International Council for the
Exploration of the Sea

CM 1986/B:46
Fish Capture Committee

REPORT OF THE WORKING GROUP ON FISHING TECHNOLOGY AND FISH BEHAVIOUR

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Rapporteur: R D Galbraith, Marine Laboratory, Aberdeen, Scotland
Meeting Place: Hull, England
Time: 12-14 May 1986

INTRODUCTION

In accordance with ICES Council Resolution 1985/2:2, the working group met in Hull from 12-14 May, convened by Mr D N MacLennan and considered, in particular:

1 recent applications of energy saving concepts in the design of fishing vessels, deck machinery and propulsion systems, and

2 engineering and behavioural aspects of the selectivity of fish sampling gears.

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 an 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.

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AGENDA

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2 PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON THE SPECIAL TOPICS

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2.2 The use of Residual Fuels in the Dutch Fisheries - A Molijn

2.3 Economy in Design and Operation of Fishing Vessels - H R English (verbal)

2.4 Methods to Reduce the Fuel Consumption of Fishing Vessels - S M Calisal and R H McIlwaine

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2.6 The Effect of Different Bridle/Sweep Lengths on Length Composition of Bottom Trawl Catches - A Engas

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2.8 A Note on Selectivity Experiments with Square Mesh Codends in Bottom Trawls - B Isaksen

2.9 Factors Affecting Codend Selectivity - R S T Ferro (verbal)

2.10 Fishing Efficiency Comparison Between Different Pelagic Trawls - L Fiorentini, E Paschini and G Cosimi

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3 PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON GENERAL TOPICS

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3.2 A Laboratory Study on the Effect of Bottom Sediments on Mesh Size - R Fonteyne

3.3 Measurements of the Headline Heights of Gill Nets in Tidal Flows - P A M Stewart

3.4 Danish Net Design Techniques - D A Wileman and S R Yngvesson

3.5 Fisheries Technology in Newfoundland - C Campbell (verbal)

3.6 Fish Behaviour Studies Related to Fish Capture - J Main and G I Sangster

3.7 Nephrops - Gadoid Separator Trawl Design; - Where Next? - J P Hillis

4 RECOMMENDATIONS

1 PROGRESS REPORTS

The Convenor requested in his letter to delegates of 15 January that each country should provide written progress reports on recent work on fishing technology and fish behaviour. All the participating countries provided a report. There was also a report from Iceland whose delegate was unable to attend. Following the precedent of 1984, all reports were not given verbally but time was allowed on 13 May for questions and discussion. Mr de Boer also described the current work and organisation of FAO Fisheries Technology Service.

BELGIUM

Trawl Gear

Within the framework of an energy saving project research was started on the possibilities of decreasing the drag of trawls. The influence of parameters such as yarn diameter, mesh size and cutting rates on the hydrodynamic resistance of trawl nets will be studied. This research aims at a better adaptation of gear size to the available engine power.

A new type of net was successfully introduced in the cod pair trawl fishery. The new net has a higher vertical net opening and is equipped with Rockhopper gear.

The study of the geometric configuration of trawls and of the forces acting in the rigging was continued.

Beam Trawling

An overload protection system has been developed for the beam trawl fishery. In this system the loads in the warps are continuously measured and in case of overloading the brakes of the winch are automatically opened and the engine speed is slowed down. With the aim of anticipating an inadmissable list in the towing vessel, the overload check does not only react on the absolute maximum traction in one warp, but also on the difference between the load in both warps.

Scallop Fishery

Trials with scallop dredges were started on board two commercial low powered (300 hp) beam trawlers. The results of this new Belgian fishery are promising.

Electrical Fishing

A new type of net was tested for the electrical shrimp beam fishery. In this net the square and gussets were enlarged in order to obtain a better definition of the electrical field at the entrance of the net.

Mesh Shrinkage

The laboratory tests on mesh shrinkage due to sediments was continued. The study now includes all the main netting materials and netting constructions used in Belgium. In addition to sand the influence of mud on mesh size was tested. The amount of shrinkage is mainly a function of the fibre type (multi- or monofilament), the yarn construction (twisted or braided) and the twist hardness. As to the sediments the amount of fine sand (125 - 250 μ) is determinant for the decrease in mesh size.

Selectivity

Comparative fishing trials with a beam trawl equipped with 85 mm diamond and square mesh codends were continued. Due to low catch rates no conclusions on the difference in selectivity could be drawn.

CANADA

Reduction of energy consumption for fishing vessels has received major emphasis throughout Canada during the past four years with all Fisheries Development offices engaged in fuel-conservation projects.

Nozzles

Several vessels in the Maritimes have been retrofitted with nozzles and new propellers and nozzles are now becoming a more common installation on new construction trawlers and draggers. In one demonstration project, fuel consumption after installation of nozzles actually increased but the change was still a cost-effective solution.

In a demonstration project, three offshore scallop draggers of 34 metres in length had new nozzles and propellers installed and the landings and fuel usage were monitored against three unmodified boats. The vessels with the nozzles increased their fuel consumption in the order of 6% but landings also increased by about 4%. Because of the high value of the product, the nozzles were paid for in less than one year.

