



THÜNEN

Digitalization sponsored  
by Thünen-Institut

This paper not to be cited without prior reference to the Council.

**INTERNATIONAL COUNCIL FOR  
THE EXPLORATION OF THE SEA**

C.M. 1988/B:38

Fish Capture Committee



**REPORT OF THE WORKING GROUP IN  
FISHING TECHNOLOGY AND FISH BEHAVIOUR**

by

B. van Marlen and J.F. Tumilty  
Netherlands Institute for Fishery Investigations  
P.O. Box 68, 1970 AB IJmuiden  
The Netherlands

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

FISH CAPTURE COMMITTEE

Report on the Working Group on Fishing Technology and Fish Behaviour

Convenor: B. Van Marlen, Netherlands Institute for Fishery Investigation, IJmuiden, Holland.

Rapporteur: J. E. Tumilty, Sea Fish Industry Authority, Hull, England.

Meeting Place: Ostend, Belgium.

Time: 18th - 19th April 1988.

---

INTRODUCTION

In accordance with ICES Council Resolution 1987/2:4 the working group met in Ostend on 18th and 19th April convened by Mr B. Van Marlen and consider in particular:-

- a) size and species selectivity of fishing gear with particular reference to fish stock surveys and methods of quantifying effects of fish behaviour on gear performance.
- b) engineering aspects of working conditions on fishing vessels.

This report has not yet been approved by the International Council for the Exploration of the Sea. It has therefore at present the status of an internal document and does not represent any advice given on behalf of the Council. The proviso that it shall not be cited without the consent of the Council should be strictly observed.

\* General Secretary, ICES, Palaegade 2-4, DK-1261, Copenhagen K, Denmark.

PARTICIPANTS

<u>Country</u>	<u>Name</u>	
Belgium	Delanghe, F.	Ostend
	Fonteyne, R.	"
	Moermans, R.	"
	Vanden Broucke, G.	"
	Vanhee, J.	"
Canada	Chopin, F.	St. Johns
	Cooper, C.	"
	Koeller, P.	"
	Walsh, S.	"
	Way, E.	"
Denmark	Hjerimitslev, N.	Hirtshals
	Hovgard, H.	"
	Wileman, D.	"
Faroe Islands	Joensen, B.	
Finland	Suuronen, P.	Helsinki
France	Brabant, J. C.	Boulogne
	Dremiere, P. Y.	Sette
	Freon, P.	
	Sacchi, J.	Sette
Germany Fed. Rep.	Dahm, E.	Hamburg
Great Britain	Bone, D. G.	Cambridge
	Everson, I.	"
	Tumilty, J.	Hull
	Ward, N.	Hull
	Watkins, J.	Cambridge
Iceland	Thorsteinsson, G.	Reykjavik
Italy	Fiorentini, L.	Ancona
	Messina, G.	"
Netherlands	Blom, W. C.	Ijmuiden
	Van Marlen, B.	"
	Veenstra, F. A.	"
Norway	Beltestad, A. K.	Bergen
	Bjordal, A.	"
	Dickson, W.	"
	Engas, A.	"
	Floen, S.	"

<u>Country</u>	<u>Name</u>	
Norway (contd.)	Isaksen, B.	Bergen
	Jacobsen, J. A.	"
	Karlsen, L.	Trondheim
	Kjerstad, E.	
	Misund, O. A.	Bergen
	Soldal, A. V.	"
	Olsen, K.	
	Olsen, S.	
	Ona, E.	Bergen
Scotland	Ferro, R. S. T.	Aberdeen
	Galbraith, R. D.	"
	Lu Chi	"
	MacLennan, D. N.	"
	Stewart, P.	"
Sweden	Hagstrom, O.	Lysekil
U.S.A.	West, B.	Seattle

## AGENDA

### 1. PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON SPECIAL TOPICS.

Size and species selectivity of fishing gear with particular reference to fish stock surveys and methods of quantifying effects of fish behaviour on gear performance.

- 1.1 "Preliminary results on the effect of environmental factors on trawl catches". R. D. Galbraith.
- 1.2 "Operational conditions of stock assessment and possible means to improve their performance". Dr. E. Dahm (Verbal and Video).
- 1.3 Catch comparison between rockhoppers and bobbins ground gear on the Norwegian bottom sampling trawl". Arill Engas.
- 1.4 "Diurnal changes in vertical fish distribution and composition of bottom sampling trawl catches". Aud Vold Soldal.
- 1.5 "Effectiveness and size selectivity of trawl gear in Arctic surveys". Dickson, William.
- 1.6 "Selectivity of the Danish seine as investigated by the twin codend method". Isaksen, Bjornar.
- 1.7 "Selective shrimp trawls". L. Karlsen.
- 1.8 "Selectivity experiments with beam trawls used in coastal fishery". R. Fonteyne.
- 1.9 "Selectivity of sole trammel nets". J. Sacchi (Verbal).
- 1.10 "Further performance measurements of the G.O.V. trawl". O. Hagstrom (Verbal).
- 1.11 "Selectivity experiments with square mesh codends". G. Thorsteinsson (Verbal).
- 1.12 "Economical noise control on Dutch beam trawlers". F. A. Veenstra.
- 1.13 "Why few Dutch beam trawlers use a controllable pitch propeller". W. C. Blom.
- 1.14 "Appraisal and experimental checking of the performance of conventional and ducted propellers". G. Messina.
- 1.15 "A note on the investment appraisal of new fishing techniques". B. van Marlen.

2. PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON GENERAL TOPICS.
- 2.1 Flume Tank testing of 1:4 scale model trawl doors. N. Ward.
- 2.2 "Simple means to measure the breaking strength of float lines". Dr. E. Dahm (Verbal).
- 2.3 "Measurements of the flow in codends". R. S. T. Ferro (Verbal).
- 2.4 Calculation of trawl friction drag on sand and mud. Lu Chi.
- 2.5 "Estimation of the drag of trawls of known geometry". D. A. Wileman and K. Hansen.
- 2.6 "Full scale trials with a collapsible fish trap design". Bjordal, Asmund and Video.
- 2.7 "Norwegian longline experiments, 1987". A summary. Bjordal, Asmund.
- 2.8 "Height and spread of the Danish seine". Isaksen, Bjornar & Larsen, Roger.
- 2.9 "Observations (UIV) of different types of ground gear for seine nets". Isaksen, Bjornar & Larsen, Roger (Verbal and Video).
- 2.10 "Stacking systems for lead and floatline in purse seine fishery". Beltestad, Arvid (Verbal and Video).
- 2.11 "Trials with large meshes in purse seine". Beltestad, Arvid & Misund, Ole Arve (Video).
- 2.12 "The design of a vertical separator panel trawl for conducting comparative codend selectivity experiments". F. Chopin and Video.
- 2.13 "Modern Norwegian longline vessel". Bjordal, Asmund (Video).
- 2.14 "Reaction of herring in relation to underwater light stimuli". Beltestad, Arvid & Misund, Ole Arve (Video).
- 2.15 "Trawl modifications aimed at reducing crab by-catch in flatfish trawls". Ch. W. West and Video.
- 2.16 "Observations of the behaviour of Baltic herring in the vicinity of and inside midwater trawls revealed by echo-sounding". P. Suuronen.
- 2.17 "Sonar observations of schooling behaviour of mackerel during purse seining". Misund, Ole Arve.

- 2.18 "The influence of deck-layout and noise on working conditions on board Norwegian fishing vessels". E. Kjerstad (Verbal and Video).
  - 2.19 "Recent observations of large mesh pelagic trawls". B. van Marlen (Verbal and Video).
  - 2.20 "Symposium of Fishing Gear and Fishing Vessel Design". F. Chopin (Verbal). The Marine Institute, St. John's Newfoundland, Canada. November 21 24, 1988.
  - 2.21 "Fish behaviour in relation to fishing operations". Olsen, Steinar (1991 Symposium), (Verbal).
  - 2.22 "Study group on the effects of bottom trawling". P. A. M. Stewart (Verbal). Meeting 24, 25, 26 May, Ijmuiden, The Netherlands.
  - 2.23 "Plankton sampling and the avoidance problem". D. N. MacLennan.
  - 2.24 "Identification of problems in zooplankton sampling". I. Everson (Verbal).
3. PROGRESS REPORTS.
  4. RECOMMENDATIONS.

1. PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON THE SPECIAL TOPICS.

1.1 Preliminary Results on the Effect on Environmental Factors on Trawl Catches (R. D. Galbraith).

A review of data obtained from recent investigations into the capture efficiency of sampling gears indicated that before any conclusions can be drawn considerably more data will have to be collected. The environmental parameters being investigated included water temperature, depth intensity, transmissability and bioluminescence. This was in addition to the usual gear parameters of headline height, depth, wing-end and door spread which were also recorded.

1.2 Operational Conditions of Stock Assessment and Possible Means to Improve their Performance (Dr. E. Dahm - Verbal & Video).

The video film examined fish escapement in three different types of demersal sampling trawls, cod-hopper trawl, plaice trawl and a Danish Young fish trawl. Typical fish behaviour was observed and critical areas for escapement were examined. It was evident that some of the trawls probably needed re-designing, however the project has only recently started and further data is to be collected.

1.3 Catch Comparison between Rockhoppers and Bobbin Ground Gear on Norwegian Bottom Sampling Trawls (Arill Engas).

Comparative fishing trials were carried out in the Barents Sea with standard bobbin gear and rockhopper gear. The results confirmed those obtained from earlier experiments that the rockhopper is more effective in catching fish close to the bottom especially small cod and haddock.

1.4 Diurnal Changes in Vertical Fish Distribution and Composition of Bottom Sampling Trawl Catches (Aud Vold Soldal).

Experiments were conducted to correlate trawl samples with acoustic estimates. The results from the trawl catches generally showed higher catches of gadoids during the day time which is the usual pattern, however the results from the acoustic survey showed the opposite. It is thought that the trawl catches are strongly affected by the differing behaviour of the fish in different light levels.



1.5 Effectiveness and Size Selectivity of Trawl Gear in Arctic Surveys (Dickson William).

The effectiveness of trawls has been found to be dependant on sweep length. The effect that long and short sweeps have on catch rates on fish of different lengths are examined and a number of conclusions drawn. 80m sweeps biases samples against small fish in favour of large fish, 20m sweeps gives a good herding effect for cod but part of this may be due to the otter boards.

