of Scotland in water depths between 600 and 875 metres. No significant increase in gear drag was observed when comparing the results to those obtained in shallow water with the same gear in 1996. However, as one would expect with much longer warp lengths, door spread, and as a consequence bridle angle, increased considerably, in the case of the latter from 11 to 15 degrees. A small mesh cover (20 mm) was also used to investigate selectivity of the regulation (100 mm) mesh cod-end. Very few of the commercially targeted species such as black scabbard, blue ling, angler, torsk and deep water sharks passed through the cod-end meshes, with the notable exception of roundnose grenadier, where in certain areas large numbers of juveniles were found in the small mesh cover. Video recordings using a fixed mini-camera with artificial light in the trawl cod-end were made and a 15 minute tape of selected shots will be shown at the meeting.

Fish and *Nephrops* survival and damage after cod-end escape and deck discarding

This EU funded project continued into its second year in collaboration with Denmark, Sweden and Norway. Improved techniques were used for holding triplicated groups of *Nephrops* in cages over periods of at least 14 days during survival monitoring. Controls were obtained from commercially baited creels. The survival of, and damage to *Nephrops* from a) 70 mm diamond mesh cod-end escapees and b) 60 mm square mesh and 100 mm diamond mesh deck discards was assessed. For the fish survival experiment, a new combination of proven techniques which had never been used together before, showed that the survival estimates obtained were conspicuously high in comparison to previous work. Haddock and whiting survival rates were obtained for 70 mm and 100 mm diamond mesh cod-end escapees. Controls were obtained by handline fishing with barbless hooks.

Physical and mathematical modelling

The SFIA flume tank was used to study cod-end drag at a half scale for a range of different catch sizes, towing speeds and cod-end netting materials. Preliminary analysis indicates that the frontal area of the catch is an important parameter.

The mathematical model of cod-end geometry was further developed to account for arbitrary membrane forces and for netting of a range of mesh shapes. The problem of a cod-end with mesh resistance to opening was investigated and it was found that for cases typical of the Scottish demersal fleet mesh resistance to opening is a significant factor.

An EU funded project on developing a predictive model of cod-end selectivity is in its second year.

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APPENDIX 1

DISCUSSION DRAFT

by

Steve Walsh, Canada and Peter Monro, United States

LOGO DESIGN with ICES Background (here)
Working Group on Fishing Technology and Fish Behaviour
ICES Fisheries Technology Committee

Chairman: Dr Arill Engås, Norway [Home link]

WHAT'S NEW
Updated 6th April 1998

Working Group Reports	History
Current Members List	FTFB Server
Study/Sub-groups	Conferences and Meetings

Other Sites of Interest

FTFB Working Group Member List 1998 [w/E -mail]

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etc.				

FTFB Related Study Groups and Sub-Groups and Leaders

- ICES Study Group on Grid Sorting Systems in Trawls, Beam Trawls and Seine Nets: Bjoernar Isaksen, Norway [Home link]

- ICES Study Group on the Use of Selectivity and Effort Measurements in Stock Assessment: Dr Robin Cook, United Kingdom [Home link] and Dr David Somerton, United States [Home link]

FTFB Working Group Reports

DOCUMENTS

Terms of Reference for Year	Annual Report from WG Meeting in
1994	France
1995	Scotland
1996	United States
1997	Germany
1998	Spain

FTFB Related Conferences and Meetings' Announcements

• FTFB WG meeting in La Coruna, April 20–23
• Joint FTFB/FAST meeting in La Coruna, April 24 am)
• Call for Papers ICES Theme Session

HISTORY OF THE FISHING TECHNOLOGY WORKING GROUP

The Working Group was first formed in.....

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