The Fisheries Development Branch in Halifax supported the development of a plastic segmented nozzle for application on a wide range of small vessels. The concept involves fastening a number of standard shaped plastic sections into a circle of the required diameter by a tensioning steel band. The high strength plastic segments interlock by protruding lugs and can be made into any diameter between 34 inches and 52 inches. One prototype was built and successfully trialed onboard a vessel. The

results compared favourably with custom built steel nozzles but because of increased tip clearance and a compromise design of nozzle length, there was an expected loss in efficiency. However, it is estimated that production models could be built at about one third the cost of custom designed steel nozzles.

Sail Assist

There has been considerable interest in the feasibility of utilizing sail assist for fishing vessels, but most of this interest appears generated by designers. Despite higher fuel costs, vessel owners have been reluctant to give the concept a try. One project was supported in Nova Scotia where a 20 metre longliner was outfitted with a simple inexpensive square sail of commercial design. While the concept was viable, the crew did not consider the additional work worth the savings. To be accepted by the Canadian fishing industry, it appears that sail assist would have to see a greater emphasis towards automation of sail controls.

Fuel Heaters, Synthetic Lubricants

Because fuel heaters were being sold by some entrepreneurs as a fuel-saving device for diesel engines, controlled experiments were performed at the Technical University of Nova Scotia. The results showed conclusively that while fuel heaters would lower fuel consumption, available horsepower would also decrease. The same savings could be achieved by throttling back.

As an adjunct to the fuel heater experiment, the improvement in diesel engine efficiency resulting from the use of synthetic lubricants was also examined. Synthetic lubricants did account for a minor decrease in fuel consumption of 1%, but in view of engine manufacturers' warnings regarding engine warranties, could not be recommended for use.

Fuel Meters

Considerable attention has been directed at assessing the impact that fuel meters would have on the attitude of fishermen in operating their boats. In Nova Scotia, eight gas powered fishing boats were outfitted with simple automobile fuel meters and the results monitored over a month. It was found that on the boats outfitted with fuel meters, daily fuel consumption dropped by an average of 18%.

Similary work was performed in Newfoundland where fishermen were provided with a calibrated chart for their boat showing fuel usage versus rpm. Again, for the short period of observation, fuel consumption was reduced in the order of 15 to 18% for most boats. It is intended to follow up with more observations to determine whether the fishermen will continue these new practices over the longer term.

Because fuel meters for diesel engines are expensive and have varying reliability, the Halifax Fisheries Development Branch office supported the development of an inexpensive device which measured fuel consumption from the fuel rack instead of monitoring fuel supply and return flows. The device attaches to the fuel rack and is calibrated from the engine's manufacturer's data. The device was constructed for a National Sea Products Ltd offshore trawler and proved successful. Refinements which would obviate some of the mechanical linkages are still being studied.

The Technical University of Nova Scotia is investigating the feasibility of monitoring diesel engine fuel consumption from the exhaust temperatures with the aim of developing a reliable practical unit for application to fishing vessels.

Computer Simulation of Inshore Vessels

The majority of small vessels built in North America receive little or no professional input into the design. Trials and analysis of these vessels have shown that many are very poorly powered in terms of the matching of propeller and engine.

Emphasis is currently being directed towards providing small fishing vessel owners with an analysis of their vessel to determine whether cost-effective changes could be made either by changing the propeller, engine or both. Two separate programs are currently being developed. The University of British Columbia, sponsored by the federal Department of Fisheries and Oceans, has developed a computer model for fishing vessels which allows simulation of any operational profile. The federal Fisheries Development Branch in Newfoundland has developed a similar program which is based upon the analysis of a number of vessels and optimizes propeller selection.

Both programs are only in the initial development stage and lack verification because there is very little technical data on small fishing vessels. A project is currently underway to perform full-scale trials on typical small vessels and model tests on the same boats. These trials will include modifying the propulsion system to determine scope for efficiency improvement.

Hydrostatic Drive

The federal Department of Fisheries and Oceans in the Gulf Region is investigating the potential of hydrostatic drives for fishing vessels as an alternative to the standard engine/drive shaft arrangement.

Deck Machinery and Gear

The federal Fisheries Development Branch office in Halifax has successfully developed and trialed dual-purpose (Scottish seine or otter trawl) fully powered rope reels on a 29 metre commercial vessel. Changeover between gears at sea required less than 20 minutes. Fully powered rope reels are in commercial production and over 20 sets have been sold worldwide.

Attention has been directed by the Development Branch in Halifax at improving the performance of scallop rakes by reducing drag, improving rock rejection and being less damaging to the resource. A prototype design has been built and gone through several modifications. Comparison trials with standard rakes have indicated improved rock rejection and less drag, but the catch rate has also declined. More trials are planned with emphasis on video recordings to pinpoint required modifications.

Several Fisheries Development offices are promoting changeover to longline gear for reasons of improved quality and energy reduction. Improvements in longline handling gear is fundamental to encouraging any change. The federal Fisheries Development Branch in Newfoundland reports mounting a longline sheave with brake on a vessel to hold monofilament longline while under-running moored gear. This equipment avoids having to hold this relatively sharp line by hand. Newfoundland has also completed work on two Nordco longline systems - one, a simple manual system for use on inshore vessels and the other, an automated system for larger vessels.

All federal Fisheries Development Branch offices are involved in work with newer trawl doors with less drag, although most work involves introducing established commercial designs to new fisheries. The federal Fisheries Development Branch in Vancouver has sponsored some preliminary wind tunnel testing of various trawl doors to quantify a lift/drag ratio at various angles of attack.