1.6 Selectivity of the Danish Seine as Investigated by the Twin Cod-End Method (Isaksen Bjornar).

Selectivity experiments were carried out using a Danish seine with twin cod-ends, one with diamond mesh and one square mesh and a vertical separating panel in the extension piece. The results indicated superior selection factor for haddock using square mesh.

1.7 Selective Shrimp Trawls (Karlsen, Ludwig).

A review of progress being made to introduce the HH shrimp trawl separating panel to commercial fisheries in Norway. The device has been approved by Norwegian Fishery Directorate as a legislative device which allows vessels using the device to fish inshore areas that would normally be closed to them. Approximately 100 trawlers in Northern Norway are now using it.

1.8 Selectivity Experiments with Beam Trawls used in Coastal Fisheries (Fonteyn R.)

A series of experiments to examine the difference in the selective properties of diamond mesh and square mesh cod-ends on light beam trawls showed no difference between the two different mesh shapes. A possible explanation is that soles, the target species, by reason of their flat body shape, are able to escape equally as well from closed diamond mesh as square mesh.

1.9 Selectivity of Sole Trammel Nets (Sacchi J. - Verbal).

The selectivity of both trammel and gill nets using several different mesh sizes were examined and compared graphically. The results showed that trammel nets whose internal mesh size was similar to that of the gill nets, were less selective owing the fish becoming enmeshed rather than gilled.

1.10 Further Performance Measurements of the G.O.V. Trawl (Hagstrom O. - Verbal).

Performance measurements of the G.O.V. trawl were presented and the effect of the use of different sweep lengths in different depths were discussed. It was suggested that the same sweep length should be used in all conditions.

1.11 Selectivity Experiments with Square Mesh Cod-Ends (Thorsteinsson G. - Verbal).

The selectivity of square mesh cod-ends for cod and other bottom fish species were studied in comparative fishing trails using twin cod-ends. The results were very much dependant on catch rate, the difference in selectivity was not very obvious in cod catches of over 2 tonnes, whereas when catch rates were moderate the selectivity of the square mesh was much better than the diamond mesh cod-end.

1.12 Economical Noise Control on Dutch Beam Trawlers (Veenstra F.A.)

Research has been carried out and data collected on the problem of machinery noise on beam trawlers. From the information obtained recommendations have been made of noise levels that should be attainable on these vessels at a reasonable cost.

1.13 Why few Dutch beam trawlers use a controllable pitch propeller. (Blom W.C.)

An investigation into the use of controllable pitch propellers was carried out on beam trawlers. The conclusions reached were that the additional cost of the C.P.P. were unfavourable in relation to their benefits and their vulnerability to damage and repair costs were also a disadvantage in beam trawlers.

1.14 Appraisal and Experimental Checking of the Performances of Conventional and Ducted Propellers (Messina G.)

Data on the performance and efficiency of ducted propellers was acquired and compared with that of a conventional propeller. The results indicated that the ducted propeller compared favourably and was an efficient tool for trawler propulsion.

1.15 A Note on the Investment Appraisal of New Fishing Techniques  
(B. Van Marlen).

The major criteria and methods of calculation of the economic performance of fishing boat and gear design were described. Importance was given to the time, value of money and the concept of discounting future cash flows to the present. The concept of the use of electro-trawling gear was used as an example for discussion.

2. PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON GENERAL TOPICS.

2.1 Flume Tank Testing of 1:4 Scale Model Trawl Doors (Ward N.)

The procedures for the systematic testing of a number of  $\frac{1}{4}$  scale trawl doors in a Flume Tank were described. The performance of a single model trawl door is assessed by measuring the tensions and angles of the warp and bridle which retain the door in a fixed position in the tank. Results were given for standard flat and vee doors over a range of angles of attack and heel.

2.2 Simple Means to Measure the Breaking Strength of Float Lines (Dr. E. Dahm - Verbal).

Experiments were carried out to measure the breaking strength of floatline, at least 20 breakages and 400kgs weight were required to obtain a valid result. Several methods of attaching the headline to the floatline were investigated, and it was found that by fixing the rope continuously along the floatline it retained 80% of its strength.

2.3 Measurements of the Flow in Cod-Ends (R. S. T. Ferro - Verbal).

Measurements of the flow in cod-ends and idealised trawls were made in order to improve the understanding of the flow in nets both for model work and for studies of the basic factors affecting selectivity. The studies showed that with diamond mesh when using 100% of the towing speed of the vessel that there was a 75-80% drop in flow along the cod-end and that there was very little change in these figures even at lower speeds. Square mesh on the other hand showed little reduction in flow.

2.4 Calculation of Trawl Friction Drag on Sand and Mud (Lu Chi).

In order to accurately predict the drag of trawl gear it is necessary to have a knowledge of the effect of ground gear friction. A series of experiments were carried out on land in which the comparative drags of various types of ground gear were measured over various bottom types. The results showed that both the coefficient of friction force and the weight in water of the ground gear influenced the friction drag. It was suggested that the way in which the gear is rigged can have a significant effect on the friction forces.

2.5 Estimation of the Drag of Trawls of Known Geometry (Wileman D. A.)

Large scale (1:5) models were tested in the Flume Tank and their geometry and resistance was measured after changing individual sections. A mathematical model for estimating the total drag of trawls was developed and checked against model measurements. The experiments showed that altering the geometry of the mouth of a trawl can have a significant effect upon its drag.

2.6 Full Scale Trials with a Collapsible Fish Trap Design.

Commercial fishing trials with a collapsible fish trap developed in 1983 were carried out and gave promising results for tusk (Brosme Brosme). Daily catches using 4-500 traps gave catch rates of 4-5kgs per trap and significantly lower bait consumption compared to longlines. The traps however were not as effective for the capture of other species such as cod.

2.7 Norwegian Longline Experiments 1987 - A Summary (Bjordal Asmund).

Norwegian research on longlining methods concentrated on artificial baits, hook designs and swivel connections between the snoods and mainline.

Artificial baits showed promising results with higher than average length of cod and tusk being caught. Studies also showed that predation by sea birds may have a significant effect on the catching power of longlines. The use of swivels to connect snoods to the mainline gave an average of 15% increase in catch rates.

A simple mechanised longline system has been developed using a fibreglass random baiter. A simple splitting unit has also been adapted for the system.

2.8 Measurements of the Height and Spread of the Danish Seine. Isaksen (Bjornar).

Experiments were carried on a commercial fishing vessel using "Scanmar" sensors to measure the spread and height of two types of seine nets. It was found that by small modifications to the attachment of the sensors that it was possible to obtain continuous information about the geometry of the gear throughout the fishing operation.

2.9 Observations of Different Types of Ground Gear for Seine Nets. Isaksen (Bjornar).

Film of different types of ground gear including the use of plastic bobbins on seine nets was shown. Also the arrangement for fixing the Scanmar sensors on the net was seen.

2.10 Stacking Systems for Lead and Floatlines in the Purse Seine Fishery. Beltestad (Arvid).

Various innovative methods developed to mechanise the hauling and stacking of purse seine nets on a commercial fishing vessel were shown. A crane was used to manoeuvre the net and a hydraulic ball hauler was used to haul and stack the leadline. A cage type hauler with hydraulic wheels had also been developed to stack the floats.

2.11 Trials with Large Meshes in Purse Seine Nets. Beltestad (Arvid).

Experiments showed that the sinking speed of the net increased with the increase in mesh size, whereas increasing the lead weights only showed a marginal improvement in speed. The maximum mesh size is limited and controlled by the size of the floats in use. The use of a white panel of large meshes at the end of the net deterred the escape of both herring and mackerel.

2.12 The Design of a Vertical Separator Panel Trawl for Conducting Comparative Cod-End Selectivity Experiments (Chopin F).

A 1:3 scale model of trawl to be used in selectivity experiments was designed with a vertical separator panel and twin cod-ends and was tested in a Flume Tank. Problems had been experienced at sea with fish avoidance reactions and with the panel tearing out. The model tests highlighted the problem areas and improvements in the design were made. A modified full-scale net is now in use at sea.

2.13 Modern Norwegian Longline Vessel. Bjordal (Asmund).

Film was shown of the latest automated Norwegian longline vessel built at a cost of 22m Norwegian Krone. The vessel can set up to 30,000 hooks, and processes and freezes the fish on board with a crew of 12 men.

2.14 Reaction of Herring in Relation to Underwater Light Stimuli. Beltestad (Arvid).

In order to increase the efficiency of coastal purse seines experiments were carried out to investigate the reaction of herring to light stimuli. The results showed that scattered layers of both spawning and feeding herring may be concentrated and guided by the use of underwater lights.

2.15 Trawl Modifications Aimed at Reducing Crab By-Catch in Flatfish Trawls.

Following a project which examined the impact of bottom trawling on red king crab and other demersal species, various sorting mechanisms whereby the crab catch was substantially reduced were investigated. Trials were carried out with two devices - a crab panel and a crab chute. The crab panel reduced the crab catch but about 40% of the fish was also lost. The crab chute did not lose any fish but approximately 50% of the crabs were removed from the catch. The mortality of escaped crabs was not assessed.

2.16 Observations of the Behaviour of Baltic Herring in the Vicinity of and Inside Midwater Trawls (Suuronen P.)

The behaviour of Baltic herring in the vicinity of and inside midwater trawls were studied. The observations provided no evidence that large herring have marked avoidance reactions to a trawl in Autumn, nor did escape reactions show any clear dependance on size, although small herring escaped in greater numbers than large herring.

2.17 Sonar Observations of Schooling Behaviour of Mackerel During Purse Seining (Misund Ole Arve).

The swimming behaviour and horizontal dimensions of mackerel schools have been quantified by the use of multibeam true motion sonar during purse seining in the Northern North Sea. The average school area was proportional to total biomass of the area. The schools also performed strong avoidance behaviour in relationship to the vessel and escaped capture in about 37% of cases.

2.18 The Influence of Deck Layout and Noise on Working Conditions On Board Norwegian Fishing Vessels (Kjerstad E.)

A project was described in which the optimum design of the deck layout of fishing vessel was being investigated in order to create efficient working conditions. A large number of vessel owners and operators have been interviewed and noise measurements taken on vessels in order to reduce this particular problem.

2.19 Recent Observations of Large Mesh Pelagic Trawls (B. Van Marlen).

Video film was shown of recent observations of large mesh pelagic trawls. The observations of the large meshes showed good correlation between their geometry and model tests carried out earlier.

2.20 Symposium of Fishing Gear and Fishing Vessel Design (Chopin F.)

A report was given on the preparations and format for the Symposium of Fishing Gear and Fishing Vessel Design to be held in St. Johns, Newfoundland, Canada, November 21st-24th. A good response to the symposium was anticipated.

2.21 Fish Behaviour in Relation to Fishing Operations (1991 Symposium).

The proposed symposium was discussed by the working group and recommendations contained in paragraph 4.

2.22 Study Group on the Effects of Bottom Trawling (Stewart P. A. M.)

The members of the Working Group were reminded of the above meeting which was to take place in Ijmuiden 24th-26th May 1988.

2.23 Plankton Sampling and the Avoidance Problem (MacLennan D. N.)

The accuracy of stock estimates depends on knowing the efficiency of the plankton sampler, the major problem is that sampler efficiency can be greatly reduced because of avoidance reactions. It is known that there is significant differences between day and night catch rates. A number of solutions were suggested and it was recommended that a study should be made of the cause of the day/night differences.

2.24 Identification of Problems in Zooplankton Sampling (Everson I.)

The principals in zooplankton sampling were considered such as the target species, characteristics of the area of interest, critical period, distribution and reaction and areas of investigation were suggested, such as the characteristics of current samplers, changes that could improve their characteristics. Also their acoustic characteristics and the possibilities of the use of acoustic equipment for use in surveys.



### 3. Progress Reports

Prior to the meeting the convenor has requested that each country should provide written progress reports on recent work on fishing technology and fish behaviour. The reports were not given verbally as time did not permit and it was suggested that any questions should be directed to representatives of the particular country outside of the meeting. Reports were received from each participating country and are reproduced here.

There was some discussion on the amount of time available to discuss matters of general interest outside the framework of presentations.

The meeting is growing into a "Mini-Symposium" and the only possible ways to allow more time for general discussion are:

- to extend the meeting;
- to limit the number of presentations;
- to skip other activities, that enable social contacts and private communication.

It was however not decided to alter the time schedule or the structure of the meeting.

Care should be taken in the future to avoid lengthy discussions on too specialised topics, which may be dealt with more efficient in ad-hoc study groups.

The convenor asked for brief presentations covering the essential points.

4. RECOMMENDATIONS

The Working Group accepted an invitation from Dr. P. Hillis to meet in Dublin. Topics for special subjects, symposium and study groups were discussed and the following recommendations made:-

4.1 The Working Group on Fishing Technology and Fish Behaviour (Convenor Mr. B. Van Marlen) recommends that the next meeting should be held in Dublin from \*\* in conjunction with the Fisheries Acoustics Science and Technology Working Group to consider in particular:-

- a) A review of the current state of knowledge concerning the size and species selectivity of fishing gear with particular reference to fish stock surveys and methods of quantifying the effects of fish behaviour on gear performance.
- b) The methodology for evaluating the survival rate of fish (and other organisms) that come in contact with fishing gears but are not captured or landed.
- c) Engineering aspects of working on fishing vessels.

4.2 A joint session of this Working Group and the Working Group on Fisheries Acoustics Science and Technology will be held on \*\* to discuss matters of common concern.

4.3 The Working Group recommends that in view of the knowledge gained in recent years and the advancement and wide application of modern technology for direct underwater observation, that it should advise the Fish Capture Committee about the needs for re-assessing the standard procedures previously recommended by the Committee for studies of trawl selectivity.

The Working Group asked Mr. S. Olsen to consult relevant colleagues and to prepare a proposal for consideration by the Council at the Statutory Meeting in October 1988.

4.4 The Working Group notes that having regarded the problem of avoidance in determining the capture efficiency of plankton sampling gear and the request from the Larvae Ecology Working Group for assistance in this field it is therefore recommended that an ad-hoc study group on sampling problems should be established with the following terms of reference.

- i) To consider the capture efficiency of nets and other devices used to sample plankton and fish larvae.
- ii) To determine what behavioural and physiological mechanisms control sampler avoidance reactions; where these are not known; to consider what research needs to be done to improve understanding of such matters.

iii) To consider the design of plankton sampling gear and how it might be improved to reduce avoidance reactions and to conquest uncertainty in the capture efficiency.

iv) To report to the Biological Oceanography and Fish Capture Committees.

4.5 The Working Group recommended that pending the results of the Study Group on net drawing (Chairman Mr. V. Van Marlen) that a further meeting will be held with the following terms of reference:-

a) To review the draft ISO standard (3169) on net drawing and current practices in net design and manufacture, paying particular attention to computer-aided design conventions.

b) To recommend an international standing for drafting net plans.

c) To report to the Fish Capture Committee at the 1989 Statutory Meeting.

4.6 The Working Group recommends that a Symposium on Fish (animal) Behaviour in relation to Fishing Operations should be held in 1991. The convenor is to be Professor S. Olsen and the suggested venue is Bergen, Norway during the third week of June. The terms of reference for the symposium should be similar to that of the 1967 symposium:-

To evaluate known facts and prevailing theories on way fish react to their environment and to each other when confronted with various means of capture.

It is recommended that a draft prospectus should be prepared for presentation to the ICES council meeting in October.

A scientific steering group consisting of Professor S. Olsen, Mr. B. Van Marlen and Dr. C. Wardle should be established.

## **National Progress Reports**

Belgium  
Canada  
Denmark  
Finland  
France  
Federal Republic of Germany  
German Democratic Republic  
Great Britain (U.K.)  
Iceland  
Italy  
The Netherlands  
Norway  
Scotland (U.K.)  
Sweden  
United States of America

PROGRESS REPORT BELGIUM

**Trawl gear**

The research on trawl gear was mainly aimed at the reduction of towing resistance by adapting existing fishing gear or introduction new techniques.

On board the research vessel "Belgica" a 4-panel trawl has been tested. Data on the net opening and the forces acting on the rigging were recorded.

A similar net was used on board a 225 hp beam trawler. The warps were lead through the blocks at the tip of the beam which results in an extra spread and permits the use of smaller otter boards. The catches however were rather poor compared to those obtained by trawlers using the traditional semi-pelagic nets.

Trials with an adapted rigging will be continued this year.

**Beam trawling**

Trials were conducted with a combination of a chain mat and flip-up ropes. This combination permitted the use of a somewhat lighter chain mat without affecting the catch rate of the trawl. A significant decrease in by-catch, less damage to the trawl and hence less loss of catches, less injured fishes as well as less tear and wear of the netting were established.

Work on the overload protection system for the beam trawl fishery was continued. This system improves the safety on board beam trawlers. The winch breaks open automatically if a previously set overload is reached, in case of a maximum load difference between the two warps and in case of a sudden increase in load in one of the warps.

**Electrical fishing**

A new underwater pulse generator has been developed. Experiments conducted with an electrified shrimp beam trawl and laboratory measurements on the field strength between two electrodes were performed.

**Selectivity**

On board a small commercial beam trawler comparative selectivity experiments with diamond and square mesh codends were carried out. No differences between the selectivity parameters of both types of codends could be established.

In the same project a comparison was made between the results of selectivity experiments using the covered codend technique and a variant of the parallel fishing technique. The latter gave rise to lower 50 % retention lengths and hence to a lower selectivity factor.

**Mesh shrinkage**

A new series of mesh shrinkage experiments has been started. In these experiments the effect of sediments on netting under tension will be examined.

## ICES FISHING TECHNOLOGY AND FISH BEHAVIOUR WORKING GROUP

Ostend, 18-20 April 1988

### PROGRESS REPORT CANADA

#### Fishing Gear Selectivity

Comparative fishing trials were carried out by the Fisheries Development Branch (FDB) of the federal Department of Fisheries and Oceans (DFO), Scotia Fundy Region, to document the benefits of square mesh cod-ends for groundfish stock management. Mesh sizes used were 121 mm. square, 130 mm square and 130 mm diamond. Initially these trials were to use cod end covers, but inspection with an underwater camera (Mermaid Explorer) showed that the covers were collapsing the codend and inhibiting escapement. Consequently, a trouser trawl was employed with square mesh on one side and diamond mesh on the other. A total of 51 valid sets were made. Results show that an equivalent size square mesh releases about 50% more cod and haddock < 40 cm in length while yielding 50% larger retention lengths. For Yellowtail flounder and American plaice the diamond mesh had improved escapement of immature fish.

The importance of location in lobster traps of escape devices for sublegal size lobsters was studied by DFO's Gulf Region. Trials with several trap models indicated that the presence of an auxiliary escape device in the second chamber of standard 3-chamber commercial parlor traps does not enhance escape.

A tangle net used commercially in Europe for catching spider crab (*Maia sp.*) was successfully tried for catching snow crab (*Chionoecetes opilio*) by DFO's Gulf Region. The tangle net catches mating pairs and allows for research on seasonality of mating in deep living populations of snow crab. Mating pairs are not usually caught in standard commercial traps.

The catchability of lobster and crabs by baited traps was studied by DFO's Biological Sciences Branch, Scotia Fundy Region with a view to developing catchability coefficients which can be used in biomass estimates for stock assessments. Catch rates were compared to density estimates measured in two habitat types (with and without kelp cover) by divers. Catchability coefficients increased greatly with size of lobsters and did not differ between habitats for either lobster or crabs.

DFO's Biological Science Branch, Newfoundland Region continued field experiments on selectivity of Diamond 9 midwater trawls used in collection of capelin samples during acoustic surveys. Escapement of capelin is being estimated by attaching trawl bags made of 12.7 mm mesh nylon to the outside of the trawl at various locations.

#### Fish Behaviour and Underwater Observations

Trials with a flapper used in conjunction with a square mesh section of a standard 130 mm diamond mesh cod-end were conducted by FDB, Scotia Fundy. Camera observations showed that the flapper encouraged fish to seek early escapement through the relatively small square mesh section. Quantitative measurements were not made but extensive experiments utilizing the flapper/square mesh concept are planned for 1988.