Demonstration work is continuing with pair trawling and although most demonstrations have proved to be highly successful in terms of improved catching efficiency, the industry has been slow to adopt pair trawling due, in part, to the desire of many fishermen to remain independent.

Work is planned on assessing the potential of knotless netting to reduce drag of trawl gear.

DENMARK

Danish Institute of Fisheries Technology: FTI

1 Research Projects

Netting resistance

Tests have been made in the flume tank of the resistance of elliptical cones of full scale netting. The netting sample is 6 m long, towed from a frame 4 m x 2.5 m, and is made fast to an elliptical hoop at the downstream end which is tensioned. The effects of material type, construction, twine diameter, mesh size, cutting rate and mesh opening have been studied and formulae derived for determining the resistance of such a section of netting. It was found that mesh opening and cutting rate/angle of attack were important parameters. The resistance of cones of square mesh netting were also measured and found to be very high.

Basic net design principles

A program of systematic tests has been initiated in the flume tank to determine the effect upon a trawl's towing resistance and the opening of the meshes in different parts of the trawl when changes are made to the distribution of strain in the net mouth. These changes are effected by altering the shaping of the net panels, the hanging of the netting on the frame ropes or the relative strain taken by the different towing bridles.

Computer aided net design

A project has been started which is aimed at producing net drawings, design help, accurate net drag predictions and matching of net size to door size and vessel towing power. The computer programs are to be used initially by the Danish trawl manufacturers and the starting point has been the Gifford Technology/Marine Laboratory CAD net package. Design techniques have been changed to Danish commerical practice and the results of the previous projects will be input to give more accurate net drag predictions for the standard Danish trawl types.

Netting material studies

Studies within this new field of research for the institute began with the measurement of twine diameter and breaking strain of the commonly used commercial products. Comparison has been made between samples from spools of untreated twine and from finished netting. In addition several tests mainly of breaking strain and elongation have been made for commercial net manufacturers and the elongation/shrinkage of nylon twines used in large mesh pelagic trawls due to the effects of tarring, water absorbtion and normal towing strains have been investigated.

A further new project has been initiated where attempts will be made to study the effect of abrasion on sheet netting. Devices used to produce the abrasion include a washing machine, a concrete mixer and a steel drum covered with small mesh wire netting.

2 Introduction of New Commercial Net Designs

Twin trawl systems

Substantial numbers of boats trawling for Nephrops have adopted the twin trawl/3 wire system first used successfully in 1984. In addition in 1985 a twin trawl system requiring only 2 towing wires was developed in the flume tank, tested at sea with instruments to check the spread of the gear and then introduced to the commercial fleet with extremely good fishing results. The use of double trawl systems has also proved to be successful for flatfish (plaice and witches) and pink shrimp in the North Sea.

Trawls for vessels of high towing power

Several new trawlers have been built within the last year which have towing power well above that traditionally available for shrimp and sandeel fishing. The institute has worked closely with the industry making a lot of detailed design studies and model tests in the flume tank in order to dimension the trawls correctly.

Siamese trawls

A new design of Nephrops trawl has been developed with a net manufacturer in the flume tank and used successfully at sea. The bosom of the footrope is made much wider than usual by in fact making two bosoms and a short centre wing which is towed off rubber disc legs functioning like a tickler chain.

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Interaction between subsea structures and fishing gear

The institute has in partnership with FTI undertaken model tests at 1:10 scale in its large towing tank where different types of trawl were towed over a well head structure and the resultant shock loads measured. The tests were made for a private client.

Improvement of fishing vessel design

The institute did not carry out any major research projects within this field but has completed some tests examining the long time durability of anti-foulant paints for ship hulls and has also concluded a general report on the design requirements for future Danish fishing vessels. The anti-fouling treatment was found to be still effective 26 months after sandblasting and application.

The institute has also recently completed model tests of a new design of fishing vessel for an Icelandic client.

FEDERAL REPUBLIC OF GERMANY

The activities of the Institut fur Fangtechnik in the field of energy saving fishing methods were continued.

Gill Nets, Trammel Nets

Due to the very poor Baltic cod 1983 yearclass only a few results were obtained from experiments with bottom set gill nets and trammel nets in the western Baltic. Small mesh gill nets (53-55 mm bar length), successful in 1984, failed completely in 1985.

Trammel nets of 60-70 mm bar length proved to be most successful in the same area. Good results were obtained with nets of 1.20 m height. Nets of 0.60 m caught much less cod, nets of 1.80 m needed too much time for cleaning and preparing for the next set.

Fishing with trammel nets for sole in the German Bight was intensified. In addition to small fishing vessels from the Baltic some vessels from the Frisian coast also took part in this fishery in 1985. In this case low nets of 0.60 m height caught as much sole as the standard type of 1.20 m but were much easier to disentangle and to clean.

Some attempts were made to introduce gill nets in the German Bight cod campaign in winter 1985 but failed due to severe ice problems.

Experiments with gill nets on wrecks in the German Bight in October 1985 gave some good results in catches but damage and losses of nets made this fishing method less successful regarding the commercial aspect. In May 1985 some trials were performed with gill netting for turbot in the southwestern part of the North Sea. The results were encouraging and the experiments will be continued in 1986 on a semi-commercial base.