Mermaid Explorer was also used successfully to observe inshore scallop rakes and pair trawls, and to search for illegal lobster traps on the bottom. National Sea Products Ltd. employed this camera system onboard an offshore trawler to determine the effect of reduced trawling speed on fish capture. There was no visual evidence to suggest that fish escapement

increases when trawling speed was reduced from 4 to 3.5 knots. DFO's Quebec Region also used an underwater video camera to study the efficiency of the Digby scallop drag, and in scallop stock assessments.

#### Fish Processing

Five devices for measuring shell hardness of snow crabs were evaluated by DFO's Fisheries Development Division, Newfoundland Region. The devices included: an ultrasound unit; Amatek force gauge; two durometers, (Shore and Pacific Transducers); and a specially designed deformation gauge (hardness calipers). The ultrasound unit, Amatek gauge and Shore gauge all proved unsatisfactory. Accurate shell hardness measurements were obtainable using the Pacific Transducer durometer and the hardness calipers. Both units resulted in highly significant correlations between hardness and claw meat yield. The results demonstrated that shell hardness is a valid predictor of crab meat content.

The Faculty of Engineering and Applied Science, Memorial University of Newfoundland developed a vacuum operated cod tongue cutter and a washer for a fish mincer. An experiment was also conducted to determine the split fish equivalent factor for salted codfish in bulk.

#### Commercial Fishing gear development

The Nova Scotia Department of Fisheries continued work with a controllable pitch propeller system in a propeller nozzle. The test vessel will be equipped with a fuel monitor and an evaluation will be conducted in the spring of 1988. An inshore vessel was equipped to drag for mussels to determine if a commercial venture can be established to supply mussel seed for commercial growers. A contract was awarded to the Technical University of Nova Scotia for a hydrostatic analysis of the area's well known Cape Island style inshore fishing boats. The group also provided funding for trials of a marine hydraulic crane for use in lobster fishing. Safer working conditions and more efficient handling of the gear were the major benefits.

The New Brunswick Department of Fisheries developed a bottom trawl with a high selectivity for flatfish. The net is fished without floats for flatfish. Satisfactory results were also obtained for cod when floats were added. Trials with gear which is easily adjustable to fish for either cod or flounder are continuing.

The Faculty of Applied Science, Memorial University of Newfoundland designed a system to harvest mussels under ice. The university also considered the use of hydraulic scale models in the design of floating fish cages used in aquaculture.

#### Under sea ice studies

DFO's Central and Arctic Region tested a prototype acoustically-triggered underwater camera for photographing targets detected under landfast sea ice. The Region has been using hydroacoustics for several years to examine Arctic cod behaviour, distribution and abundance beneath sea ice. This camera will provide a mean for verification in addition to more traditional approaches, such as vertical gill nets. Initial tests in Chitty Lake, North West Territories, were successful and development of a deep-water version (to 200m) continues. DFO's Quebec Region is currently analyzing data from winter groundfish surveys to study the interaction between ice coverage and catch size.

#### Trawl monitoring

DFO's Biological Sciences Branch in Newfoundland completed trials on SCANMAR's trawl monitoring package to be used on demersal biomass surveys. The package includes height, depth, temperature, and spread sensors. Software was written to log the data onto computer tapes. The equipment will be used on all bottom surveys of the Grand Bank in 1988 and the data will be incorporated into estimates of minimum trawlable biomass for stock assessment. Scotia Fundy Region also purchased the system for the same purpose, and to determine net configuration and depth during juvenile fish midwater trawl surveys.

ICES FISHING TECHNOLOGY AND FISH BEHAVIOUR WORKING GROUP  
Ostende 18-22 April 1988

PROGRESS REPORT DENMARK  
Danish Fisheries Technology Institute

Development of improved trawl designs.

Contact persons: Stig Rune Yngvesson and David Wileman.

The development work on plaice trawls started in 1987 was continued. Improved trawl designs with large mesh upper panels, a high degree of spread and mesh shaped tickler chain systems were model tested in the flume tank and successfully introduced to the commercial fleet.

Development work on separator panels to reduce fish by-catch in shrimp trawls was also continued in the flume tank. The funnel shaped panel used on the beam trawlers fishing for brown shrimp *crangon crangon* was examined and a project was started to develop a panel suitable for the high opening trawls used for pink shrimp *pandalus borealis* in the Skagerak.

Both the above development projects have been financed by the Fisheries Ministry. There has also been the usual program of development work, commissioned by commercial trawl manufacturers with emphasis in 1987 on large mesh pelagic pair trawls with rope wings for mackerel and herring and shrimp trawls to be used in tropical waters.

Trawl Drag Studies.

Contract persons: David Wileman and Kurt Hansen.

The project financed by the Danish Energy Ministry to investigate the effect of replacing individual sections of a trawl with sections of less resistance was completed. Large scale (1:5) models were tested in the flume tank and their geometry and resi-



stance measured after changing individual sections. A mathematical model for estimating the total drag of trawls by summing that of the individual sections when their geometry is known was developed and checked against the model measurements. These tests gave the possibility to determine the relative effects on trawl resistance of the 3 main netting energy saving strategies for bottom trawls - use of big meshes in the upper panel, use of knotless netting and use of thinner kevlar based twine.

It was found that insertion of these energy saving sections also had an effect upon the geometry of the trawl and its bottom contact. The differences were not large, however, and could be corrected in the mouth by adjustment of the hanging of the netting to the frame ropes or floatation/footrope weight. Differences in the aft part of the bellies have to be corrected by altering the net design or extending the small mesh belly sections towards the net mouth. It was not possible to quantify these geometrical changes.

Measurement of the full scale engineering performance of fishing gear at sea.

Contact person: Thorkil Berg.

A new method of rigging high opening bottom trawls such that the doors are towed a short distance off the bottom but where the lower sweep and footrope are in bottom contact was developed in the flume tank. The practicality and ease of control of this system was tested at sea on board a 500 HP trawler. SCANMAR height and spread sensors were mounted on each door and readings of the warp lengths and tensions were taken off the auto trawl system. The effects of towing with equal warp length, towing with equal warp tension, door height control by towing speed, door height control by warp length adjustment and turning were all examined. This project was financed by the Ministry of Industry.

Limited testing was also carried out for skippers experiencing problems with choosing the correct door size for Baltic cod mid-

water trawls and with equalising the towing tensions on 2 boat bottom trawls.

Fish behaviour studies.

Contact persons: Jørgen Svane and Ulrik Jes Hansen.

The institute has now started a long term development programme withing this field. The first phase is the development of a relatively small (1,1 x 1,1 x 1,1 m) towed underwater vehicle for use onboard commercial fishing vessels. It has been designed and model tested by the Danish Maritime Institute. The prototype is now under construction and full scale seatrials are planned for 1988.

Netting Material Studies.

Contact person: Thorkil Berg.

A study of the properties of combined/blended netting materials has been started. The aim is to investigate if it possible to combine the properties of high extension - low strength materials with those of low extension high strength materials. The study is funded by the Ministry of Industry and a group of netting manufacturers.

Computer Aided Trawl Design.

Contact persons: Kurt Hansen and David Wileman.

The CADTRAWL system has been introduced to the commercial trawl manufacturing industry and has been further developed. Routines have been added for drawing the leading sections of large mesh pelagic trawls mesh for mesh and for calculating the strengthening guards in the wings and bosoms of panels.

There is also now the possibility to use the system in the production of model scale specifications from full scale.

ICES  
Fishing Technology and Fish Behaviour Working Group  
Ostend, 18.-20.4.1988

PROGRESS REPORT - FINLAND

The behaviour of Baltic herring in the vicinity of and inside midwater and bottom trawls was studied in spring and autumn in the Archipelago Sea and Gulf of Finland with an echo-sounder in a small motorized boat moving above the gear.

The escape of herring through the upper belly panels of a pelagic herring trawl was studied in autumn by attaching small-meshed bags to different parts of the belly to catch the escaping fish.

The effect of the towing speed on the size distribution of the herring catch was studied in autumn in the Gulf of Finland.

The diurnal activity and swimming depth of spring-spawning Baltic herring were followed with an echo-sounder in the vicinity of a herring trapnet leader in May and June in the southwestern archipelago of Finland.

Testing of the resistance of the different kinds of netting material used in herring trapnets was continued in collaboration with the Institut für Fangtechnik (Hamburg).

Petri Suuronen

COMITE CIEM POUR LA CAPTURE DES ANIMAUX MARINSRAPPORT D'ACTIVITE POUR 1987ACOUSTIQUE PECHEEtude de matériel

Comme les années précédentes, l'activité en matière d'acoustique sous-marine a porté sur les applications à la pêche mais aussi à la recherche halieutique :

- . un sondeur de pêche classique à 4 fréquences a été modifié pour lui adjoindre un dispositif TVG numérique et pouvoir appeler chaque fréquence par clavier. Cela permet de disposer d'un sondeur scientifique à 4 fréquences et de faible coût ;
- . la visualisation couleur sur un écran de micro-ordinateur type PC est maintenant au point avec la possibilité de sortie sur imprimante couleur ;
- . les programmes de recherche sur les sondeurs large bande et multifaisceaux continuent ;
- . une première expérience de détection planctonique a été effectuée. On a pour cela utilisé comparativement 6 fréquences différentes comprises entre 28 et 200 kHz ;
- . dans le cadre de l'écho-intégration, l'étude des réactions d'évitement des poissons à l'approche du navire est poursuivie. On essaie en particulier de quantifier l'influence du phénomène sur les évaluations acoustiques de stock ;
- . enfin, dans un autre domaine, l'acquisition par voie acoustique de données sur la géométrie du train de pêche est étudiée.

### Etude du comportement des espèces

- . L'observation des réactions d'évitement des bancs de poissons au moyen d'un sonar omnidirectionnel porté par le chalutier et d'un sondeur vertical porté par un corps remorqué largement écarté du sillage du navire par un divergent a été poursuivie dans le but de corréler les réactions d'évitement aux espèces rencontrées, à la période (dans la journée et dans l'année) et au lieu de ces observations.
- . Le projet de dispositif concentrateur de poissons instrumenté, étudié en 1986, a été retardé ; l'étude n'a été achevée qu'en 1987 et la réalisation n'en est qu'amorcée. Le système comportant à la fois un suivi du comportement des poissons par voie acoustique et une visualisation photographique des espèces devrait être opérationnel à Tahiti en 1988.

### TECHNIQUES ET ENGINES DE CAPTURE

#### Chaluts et chalutage

- . L'étude sur les chaluts jumeaux, commencée en 1986 par des essais sur maquettes en bassin d'essais s'est poursuivie par des essais à la mer qui ont permis d'affiner les moyens de dimensionner les chaluts jumeaux (ouverture verticale, surface de fil, effort de remorquage).
- . Un chalut à 3 ailes a été étudié, à la fois en bassin sur maquette et à la mer. Les résultats (gain en ouverture verticale et choix des gréments) ont permis un transfert presqu'immédiat aux professionnels.
- . Le programme d'étude sur la conception des chaluts assistée par ordinateur se poursuit avec la modélisation de formes de filets encore simples (à symétrie axiale) pour lesquelles existe une bonne corrélation entre formes obtenues par le calcul et formes observées en bassin.
- . L'utilisation du chalut pélagique pour la capture du germon a été tentée par des professionnels avec la collaboration de l'IFREMER. Les résultats obtenus sont très encourageants et motivent le démarrage de l'étude d'un chalut spécifique.

#### Panneaux

Des panneaux roulant sur le fond, imaginés par un industriel installé à Lorient, ont été testés en bassin et essayés en mer. Les premiers résultats font apparaître un écartement comparable et un effort de traction inférieur à ce que l'on obtient avec des panneaux classiques de surface équivalente.

Par ailleurs, dans le cadre du Projet HALIOS (projet EUREKA de chalutier franco-hispano-islandais), plusieurs propositions d'études ont été faites :

- . pour des divergents souples,
- . pour des divergents à flottabilité positive,
- . pour un système de blocage à poste des panneaux classiques.

#### Filets droits

- . Une étude sur la sélectivité des trémails à soles a été entreprise et sera achevée en 1988.

#### Manutention des filets maillants à bord des petits bateaux

- . Après les difficultés relatées précédemment sur la difficulté de mécaniser la totalité des opérations de mise en oeuvre des filets droits à bord des petits bateaux (moins de 12 mètres), le travail entrepris a permis d'aboutir à des propositions d'aménagement de plans de pont et d'emploi d'appareils facilitant la manutention et le stockage des filets à bord.
- . Dans le cadre des essais de pêche du germon aux filets dérivants (voir compte-rendu d'activité de 1986), les travaux ont été poursuivis pour déterminer l'influence du maillage sur la taille des captures et le rendement de la pêche, la profondeur optimale d'immersion et la possibilité de pêcher de jour.

#### Dragues à coquillages

Des difficultés techniques retardent la mise au point de la drague hydrodynamique (à effet Magnus) à coquilles Saint-Jacques.

Par contre, une nouvelle génération de drague cribleuse rotative, aspirante ou non, a été développée pour être mise en oeuvre par de petits bateaux, éviter l'engorgement de la drague et simplifier le tri à bord.

#### Palangres

Une campagne de pêche à la palangre profonde sur les côtes françaises de la Méditerranée à l'Est de Marseille a été réalisée mais a donné des résultats décevants à la fois pour des problèmes pratiques (conditions météo, choix des appâts) et de faible disponibilité des ressources visées.

NAVIRES DE PECHE

- . Une étude visant à définir les points communs entre les besoins des pêcheurs armant des bateaux de moins de 25 mètres pour en rationaliser la construction est actuellement en cours.
- . L'étude de la salle de travail d'un chalutier industriel permettant la rationalisation et la mécanisation du travail des captures est achevée.

A métier pratiqué comparable et captures identiques, sa prise en compte devrait permettre une réduction substantielle des effectifs affectés au travail du poisson.

- . Dans le but de répondre aux besoins des pêcheurs de pays peu industrialisés, les plans, caractéristiques, appareils et aménagements de thoniers senneurs de taille moyenne ou petite ont été étudiés et doivent aboutir à un dossier de construction d'un navire de 40 mètres et d'un navire de 27 mètres.
- . L'étude des conditions de travail et de la sécurité à bord des bateaux de pêche artisanale de 12 à 18 mètres a été réalisée par l'I.U.T. de Lorient avec le concours de l'IFREMER.

NATIONAL PROGRESS REPORT  
Germany F.R.

Energy-saving fishing methods have also in 1987 been the central research subject of the Institute for Fishing Technology. They have been supplemented by special investigations on trawls used for stock assessment purposes and on the environmental effects of different beam trawl types.

Cod stocks in the German inshore waters of North Sea and Baltic are still in a bad status. Trials with the aim to replace at least partly the missing cod by catches of other species were therefore continued. In Baltic the gear research in 1987 concentrated on the improvement of gillnets capable to exploit big sized herrings. It was found that under normal conditions the thickness of the monofilament netting yarns influenced greatly the catching success. However, during the spawning time when the herring fishery is most effective yarn thickness seemed to be of minor importance.

Pair trawling, another important fishing technique for Baltic herring was also investigated, especially the influence of mesh shape (diamond/square) in the codend on the selection. Square meshes showed a sharp selection towards herring with a narrow selection range, confirming thus results from experiments with other species.

The fishery of another candidate for substitution, the flounder, is often severely hampered by a mass development of jellyfish. Gillnets of multimono yarn and half the height of the conventional nets made of twisted yarns showed to be more effective than these under the mentioned conditions.

Fishing boats from the Baltic exceeding ca. 16 m length can possibly avoid the present cod misery by taking up a turbot fishery in the Southern North Sea. This was the result of a trial series carried out since a few years and affirmed during an experiment on commercial basis in 1987. The main season for this fishery lasts from the beginning of May to mid of July and it can be prolonged by switching over to a cod gillnet fishery in the following month.

A relatively untouched source of good quality fish are the many wrecks lying in the German inshore waters. However, fishing on these underwater obstacles is connected with a high risk of damage. During trials in 1987 the catch rates could be improved by using sonar for the search of and approach to the wrecks. Additional experience could also be gained with regard to the optimum construction of the gillnets necessary for this



fishery. So e.g. damages could be considerably reduced by including weak points in the lead line.

Preliminary trials were also made with a special wreck long-line. As with the gillnets exact positioning and limitation of damages by inclusion of weak points are the essentials for good results with this gear. Catches referred to the number of hooks used were so far very encouraging.

Meanwhile the UW-TV equipment has become one of the most important tools for research at the Institute for fishing technology. For the first time the behaviour of soles in front of an electrified beam trawl was observed directly. Standard otter trawls used for stock assessment purposes were investigated, especially the influence of rigging on the geometry of the net, the bottom contact of the groundrope and the fish behaviour. From observations of codends used for selection experiments it was learned that the escapement of small fishes is influenced considerably by the rigging of the small meshed codend cover.

To study the effects of beam trawls on bottom structure and benthos life, in 1987 the Institute has taken up UW-TV investigations on different types of beam trawls. Investigations of such kind will be continued for the next years and, hopefully, contribute to the new established ICES research program in this field.

To check the influence of camber on lift and drag of V-trawl doors wind tunnel tests were performed at the Institute of Naval Architecture, University of Hamburg. A camber of 13% of the board's chord length increased the lift coefficient by the factor 2.4 when positioning the board close to a bottom plate. When put into the centre of the flow the factor changed to 1.4.

Transfer errors before processing in a computer of data collected on length and weight of caught fishes could be considerably reduced by use of an electronic measurement board developed in the Institute. A prototype was tested with satisfying success under research ship conditions and after minor amendments negotiations with a commercial firm for production arrangements will be taken up.

# ICES FISH CAPTURE COMMITTEE

Working Group Meeting in Ostende, April 1988

Report of Activities for 1987 - GDR

## Deep sea fishery

Engineering trials on various variants of midwater trawls have been carried out in a wind tunnel. As a result was developed a variant with an opening height more than 100 m. Samples were tested on a 2500 kw trawler. These was obtained an opening height up to 115 m. The trawling speed at this runs to 5 kn.

Using a remote-controlled device-carrier equipped with an underwater-TV-camera these were made observations in order to investigate fish behaviour in the sphere of influence of midwater trawls. The observations were carried out on the fishing grounds of Namibia in the periode from October 1987 until March 1988. There were made informative observations on horse mackerel especially during hauling the trawl. The observations are recorded on video tapes. At present the observations will be interpreted in order to get conclusions.

A new cutting method for demersal trawls was introduced. The cutting is carried out not along the lestridge but along the middle axis of the net panels. Using this method the netmaterial consumption was reduced to 25 per cent. The catchability was improved also.

## Sea and coastal fishery

In 1987 works have been proceeded dealing with the development of energy-saving fishcatching procedures, in the course of which the fish stock is protected as much as possible. In this connection research and developing works have been carried out especially in the field of set gillnet fishing, line trawling and Danish seining. In the field of set gillnet fishing, works on the development of a hydraulically driven net lifter had been finished. This was a contribution to the almost complete mechanisation of set gillnet fishing in the GDR.

The works on the development of a floater shape adapted to the requirements of mechanisation in set gillnet fishing are going to be finished in 1988. Furthermore, several types of set gillnet constructions and sorts of netting materials to be used for catching cods and flatfishes have been investigated with respect to their catching effectivity and applicability. These investigations are still to be continued. In the GDR so far long-lining is applied commercially to a low extent only.

However, because this catching method proved to be a real alternative possibility for cod fishing compared to highly energy-consuming trawl

fishing applied so far and not protecting-the fish stock, in 1987 the works for developing a mechanized long line system have been continued. It is the aim to create a system for smaller fishing ships applying any sorts of materials for the main line without necessarily separating snood lines and hooks from the main line - this refers to a daily consumption of approximately 5000 to 6000 hooks. In 1987 first tests have successfully been carried out applying a partly mechanized system functioning according to this principle.