Longlining

The development of a semi-mechanised longline system for monofilament lines was continued. A random baiter was tested with good success.

Danish Seining

The activities in Danish seining were reduced to a few cruises with a chartered commercial fishing vessel in 1985. There were only poor catches and no further experiments will be performed in 1986.

Electrified Beam Trawling

Experiments with an electrified beam trawl, developed at the Institut für Fangtechnik, were continued in 1985 with a chartered commercial vessel.

Underwater-TV

A major activity in 1985 were first investigations of trawls by means of an underwater TV-system. The system corresponds to that type developed by the Marine Laboratory, Aberdeen. The TV-camera is mounted on a towed vehicle controlled by Magnus rotors in vertical and horizontal direction. The system in the present configuration with separate towing wire, TV-cable, and power cables for lamps and rotors was used with success on two cruises of FRV "Solea". Improvements such as towing cable, special cable winch and additional photo camera are planned in the near future.

Trawl-selection

Experiments with the selection of trawls during the winter cod fishery in the German Bight were continued in 1985. No influence of the duration of tow on the selectivity of trawls was observed.

Trawl Design

By means of full-scale experiments the influence of cutting rates of the panels on the drag of trawls was investigated.

Differences of up to 20% in warp tension could be found.

FINLAND

In 1985, the technological research conducted by the Finnish Game and Fisheries Research Institute was concentrated on the possibility of increasing the mesh size of the leader in the Baltic herring trap net. The results obtained confirm that the leader mesh size can be increased from 14-15 mm to at least 60 mm (bar length) without decreasing average catches. Large mesh leader netting made of twisted polyethylene (PE) monofilament twine had many favourable properties compared with the ordinary small mesh nylon (PA) netting or large mesh nylon netting. The use of stiff PE twine eliminated the meshing of herring and other fish, which is a problem with softer nylon twine. It also caused a marked reduction in the dirt and algal growth fastening on the leader netting and substantially facilitated cleaning. The buoyancy of the PE twine makes it possible to keep the leader netting stretched in the water, without

discontinuities which might disturb herding effectiveness. The orange colour and considerable thickness of the PE twine may significantly improve the contrast of the PE netting compared with the thinner and greyish nylon netting of the same mesh size. On the other hand, the resistance of PE twines to sunlight is known to vary greatly depending on the manufacturing procedures, and differences were actually apparent between two products used in this experiment.

A preliminary test with larger meshes in the wing netting of a herring trap net proved unsatisfactory. Most of the fish evidently escaped through the meshes of the wings.

For further development of the trap net construction, we are planning to observe the behaviour of herring in and around the trap net.

The fishing performance of a midwater trawl with 8 m half meshes in the wings and front part of the trawl was tested in order to consider the suitability of a large mesh trawl for the Baltic herring fishery. Fishing trials were carried out in collaboration with the Institut für Fangtechnik (Hamburg) on board the Finnish commercial stern trawler "Ceylon" in September 1985 in the Bothnian Sea, where the herring stock is very scattered at that time of year. Hauls were made only during daylight and twilight. The fishing efficiency of the large mesh trawl was of the same order of magnitude as that of a comparable conventional herring trawl, which suggests that the efficiency is not markedly affected by using larger meshes in the front part of the trawl. However, the test period was too short to allow definite conclusions regarding the fishing performance of large mesh trawls, and the results will have to be verified with further tests.

FRANCE

Fish Capture

1 Nets

1.1 Trawls

- Trials of twin trawls at Lorient test facility and at sea
- Underwater observation of a trawl at sea (using the Sea Rover)
- Computer aided design of trawls, including hydrodynamic effects on doors and trawls
- Study of trawls fit for Tunisia's fisheries

1.2 Gill nets

- Video movie of gill nets - (visibility of the nets according to materials and construction)
- At sea trials of drift nets for Atlantic tuna capture forseen in July 1986

2 Longlines

- Use of artificial bait and test of longline fishing in great depths in Mediterranean

3 Fish Traps

- Use of artificial baits in fish traps

4 Shellfish dredges

- Development of a grading dredge for clams
- Tests of a hydrodynamic dredge for scallops

Fishing boat technology

- Development of an electronic scale
- Study of an automatic fish grading system

ICELAND

In cooperation between private companies and the Marine Research Institute the behaviour of Nephrops against a bottom trawl was observed with an underwater TV camera. Attempts will be made to use the results to increase the catchability of conventional Nephrops trawls for the 1986 season. On the same occasion the behaviour of different fish species against two designs of four seam trawls was observed under different conditions. Videotapes on the most interesting results of the cruise are available.

Comparative selectivity experiments with different codend mesh sizes were conducted on haddock.

Fishing experiments on crabs have resulted in commercial fisheries in some places. Experimental fishing on basking shark started in 1985 and will be continued in 1986.

During four weeks in August-September the MRI with the 23 m long research vessel Drőfn has searched for demersal fish species and shrimp with many different fishing gears in the Skjőldungen and Angmagssalik fjords (E-Greenland) for the Greenland authorities. The catches with demersal fishing gear proved to be very poor whereas interesting salmon catches were taken in the Skjőldungen fjord with drifting and stationary floating gill nets.

A new design of scallop dredge improved rock rejection for less damage to the scallops while maintaining catch rates.

Mesh breaking load tests were exceptionally numerous in 1985 especially on hexagonal purse seine netting which made a good appearance in the capelin fishery.

Measurements on fuel consumption of different vessel types were continued. The results have been presented in fishery magazines and also on a video-tape. Many Icelandic vessels have had new propellers and propulsion systems installed, and this has led to significant reduction of fuel consumption.

Due to interest in utilising the black quahog stock design work on a suitable veesel construction for a possible black quahog fishery has started.

In 1986 the following investigations are planned:

In May:	Continuation of direct observation on the behaviour of Nephrops with a TV camera.
In June:	Model tests in the flume tank in Hirtshals.
In July:	Direct observations on the behaviour of cod and other demersal fish species in relation to bottom trawls.

IRELAND

Work in fishing technology and fish behaviour during 1985-86 has been applied towards the problems of the Nephrops fishery and its whiting by-catch in the Irish Sea, Division VIIa.

Separator Trawls

Work on separator trawls in use by three normally fishing trawlers has been reported (Hillis, 1985). Since then, work has continued, the skipper of the trawler "Golden Harvest" recording landings subject to checks from time to time. So far, he records mean percentages of 99% Nephrops in the lower codend and 94% whiting in the upper, albeit with very small whiting catches. Discussions have been held with the skipper of the "Brian Og" to arrive at a type of codend with separator panel which he would be willing to use for normal commercial fishing. Steps are currently under way to construct a single codend with separator panel of width equal to the diameter of the codend assuming circular cross-section and equal lateral strain on all meshes.

Parallel Haul Mesh Experiment

A parallel haul mesh experiment was carried out in December to assess the difference between catches with trawls of equivalent size and 60 mm V 70 mm meshes. Catch, landing and discard weight of Nephrops and landings of other species were noted and those of the 70 mm trawl, as a percentage of the 60 mm trawl were as follows:

Species		Wt 70/Wt 60%	Species % of Landings	
			60 mm	70 mm
Nephrops	Catch	38	-	-
	Landings	59	24	21
	Discards	22	-	-
Whiting	Landings	59	65	62
Cod	Landings	92	7	9
Plaice	Landings	103	3	5
Others	Landings	110	2	3

It is planned to repeat the experiment in summer, when Nephrops are more numerous, and probably in autumn when recently recruited whiting are present in strength.

NETHERLANDS

Electric Sea Fishing

A workshop has been held on 25 January at Rivo, IJmuiden with representatives of Belgium, West Germany, United Kingdom and The Netherlands. Technical details were exchanged. It was felt that each participating country should try to develop and commercialise its own system and exchange information on a regular basis. This suggestion has been supported by a formal ICES recommendation, made by the Fishing Technology and Fish Behaviour Working Group meeting in Tromso, Norway, May 1985. A report of the meeting is given in ICES CM 1985/B:37.

Three experimental cruises were conducted by FRV "Isis" during 1985 on electrofishing. Tests done in May/June showed a percentage increase of total sole catches of +117% at 700 V and 20 Hz in comparison with the conventional gear. A slight tendency of catches per square metre to decrease with speed was found for the 72 hauls included, but there was a great scatter in the results. During this period no significant problems were encountered with the electrode endurance as reported in 1984 with similar voltages. A steel wire braid on the copper electrode improves its lifespan considerably.

A five week trip in November/December was committed to a comparison of two different systems on one boat, namely the systems developed by RIVO and by the Institut für Fangtechnik (IFF) of Hamburg, West Germany. With all testing, installation and travel time included, two weeks of comparative fishing remained. The results were rather discouraging for the Dutch system concerning reliability of the system. Many components were troublesome such as the winch, feeding cable and connecting cables between the beam and the electrodes, while IFF's system performed well in this respect. The Dutch pulser itself did not malfunction however. The catch results were not firmly conclusive, due to the poor fishery, a small number of hauls, size and rigging differences between both gears, but it cannot be denied that sole and plaice catches of RIVO's system outnumbered those of IFF's system. It should be borne in mind that the design philosophies of both systems were different. RIVO's system has been developed to meet conventional gear catch rates at speeds over 4.5 knots, while the approach for IFF's system was to aim at maximum energy saving and good performance at speeds around 3.0 knots. Particularly this system was not towed at its optimum speed and further engineering of the net itself may raise its catch potential. On the other hand it may be a necessity to use the considerably high electrical power of RIVO's system to obtain good catch rates at higher speeds. The attempts to commercialise the system will be given strong emphasis in the research programme of RIVO during 1986. The aim is to test a newly designed system with better reliability built by the industry on the basis of present knowledge and to evaluate its economical potential.

Safety and Working Conditions

Generally safety problems can only adequately be handled by good contact between research personnel and the industry. Cases that worked well are the introduction of easier and safer fish landing techniques, now in use by five older vessels and usage of separate winch drums for the lazy decky instead of the main winch capstans. This was supported and promoted by the Technical Research Department.

Preliminary studies indicate a substantial decrease of hard physical labour during fish processing and storing on board by using fish containers instead of ice boxes. A necessary condition will be good quality of the landed fish, which stresses the need for investigation by a fish processing research station. The fish sorting machine installed on the UK 173 has been monitored by the Technical Research Department until June 1985, when the machine was dismantled and reinstalled in a fish processing plant on Urk. A gain in labour was not experienced as the crew found difficulties with hooking the fish on the conveyer system of the machine. The use of fixed weights as a reference to overcome dynamic problems, when measuring weight on a moving boat, worked very well however and further research using a system based on this method may very well follow.