For selective catching of flatfishes preserving the fish stock, investigations regarding the introduction of Danish seining have been taken up. First tests have been carried out applying cutters of 12 and 17m length. Here various headline combinations and net constructions have been tested and the heaving procedure has been varied. Perspective works have been started in order to introduce the anchoring method for catching flatfish and fresh-water fish within the 3-mile zone.

#### Basic investigations

The investigations on the stability of otter boards have been continued. The problems of small disturbances can be considered to be solved. For large disturbances first set-ups are available.

The damping coefficients and hydrodynamical mass moments of inertia for the Sueberkrueb otter board have been determined experimentally. In order to adapt and calculate the otter boards in the trawl system, the programme SKIT has been developed.

Furthermore the research work for creating a mathematical model for design and calculation of net cages has been continued. Here the method for the calculation of discrete towing systems have been applied. The shape of the net cages and the load acting on them in a seaway and in non-uniform flow have been investigated.

ICES FISHING TECHNOLOGY AND FISH BEHAVIOUR

WORKING GROUP, OSTEND APRIL 1988

PROGRESS REPORT

SEA FISH INDUSTRY AUTHORITY, U.K.

1 TRAWL GEAR DEVELOPMENT

1.1 Model Full Scale Relationships

Work on the above project has continued steadily throughout the year with the main focus being the construction of models of the Marine Laboratory pelagic trawl PT163 for which full scale data already exists and also a 600hp pelagic Dutch trawl for which data was collected on the research vessel TRIDENS.

In order to progress the project further a critical problem has been to establish a uniform flow over the full cross-section of the Flume Tank and to develop instrumentation sensitive enough to measure the component loads in the trawl models. This work is continuing and significant improvements in the flow have been achieved.

1.2 Otter Board Model Tests

A systematic series of tests on  $\frac{1}{4}$  scale models of flat, vee and cambered otter boards have been carried out in the Flume Tank and a comprehensive set of data obtained for each model. Full scale sea trials have also been carried on boards of similar design and size and the results have been compared.

1.3 Separator Trawls

Further commercial fishing trials were carried out from the North East England port of North Shields with 2 vessels involved in the winter prawn (nephrops norvegicus) fishery. A standard prawn and a standard dual purpose trawl were fitted with double cod ends and a separator panel. The upper cod ends were 90mm mesh and the lower cod ends 70mm. The handling of this gear did not prove to be a problem and separation of prawns and white fish was highly effective giving a substantial reduction in undersize fish and much easier sorting on deck.

#### 1.4 Twin Trawl System

Engineering trials and commercial fishing trials with the two wire double trawl rig were carried from the West Coast of Scotland again in the Nephrop fishery. The system proved to be effective with similar catch rates achieved for approximately 25% less fishing time than a single trawl.

## 2 STATIC GEAR

### 2.1 Drift Nets

Progress has continued to re-introduce drift nets of synthetic materials to the Cornish pilchard fishery. Fishing trials were carried out during the winter with a number of materials treated with bitumastic solution to simulate the properties of the old cotton nets with very encouraging results. It is intended to continue this work to improve hauling methods and the marketing situation as this fishery could have considerable economic importance for Cornwall.

### 2.2 Trammel Nets

Sea trials were carried out from the East Coast of England with trammel nets of different materials, monofilament, multi-monofilament and twisted nylon to improve the handling characteristics due to the fact that less rubbish and crabs were caught and were therefore easier to "turn-over" ready for shooting.

### 2.3 Squid Jigging

A voyage on the Shetland trawler Vega was undertaken to Rockall last summer in order to carry trials of Japanese-type jigging machines using light attraction techniques. However, although the machines worked well there was no squid in the area to test their fishing capabilities.

3 SAFETY ENGINEERING

A number of low cost projects were carried during the year to improve safety on board inshore vessels. Two vessels from the East Coast port of Bridlington were used to demonstrate the benefits of such improvements. These included:-

Non Slip deck paint

Hydrostatic life raft release

Separate unloading winch

Rescue Net

Sound Insulation

Pivot Block (to make "knocking out" procedure safer on side trawlers)

Oilskins with built-in buoyancy

Work has also continued to investigate hydraulic noise on vessels fitted with shelter deck. Attenuators have been fitted to a number of vessels and a significant quantity of data has been gathered on the problem.

4 STANDARD TOWING TEST FOR TRAWLERS

Further sea trials of a sea anchor type drogues have been carried out in order to obtain data on the towing ability of trawlers. Once the optimum design of drogue has been determined, this method will be a much better indication of a vessel's propulsive efficiency than the standard bollard pull test. It will provide a much more reliable method of matching vessel performance to the towing requirements of the gear.

ICELAND

Selectivity

The selectivity of square mesh codends for cod and other bottom fish species was studied in comparative trials using twin codends consisting of square mesh in the one half and diamond mesh in the other. The results were very much depending on the catch rates. When the cod catches were more than 2 tonnes/h the difference in selectivity was not very obvious whereas the selectivity of the square mesh codend was very much better than of the diamond mesh when the catch rates were moderate.

In the case of haddock the square mesh codend of 155 mm mesh opening proved to release far to big quantities of big fish. These selectivity experiments will be continued in 1988 with the conventional codend covers and direct observations with an underwater TV camera.

Direct observations

In July 1987 observations on modified bottom trawl designs were made with the TV camera. Due to poor visibility during the time of observations no video film could be made. The results were however important for the development of bottom trawl designs and the modified trawl types are already in commercial use.

In April 1988 colour TV observations on cod gill nets and longlines were made including interesting observations on fish behaviour towards these gear types.

Other experiments

Experimental hydraulic dredging on black quahog started in 1987. Due to positive results some commercial fishing has started.

The fuel measurements project was accomplished.

G. Thorsteinsson

ICES - FISHING TECHNOLOGY AND FISH BEHAVIOUR WORKING GROUP

Ostend 18-20 April 1988

Progress Report of Italy

Tests on the influence of door spread and net openings on the catch composition were continued in 1987. A series of hauls were done to measure the horizontal and vertical openings of the net as well as the length frequency distribution and weight of the most important species caught.

Different solutions have been studied to increase the vertical opening of the traditional Italian bottom trawl keeping constant its bottom holding and its drag characteristics. The first solution tested was that adopted by fishermen: the net is identical to the traditional one but the wings are split at the ends, so to obtain a four-wing net; each wing is connected directly to the door through a sweep of 50 m. Tests were carried out on this trawl to measure the horizontal and vertical openings and the loads ahead the four wing tips. The second solution was an our modification of the design of a traditional trawl: satisfactory results were obtained during instrument tests.

As regards the fishing vessel and deck machinery technology the following topics have been developed:

- fishing operations safer and more profitable by means of some structural changes in the trawl winch as well as by the adoption of particular devices which allow the cable to be paid when its load exceeds a threshold value, in order to avoid the occurrence of dangerous situations when the fishing equipment is trawled;
- standardization of the fishing vessels operating in the same area: a statistical analysis of the whole Italian fishing fleet was firstly carried out; then an energy saving hull was studied and tank tested.  
This research has already been concluded for the trawler operating in the Mediterranean sea and is now being carried out for the inshore small fishing boats;
- acquisition of experimental data on ducted propellers by means of direct measurement on board fishing vessels.



## PROGRESS REPORT 1987 - THE NETHERLANDS

### TECHNICAL RESEARCH DEPARTMENT OF THE NETHERLANDS INSTITUTE FOR FISHERY INVESTIGATIONS (NIFI) - IJMUIDEN.

#### General

Many discussions were held with the Dutch fishery industries and maritime research institutes/universities in order to stimulate contract research. Various project proposals for this purpose have been elaborated. Apart from this attention has been given to fishery policy orientated projects, particularly on survey-nets and selectivity.

Technical advice was given concerning ad-hoc problems (fuel quality, engine damages), concerning (potential) projects in developing countries as well as to the Dutch navy concerning new deck layout and gear handling of future mine sweepers.

#### DESIGN OF FISHING VESSELS

With regard to a number of vessel design aspects two co-operative research projects have been continued and one new project has been proposed.

##### Ships acoustics (RIVO/TPD-TNO)

The systematic noise level research studies on board of a representative 2 000 and 300 hp beamer were finished and presented in a tripartite report: the noise measurement results, noise sources and sound-transfer paths in part I and II, with in part III a description of the dominant noise contributions and major noise control measures. In a separate ICES paper the RIVO noise readings up to 1987 of 20 beamers have been given, which results clearly show that almost all the 20 fishing vessels exceed the IMO and Dutch Shipping Inspectorate noise limit references (merchant marine) with 10 - 15 dB(A).

##### Systematic hull form model tank tests (RIVO/MARIN)

Preliminary to model tank tests a personal computer prediction model (FISPOW) was made for the resistance and propulsion of 30-70 m fishing vessels. Under RIVO-chairmanship various fishing vessel designers and yards had their input in this co-operative project, while the model was made by MARIN. By means of this model every Dutch designer can optimize the hull form with appendages (coefficients, bulb) with regard to the fishing and steaming speed.

##### Ergonomic bridge lay out design

In co-operation with the Technical University Delft and IZF-TNO, RIVO made a CMO proposal for ergonomic bridge lay out design.

Up to now no optimizing studies were made in this field, while an increasing number of beamers are getting involved in North Sea collisions. On the one hand side due to the strongly increased number of vessels, but on the other hand due to the traditional bridge lay out with often a redundancy and mismatching in electronics.

##### Reducing energy costs

In 1987 there was much attention given to the reduced qualities of

fuels. This problem resulted in engine damages and a higher use of lubricating oil. In co-operation with engine builders, oil companies, ship-owners and insurance companies it was decided to start a new project to find the causes of these problems. After discussions in 1987 a co-operative proposal will be made regarding the influence of part-load diesel engines during the beam trawling fishing cycles.

Because the last time many additives to fuels and lubricating oils entered the market, RIVO decided to test one of these, the fuel catalyser CP 3500 on a beamer with an output of 2 000 kW. The results gave an improvement of the cleansing degree of about 30 % and a fuel saving of 3 - 4 %. The tests went over 2 600 running hours.

#### Safety and working conditions

Up to now there still are not good working machineries to peel Dutch shrimps. The Government, however, ask for it to stop the hand-peeling. Requested by the industry RIVO started a number of tests with a system of pressure/vacuum waves, a foreign possibility to remove the skin of the body. The first results were hopefull, but for continuing RIVO should to find participators and funds for extensive experiments.