Noise Control

A brief survey of noise levels on board eight different Dutch beam trawlers has been conducted. Measurements were done in the mess-room, pantry, huts and on the bridge as well as in the machinery room during steaming and fishing operations. The results were also compared to measurements done by other national and foreign institutes on beam trawlers and stern trawlers and related to recommendations drafted by the "International Maritime Organisation" and the Dutch Shipping Inspection, which apply to new sea trade vessels. As can be expected with relatively small and high powered boats, the noise levels exceed these standards in a lot of cases, except for the machinery rooms, when steaming and to a lesser degree while fishing. Pair trawling showed slightly lower noise levels than beam trawling.

Reduction of Fuel Costs

The research project on heavy fuels has reached its final phase during 1985. Looking back on the past years it can be regarded as advantageous to use heavy fuels in order to reduce fuel costs. The outcome, however will always depend on the price difference between gasoil and heavy fuel. Difficulties were encountered in the beginning due to lack of experience in handling the fuel and the use of relatively new engines. The beam trawlers use a fuel with a viscosity of 180 mm^2/s (cSts) and stern trawlers burn even heavier fuels of 360 mm^2/s (cSts). Generally a decrease in fuel consumption of some 7% could be obtained. A total net cost reduction of 18% resulted with the average price difference of 1985, taking into account some additional costs on maintenance.

Measurements of Fuel Consumption and Power on Beam Trawlers

During October and November 1985 two weeks were dedicated to measurements of fuel consumption, main engine and winch power, warp loads, speeds etc on the beam trawler UK 173 with the aid of a new data-logger (FLUKE 2280-B) and the TRACOR-MACRON condition monitoring equipment, described in the annual report of 1984. These measurements were conducted during steaming, shooting, hauling and fishing. Data has been recorded on magnetic tape and will be processed and analysed during 1986.

Improvement of Towed Fishing Gear

Several projects run under this heading. Large mesh trawl GM3 of 4320 meshes circumference was tried out in comparative fishing experiments on FRV "Tridens" during two weeks in June and July with no escape of herring through the big mesh.

The footrope needed some additional weight (120 kilo) to keep good bottom contact. The size of this net requires full power of the vessel (approx 1300 kW (1800 hp), a fact that limits further extensions in size on this boat. Towards the end of the year the gear has been rented to a private shipowner and tried out on the stern trawler "Ariadne" SCH 303 with encouraging results. It has not left the company since and applications for even bigger nets of similar construction were directed towards the Technical Research Department. In March 1985 co-operative research has been carried out on FRV "Tridens" on square mesh codends and codend covers on bottom trawls, using the Marine Laboratory remotely controlled television equipment. Details of these experiments were presented at the ICES working group meetings at Tromso, Norway, in May 1985 and are given in report CM 1985/B:34 of the Fish Capture Committee. RIVO is now building up a system of its own on the basis of this vehicle, which will be operational during 1986. It can be regarded as an important tool in fishing gear research. Major conclusions of the trials are a favourable effect on small fish bycatch when codends with square meshes are used and a good net shape with a junction rate of diamond to square mesh of 2 to 1, assuming both having similar bar lengths.

Model research has been done in SFIA flume tank, Hull, England in April 1985. Three different nets were investigated:

- A 1:25 scale large mesh pair trawl for herring with a maximum mesh size of 12.9 metres and a circumference of 3354 meshes of 20 cm. The headline, footrope and sidelines were cut with simple taper rates to avoid a number of ropes of unequal length for ease of manufacture and repair. The model tests showed no considerable distortion of the net shape. A full scale net has been made later in the year and fished successfully on commercial pair trawlers. Several others are using similar nets now.

- A 1:4 scale beam trawl net for electrofishing. The distance between the beam and the electrodes has been varied to appraise the effect on bottom contact and the effect of the hanging of meshes in the sides upon the net shape has also been determined.

- Finally a 1:40 scale model of a 5000 meshes midwater trawl, supplied by a net manufacturer, was studied to investigate its shape and performance.

Design of Fishing Vessels

The purchase of an Apple IIe micro-computer with an existing software package for ship design calculations proved helpful in advising the industry. Problems concerning stability and adding midship sections can be handled quicker and with better accuracy. Close contacts with the industry revealed common areas of interest, among which are:

- optimization studies on stern and small trawlers, emphasising fish processing and storage on board
- measurement of energy flows on commercial boats, eventually leading to energy saving concepts.

Future research programmes will be focussed on these topics.

Fish Behaviour and Reaction

Studies of reactions to light by saithe in a large net cage indicated clear colour preferences and greater attraction by subsurface than by surface lights.

The reaction of herring towards vessel and net has been studied in the coastal purse seine winter fishery and during summer in the North Sea. The winter herring is clearly more affected by vessel generated stimuli than the North Sea herring during summer.

Experiments have been started aimed at reducing construction costs, storage space and hydrodynamic resistance in purse seines by making parts of the seine of large meshed webbing. Initial trials with small herring were positive.