The development of a portable fishing line greaser was completed. The proto type was taken over by trade and industry.

For fresh fish handling on board of the beamers various new proposals were made for application of containers in stead of fish boxes in relation to improve the working conditions, the fish quality and to reduce the handling costs in the auction.

#### Projects in developing countries

Missions were made to Western Africa, Senegal and Mauretanie. In Mauretanie an evaluation was made of economic, technical and operational aspects of the industrial fisheries. This mission was carried out in co-operation with LEI and a report was effected, resulting in the building and delivery of ten new ships.

Two missions were made to Senegal by order of FMO (Netherlands Development Finance Company) to fix the value of four existing fishing vessels and to evaluate the technical possibilities of those ships. A new company named "Nouvelle Chalucap" has been started with the four existing ships and four new ones, to be built in 1988 RIVO will supervise the new buildings.

#### Techno-economic research

Major criteria and methods of calculation of economic performance of fishing boat designs are given in report TO 87-02. Important is the time-value of money and the concept of discounting future cash flows to the present. The choice fo a criterian depends on whether future revenues and costs are predictable or not.

An example of weighing the decisions to invest in a system for electrical stimulation of flatfish is worked out with the following variables: - initial investment

- fuel oil price level
- fuel oil reduction percentage
- interest rate
- depreciation period
- income increment

Acceptable pay back periods may be reached when revenues can be raised by several percent, for instance from an improvement in fish quality leading to higher fish price or a shift to species of higher commercial value.

Fuel-oil reduction plays a lesser role at the present price level.

An analysis of the economic performance of ten freezer trawlers has been started. The aim is to build a detailed situation model of trawling operations. A study has been undertaken to describe the catch input process as a stochastic process using catch data.

#### Direct observation on fishing gear

In conjunction with research done the previous year an extended observation cruise has been carried out on TRIDENS during the summer, involving commercial bottomtrawls and midwater big meshes trawls.

The practical use of the R.O.V.-tool has been demonstrated clearly to skippers and net designers, enabling them to tune their nets better. Unique shots were taken around and inside big meshes trawl GM 2 showing good correspondance of its geometry with model tests done earlier. Observations on the GOV-trawl invoked the wish to monitor its performance preferably during surveys. Adjustments on the pan and tilt unit will be necessary to be able to follow individual fish during capture.

Further modifications will include a hydraulic power unit self-propelling facilities, and the use of an umbilical for towing and signal transmission.

#### Development of new fishing gear

##### Deep-water midwater gear

Further to experiments done in 1986 several rigging configurations were tested to reach greater depths in midwater trawling, like:

- backstop V-arrangement in front of and behind the doors
- additional weights on the doors and on the lower wing-ends
- depressors instead of weights
- pony-doors on the lower wing-ends
- small and large depressor plates, mounted on the doors.

The simplest and most effective way to improve a gear's depth is to add weight. Restrictions may follow from the lifting devices or difficulties during handling. Depressor plates may results in a lighter though bulkier construction, but fact is, that with the trawling speeds used and the large water density these plates may

generate considerable downward forces. Problems may arise with door stability as the dynamic equilibrium of forces is drastically altered. Possibly a combination of both effects in a newly designed door will lead to the best results. Model studies on a new design will be discussed under a separate heading.

#### Beams trawls for Pandalus borealis

Fishery on Pandalus has been tried on ISIS with beam trawls using meshsizes of 24 mm and 30 mm (full mesh), in order to appraise the catchability after changing the minimum meshsize to 30 mm. The 30 mm showed 35 % decrease in catches over 16 hauls, although the amount of commercial sized prawns did not fall dramatically. It was concluded, that commercially attractive catch rates can be obtained with the 30 mm cod-ends.

#### Reduction in fuel consumption of beamtrawls

#### Electric fishing

The RIVO electric fishing system has been thoroughly checked and simplified to create a more robust device.

Much attention has been paid to attract private companies to pick up the development into a commercial product. A system supplied by a private firm was tested simultaneously with the RIVO-system on FRV ISIS and tested further on the commercial vessel GO-65 at the end of the year. Sole catches could be improved by some 30 %, whereas plaice catches fell short by some 50 % and tarbot by some 15 %. The introduction in the Dutch beamtrawl fleet is not possible as a consequence of a ban on electric fishing by the Dutch Government.

#### Beam twin trawls

Apart from the replacement of chains there are other ways to reduce the drag of beamtrawls, like a reduction in their total twine area. This was done by splitting up the nets into two smaller nets or one net with two separate and shorter cod-ends.

A reduction in twine area of 50 % led to a drag reduction of 10 %. Such net-configurations did not result in lower catches.

The problem of by-catch of cod in the Dutch beamtrawl fishery causes great concern as by-catches of this sector are to such an extent that little is left for the specialised cod-fishers.

Modifications in headline mounting were tried to find out whether by-catches of cod could be reduced. Due to the tendency of this species to dive when nets approach, the by-catch did indeed decrease and so did the net drag.

#### Technical fishing gear design studies

#### Multifoil depressor otterboard

A biplane otterboard was designed and tested in the Flume Tank of Hull with discouraging results at first due to instability and

unknown optimum warp and backstrop attachment points. Therefore a new design was made and a bigger model constructed and tested in the tank of Hirtshals.

The range of possible attachment points was increased and now a stable set-up could be found. Compared to a Süberkrüb door of equal total surface area and weight it was clear that a bigger spreading force can be achieved with a bi-plane while its diving capacity turned out to be similar. Further optimization of this door type will follow.

#### Fishing net model studies

Separator panels in midwater trawls can pay off when a distinct separation of for instance horse-mackerel and herring can be obtained. Prior to full scale tests a separator panel was mounted in a model of big meshes trawl GM-2 to analyse the impact on its drag and geometry. The force distribution along the frame lines was altered dramatically, with the side frame lines pulled in a V-shape. A way to lead the drag forces into the gear is to attach a third bridle from the separator panel front to the upper bridle.

A new design of a midwater pairtrawl was tested with success. Its shape turned out to be adequate for full scale construction.

#### INFORMATICA

This year the institute was equipped with a new document-processing system and a new network-architecture. Various computer-programs were written and tested for people in or outside the department. Good progress was made in implementing a system to scan otoliths with a computer-driven microdensitometer. Furthermore an experiment was done to look for shellfish in deeper water using commercially available sonar equipment. The result were negative as given in TO 87-01.

ICES  
FISH CAPTURE COMMITTEE  
FTFB WORKING GROUP  
NATIONAL PROGRESS REPORT / NORWAY, 1987  
by  
Åsmund Bjordal

Fish Behaviour and Reactions to Fishing Gear.

- The behaviour of cod, saithe and haddock - particularly in relation to selective devices in trawls was studied by using a remote controlled TV-vehicle.  
The same method was used to evaluate the effect of gear type and sweep lengths on a demersal sampling trawl. Size- and species composition of catches by demersal trawl and pelagic trawl operated on bottom were compared.
- Effects of trawl selectivity are being investigated and quantified through use of a high frequency scanning sonar.
- Further investigations on fish reaction to different light stimuli has shown that scattered layers of both feeding and spawning herring may be concentrated and guided by use of over - and/or underwater light.
- Studies of herring behaviour in relation to vessel and gear in purse seining have shown that the movement of herring schools during the catching process may be predicted.
- Trials have shown that both herring and mackerel are herded by large (150 mm stretched) meshes in the last part of purse seines. The observations were done with a SIMRAD FS3300 sonar which proved to be a very good tool for observation of

school behaviour and net geometry.

- Underwater observations of longline gear in the field have comprised studies of hooking behaviour (tusk) and bait predation by different species.

#### Selective fishing.

The work on selective fishing has included:

- Fishing trials with separating panels in new types of shrimp trawls.
- Funnel arrangements in the belly of shrimp trawls to improve size selectivity of shrimp. The arrangement gave better selective properties compared with cod end selection.
- Experiments with square mesh in the codend on shrimp trawls.
- Development of codfish trawl with combined square/diamond meshes in codend, change of trawl design and increased wing mesh size.
- Systematic species differences with height from bottom have been observed in bottom trawl hauls on cod and haddock.
- Effect on selectivity of codend of material (PA and PE), round straps and length of panels in 2-panel codends were TV-monitored during comparative trials based on a modified trouser codend method. The selectivity of PA and PE codends was similar, while the 50 % roundstrap experiments gave inconclusive results. A shorter upper panel in two panel codends had a negative effect on selectivity.
- In longline experiments, artificial bait caught larger cod compared with natural bait. This seems to be an effect of larger size of artificial baits.

Improvements of fishing gear and methods.

- Significant catch improvements are obtained in mechanized longlining by swivel connected snoods and a more effective hook type.

- A new artificial bait has been tested with promising results for cod and tusk.

- Preliminary studies indicate that bait predation by sea birds might have a severe negative effect on the catching power of longlines.

- Full scale trials with collapsible fish traps have given promising results for tusk (*Brosme brosme*).

- Development of high opening bottom trawls is continued. Trawl gear of used types is tested for rough bottom trawling. Danish seine operation is observed by underwater TV.

- Sinking speed experiments are conducted on purse seine with different gear parameters. Sinking speed was maintained using less lead weight when combined with larger mesh size.

Other relevant activities.

- In a project aimed at exploring the feasibility of using wild cod fry as seed fish in aquaculture, 0-group NE-Arctic cod in August-September were found concentrated in shallow waters occurring in small, nearbottom schools which could be easily located with a commercial echosounder. Aimed fishing with a small-meshed danish seine produced catches up to 20 000 per haul. This suggests that also for such small fish "blind", random survey fishing may give rather misleading results.



- Work on textile material properties for fishing gear purpose continued, implying fishing experiments with different twine types in cod gillnets in the Lofoten fishery and some more basic studies of textile twine properties and their applications in fishing nets.

## ICES FISH CAPTURE COMMITTEE

### Fishing Technology and Fish Behaviour Working Group - Ostend 1988

#### Report of Activities 1987 - Scotland

Discard experiments have been conducted on prawn trawls to compare catches from codends of different design - with a short extension, with fewer meshes round the circumference (narrow), with square mesh and with longitudinal ropes along the codend. Compared to a standard commercial codend significant reductions in discards of small Nephrops were found with all except the narrow codend. Observations of the codends of seine nets with and without covers showed that codend selection could cease completely when the cover or codend contained large quantities of small fish which masked the codend meshes.