Further detailed studies have been carried out of fish distribution and behaviour in relation to gill net fishing in a local fjord. These studies also contribute to the input data required for the previously reported numerical model which simulates the interacting factors and processes in gill net fishing. This project will be completed and fully reported in 1986.

Analysis of detailed statistics of the Lofoten spawning cod fishery confirms that the catching efficiency of the passive gears (gill nets, longlines) is a negative function of fishing effort (or gear density) and of fish density. These effects have a significant impact on the economy of fishing and cannot be neglected in fisheries management and regulations.

Selective Fishing

The 1985 programme has included studies of selectivity, gear technology and fish behaviour in relation to trawl fishing for shrimp and round fish. Another feature has been the study of differential escapes from the trawl which has been a worrying factor in quantitative sampling for resource assessment.

Good progress has been made, particularly due to the use of new instruments and equipment for gear measurements, monitoring and direct observation by a remote controlled underwater TV system, "the Ocean Rover".

Experiments with a shrimp sorting system, incorporating small meshed funnels inside a very large meshed netting cylinder inserted in front of the codend, have given a 60-70% release of cod and haddock above 20 cm and reduced catches of undersized shrimp.

Direct TV observation of a bottom trawl suggested that simply by lengthening the chains between bobbin groundrope and fishing line more cod could be released without much affecting haddock release, important for instance if the cod quota has been reached and the haddock quota not. The observations also showed that in the type of bottom trawl mostly used by Norwegian trawlers heavy escapement of cod occurs under the lower wings.

Initial experiments with trawl codends made of square meshes, monitored with the use of underwater TV, have confirmed the good selective properties of such codends.

Studies of quantitative sampling technique are being conducted in cooperation with the Institute of Marine Research. It is evident that many small cod escape below the fishing line of a trawl rigged with bobbins in the normal way. The sweep length of the sampling gear is also affecting the length frequency distributions of cod and haddock.

Improvements of Fishing Gear and Methods

Longlining work has been aimed at developing alternative bait types and has been concentrated on producing a bait partly based on fish offal. Control of the stimuli leaching or dissipation rate has been a problem, and a method for testing this critical factor has been developed. Fishing trials in the fall of 1985 gave very promising results, especially with regard to longline fishing for haddock.

Trials with new types of lines have given marked increases in the catch rate for bottom set longlines (40-70%). A new type of hook and swivel mounted gangions of monofilament are the most important reasons for this increase. This new type of longline is now being commercially applied with good results.

Further experiments with gangion floats in the bank line fishery gave no significant increase in catching efficiency.

A simple line mechanization system for small vessels has been developed and tested with good results. The system consists of a new type of random baiter, short magazines and tubs. During the hauling, the lines are coiled in tubs and the hooks are stored on short magazines, either at sea or ashore. Pilot trials of three to five systems will be carried out on commercial vessels in 1986.

On purse seining a system for hauling and stacking the net and leadline on larger boats has been developed and tested. The system consists of a Japanese "Ball-Roller" mounted on a small manouverable crane and it has greatly reduced the manpower requirement and the work hauling the heavy leadline.

Trials aimed at reducing the net tearing in purse seine and trawl have also been conducted.

Vessel Technology - Marine Engineering

During 1985 considerable efforts have been made developing new generation trawlers, both for wet fish and freezing at sea. Direct gutting with bleeding in ice water has been a central labour saving feature in these vessel designs.

Work has been carried out to clarify the detrimental effects of fisheries regulations on fishing vessel design and efficiency.

A handbook for fishermen on vessel design and procurement has been completed.

Work has continued on fishing vessel safety and working conditions, the work has included:-

- clarification of the causes of accidents
- development of measures for reducing accidents
- practical tests of various measures

An investigation into the safety standard of the fishing fleet is being conducted. A sample of 600 vessels has been drawn, and the field inspection work is almost completed.

In the field of energy saving, the information campaign has continued in 1985, with local courses, distribution of leaflets and video-tapes.

The monitoring of the performance of a heavy fuel system on a large trawler continues, and will be reported in 1986.

Further model tests have been carried out to develop hull forms with less resistance in a seaway. Full scale tests to confirm the results have complemented the model tests.

A fuel consumption simulator is being developed, the software will be implemented on standard personal computers.

SWEDEN

Fish Behaviour and Reaction

Behaviour studies of both salt water and freshwater species have been carried out using telemetric methods and underwater observations. Work on fish reaction toward stationary gears such as gill nets and pond nets has continued. Construction of a new telemetric system has been started.

Selective Fishing

An investigation has been carried out on selection and meshing of Baltic cod in codends with 95 mm and 110 mm mesh size respectively. The work has been carried out on board commercial trawlers.

Improvements of Fishing Gear and Methods

There are ongoing projects to improve pelagic trawls for both pair and single trawlers. The trawls are designed for catching herring, sprat and cod.

Comparative fishing with different types of Nephrops traps has been concluded. The main objectives were to optimise the catch per trap. Preliminary results indicated significant differences between traps. Minor alteration of the rigging and entrances as well as lower centre of gravity appear to have made the differences non-significant. A commercial fishery has started.

Fishing Vessels and Equipment

Several projects with the main objectives to give better working conditions on board fishing vessels have been started. Work on reducing fuel consumption continues. Experiments with noise reduction on a new trawler show promise.