A preliminary study using mathematical simulation of the influence of codend shape on selectivity was able to demonstrate typical features of real selection curves. The technique may be used to investigate the effect on selectivity of design features. A theoretical investigation was conducted into the usefulness of the alternate haul method of estimating selection parameters. A comparison was made between the catches obtained in the two sides of a vertically divided trawl. In almost all of the 24 hauls there was no significant difference between the quantity and distribution of the catches in the two codends. The technique is being tested as a possible alternative to the covered codend method for selectivity measurements.

Two cruises were undertaken to investigate the effect of environmental factors on the catch of fish sampling gears. Further cruises are planned to assess the significance of the variation of catch with sea bed type as well as trawl geometry, towing speed and parameters defining visibility.

The study of damage to fish escaping from codends was continued. Scale damage and survival rates for fish subsequently kept in cages on the sea bed were carefully monitored over periods of up to 52 days. Control fish caught by barbless hooks on handlines had a survival rate of 100%.

Further trials to measure the performance of a 200 hp seine net were conducted. Tensions and geometry were measured to determine swept area and gear drag throughout the haul. More film of commercial pair trawls was obtained.

Diving observations were made on a twin trawl using a two warp system. Fish behaviour and the catch in the two sides of the gear were recorded. Even small differences in the two nets due eg to temporary mending caused noticeable differences in catch between the two sides.

The use of separator panels in fish/prawn trawls has now been taken up by a significant number of boats in north east Scotland. 85 mm mesh is used in the upper net and 70 mm mesh in the lower net resulting in major reductions in the discard of small white fish.

The computer model of a trawl is being developed further to improve representation of the construction of the net and to reduce convergence times. Preliminary measurements of the flow in codends and idealised trawls were made to improve understanding of the flow in nets both for the model work and for studies of the basic factors affecting selectivity.

The investigation of food preferences in cod in relation to line fishing bait selection has continued. The effect of previous feeding history on food preference is currently being studied using a multiple choice experiment with cod.

ICES FISH CAPTURE COMMITTEE

Fishing Technology and Fish Behaviour Working Group  
Ostend 1988

*Progress Report 1987 - Sweden*

Sweden are still without an institute for research in the field of fisheries technology. Development and research activities are however ongoing but an overview is hard to come by as the projects are carried at several different institutes and Universities. In additions development of fishing gear trawl door sand vessel design are carried out by private companies and the results are not published. The present progress report is to be regarded as indicative of ongoing activities rather than giving an total overview.

Vessel design

Hull design of fishing vessels and studies of ducted propellers are carried out to reduce fuelconsumption. A special project about using catamaran hull in fishing operation is currently ongoing. A 12 m catamaran have been ordered. The vessel will be equiped for Nephrops trawling.

Distribution systems of fresh fish.

A majority of fresh fish landed for human consumption are landed in reusable boxes of 30 or 40 kg. The present box system have been critised being costly, ineffictive and involving to much handling both onboard fishing vessels and in subsequent distribution to the market. A container system which could hold 400-500 kg in each box is considered and the effects on the present distribution and handling system is studied.

Working condition onboard fishing vessels.

Fishermen are known to be subjected to high risks of short term and long term damage due to difficult working condition on a fishing vessel . Several projects have been carried out to identify high risk elements in the work and of the equipment used. New methods and improved equipment have been suggested and implemented in the fishing fleet. Special attention have been payed to noise reduction, new equipment for handling boxes, ergonomic design of working areas onboard a fishing vessel. A simulator setup are in construction to study the effects of ships movements on people and equipment under controlled conditions. The simulator will be able to simulate movements with 6 degrees of freedom.

### Northeast Region

Researchers from the Maine Department of Marine Resources have recently been engaged in two major fishing gear development projects. In one study they investigated the effects on selectivity of square mesh netting in the extension section of typical bottom trawls used in the Maine mixed groundfish (flatfish and demersal roundfish) fisheries. They found that the square mesh sections had no significant effects on the size distribution of the fish captured, a departure from European findings, but speculate that this may be because of the larger (90 to 125 mm, stretched) mesh sizes used in their study. In another study they used a "trouser trawl" to compare the effectiveness of several different styles of fish separating systems for shrimp trawls. These included large mesh panels behind the footrope, square mesh netting in the extension section, openings in the top or bottom of the extension section, "HH panels" in the extension leading upwards towards an opening, and a "double funnel" separating section. Preliminary results showed that the HH panel yielded the best fish escapement, but lost a large proportion of the shrimp and was troublesome to use because it quickly plugged with fish and debris. The double funnel fish separator successfully sorted out more than 50% of the fish with some shrimp loss. It was noted that funnel spacing was critical to both fish escapement and shrimp loss. Nets with fish escape openings, but no leading panels, showed lower levels of both fish escape and shrimp loss.

The Center for Fisheries Engineering Research at the Massachusetts Institute of Technology has been active in several aspects of fishing gear development. The Center coordinates all gear testing and fishermen's training sessions at the U. S. Navy's hydrodynamics laboratory near Bethesda, Maryland, and has continued efforts to refine methodology and instrumentation to facilitate gear research activities there. The 52-ft (16-m) wide towing basin proved particularly useful for observations of complete trawl systems (net, bridles, sweeps, doors, and warps) in large scale (1:5), thus reducing many of the inherent scaling inaccuracies encountered in model studies. MIT also is leading an effort to develop a portable, low-cost towed ROV system for observing trawls and other towed gears during fishing operations. The prototype system has shown promising results during field trials (including observations of the shrimp/fish separators tested in Maine) and is undergoing further development. Center investigators evaluated various means for damping the rolling motion of models of typical trawler hulls, and ranked the roll-damping effectiveness of passive bilge fins, paravanes, and bilge keels in that order.

Other gear research activities in the Northeast region have been carried out by various Federal and state agencies and universities. These include work on enhancing the selectivity of scallop gear, reducing the impact of "ghost-fishing" by lost gillnets, and evaluating the fishing power of sampling gear used for resource assessment. Several public agencies and at least one private gear builder have purchased trawl instrumentation systems which will be taken from vessel to vessel to evaluate gear performance and identify problems or areas where efficiency might be improved. A

manufacturer of ropes and cordage has cooperated in trials of warps and rigging made from Kevlar, with promising results.

### Southeast Region

Most of the groups conducting gear research and development activities in the southeastern United States are involved in work on Turtle Excluder Devices or TED's. Use of TED's has recently become mandatory for most commercial shrimp trawlers in this region, and a number of alternative TED designs have been certified as meeting Federal standards of effectiveness. However, most of the designs approved to date rely on some sort of rigid or semi-rigid framework, and thus are not fully acceptable to fishermen who would prefer to use a "soft" design built entirely of ropes and/or netting. All of the TED's, whether rigid or soft, suffer from impaired effectiveness or unacceptable shrimp loss if they become clogged with sea grasses or other debris. Most current efforts are aimed at finding designs that overcome these problems.

In addition to its responsibilities for developing and evaluating TED designs, the Harvesting Systems group at the National Marine Fisheries Service's Mississippi Laboratories has been conducting research on sampling and harvesting gear for latent resources in the Gulf of Mexico. These fishes are generally small (less than 20 cm), fast-swimming herring- or mackerel-like species, and have proven very difficult to catch with any of the types of fishing gear commonly used in this area. This group has undertaken efforts to identify or develop gear suitable for harvesting these species. In addition to at-sea fishing trials, they have directly evaluated gear performance and fish reactions through visual observations by divers and/or ROV's, as well as various hydroacoustic instrumentation systems. Several types of net have been identified that can effectively capture these fish, but it has proven somewhat more difficult to contain the fish during haulback operations, compelling the group to develop special "fish valves" (similar in concept to flappers) that will prevent their escape.

Other topics of research in this region include studies of trawl efficiency and selectivity, fishing vessel safety, alternative gear development, and fuel conservation.

### Southwest Region

The author is not aware of any fishing gear research taking place in this region, other than some efforts conducted in Hawaii and targetted on artisanal fisheries and fish aggregating devices.

### Northwest and Alaska Regions

The majority of fishing gear research and development taking place in this region has been carried out by private industry, or by private industry with Government assistance. The principal example is the crab bycatch reduction project to be reported in more detail at this meeting. In summary, during this project investigators reviewed the gear types most commonly used in the Bering Sea flounder fisheries with respect to the possibility of

modifying them to reduce bycatches of crab, which are protected from trawling in these fisheries. Designs were developed for possible crab-sorting devices that would be compatible with existing gear and fishing practices. Models of the conventional and modified nets were constructed, along with scale doors and rigging, and taken to the U. S. Navy's hydrodynamics laboratory for testing in the circulating water channel and the model towing basin. Following the model studies full-size gear was built and furnished to commercial vessels which had volunteered to participate in a controlled comparative fishing experiment carried out in the fall of 1987. During the experiment an ROV was used to observe the performance of the experimental and control gear types, and to observe the reactions of fish to the gear. Results from the study showed that both of the crab-sorting devices tested reduced crab bycatch, although one reduced fish catch per hour by 40%, while the other lost no fish but was not effective at expelling smaller crabs. Despite the shortcomings of both of these systems, numerous fishermen have purchased and installed one or both in their nets for the 1988 fishery.

Experiments continue with Kevlar and other exotic fibers as materials for fishing gear. In general these fibers have performed well, yielding the desired strength and/or reduced towing resistance. However, despite their many desirable properties their durability has not been great enough to overcome resistance to their high cost.

Some gear-related research is being undertaken by public agencies or universities. In Alaska the Fishery Industrial Technology Center (affiliated with the University of Alaska) is continuing its studies of fish reactions to trawls with the goal of reducing bycatches of Pacific halibut (Hippoglossus stenolepis) in groundfish trawls. The Fisheries Research Institute at the University of Washington is leading an effort to determine mesh selection parameters for codends used in the mixed rockfish (Sebastes spp.) fisheries off the coasts of California, Oregon, and Washington states.