Acoustics

Routine surveys are carried out in Skagerrak/Kattegat and in the Baltic area. Measurements of target strength of clupeoides and cod in situ with split beam sounders have commenced.

Static Gear

Gill nets

The objectives of the work undertaken over the last three years have been steadily refined. The observations that we made two years ago suggested that there were species specific behavioural responses which resulted in characteristic vertical distribution patterns for each species. The work over the last 12 months has tried to validate this hypothesis. One method that has been used has been to see if any change in the distribution patterns or catch rates is induced by some variation in the rigging arrangements of the nets. For this purpose three experimental designs were used:-

1 Modified headline - high visibility netting to act as a barrier to fish moving over the headline.
2 Tied down nets - nets tied down to 65% of stretched height.
3 Dummy footrope.

The analysis though not yet finalised has shown real and significant differences between the distribution patterns of fish in the various net types.

The variables which were considered included the significance on catch rates of the position of a net in a fleet, the position of the fleet, the fishing time and any damage sustained.

The first analyses have derived an average figure for the position of fish in each net type in relation to the mid point. In the modified and false footrope nets this position was above the mid point and in all other net types the average position was below.

The modified headline nets in some circumstances caught more than any other type of net but more examination of the variables is required in order to be more confident.

Drift nets

In addition to the work on gill nets an attempt is being made to revive the pilchard drift net fishery in the south west of England. The initial problem is to identify suitable modern synthetic materials that will adequately replace the traditional cotton nets that are now difficult to obtain and to maintain. For this purpose three different types of materials have been selected and made up in the traditional manner. It was hoped to have carried out trials during the early part of this year but the continuous bad weather at the appropriate time has meant that the fishing trials have had to be postponed until the autumn.

Trawl Gear

Separator trawl

Further trials of the selector panel trawl have been carried out this year. This is a continuation of work that started some three years ago. The work has continued to concentrate on the Nephrop fisheries, where trials have shown that it is possible to achieve 90% separation between the Nephrops and earlier finfish by-catches. The optimum position of panels can now be identified for a number of the various trawls,

the handling operation of the modified nets are in no way more difficult than with the normal trawl and deck sorting operations can be significantly eased because of the separation of high and low value segments of the catch. This work will be continuing this year.

Twin trawls

There have been some preliminary trials to investigate the engineering parameters governing the use of the twin trawl rig and to determine the effectiveness of this gear.

This work is continuing this year with the cooperation of DAFS Marine Laboratory in Aberdeen.

Electric fishing

There have been no further sea trials of the equipment during the last year. The system has however been refurbished so that sea trials will be taking place during this summer.

Trawl door development

Due to the lack of reliable information on the performance and efficiency of trawl doors - and the prediction of door performance from model tests - a joint SFIA/DAFS project was set up to obtain basic information on door performance and the factors affecting it. The work carried out last year consisted of the first stage in flume tank testing of 1:4 scale model vee and flat doors.

UNITED KINGDOM - SCOTLAND

Progress has continued on the development of a computer model of a pelagic trawl. Convergence times for the calculation have been reduced. The results have confirmed that the degree of stretching of the netting on the frame ropes has an important effect on net shape. Work has begun on studying water flow in codends. In a flume tank the paths of small particles were tracked through the meshes by viewing a laser illuminated slice with a TV camera. The video signals are recorded and replayed frame by frame which allows the tracks and velocities of individual particles to be determined.

The performance of the ICES Young Fish Sampling (GOV) trawl was measured on FRV "Scotia". Data were collected on the performance of the gear using Polyvalent doors, the two permitted sweep lengths and the three permitted types of groundgear. Underwater TV observations were made using the Remote Controlled Towed Vehicle. It was seen that at 4 knots the lightest groundgear was lifting off the bottom. The net was not distorted like some of the flume tank models of the GOV trawl.

Performance measurements were made on two sizes of demersal pair trawl, for vessels of 200 hp and 600 hp. With the existing data on a net for 350 hp vessels a useful range of performance measurements has now been obtained. Complete analysis of this data will take some time, however computer programmes have been developed to predict wire shape. Divers inspected the smallest size of gear in shallow water and observed the sweeps to be digging in deeply near the net and to leave the bottom not far ahead of the net. Ground friction may be a significant component of gear drag.

A new series of measurements on otter board performance has been started using the improved instrumentation which is now available. The aim is to produce systematic series of measurements on common types of door. Initial work has demonstrated that the performance of Vee boards is more sensitive to small changes in the rigging than was previously thought. Some work on model doors has been carried out in collaboration with the SFIA. Groundgear drag is also being investigated in order to quantify bottom friction forces in demersal trawls.

Further measurements have been made on the heights of gill nets in a tideway, using manometers. Bottom current speed was also measured and height was found to vary significantly with speed. In strong tides the nets spent little time at full height.

A series of comparative fishing experiments investigated aspects of codend mesh selection. Further work using small mesh covers, on the selectivity of square mesh codends, included experiments on Nephrops. The influence of codend dimensions on mesh selection was studied. It was found that, for a given mesh size, increasing the length of the extension piece, between net and codend, reduced the 50% length. Reducing the width of the codend increased the 50% length. These effects were thought to be due to changes in the degree of mesh opening in the codends.

Direct observation techniques continue to be used to investigate the behaviour of fish within trawls, the damage to escaping fish and the possibility of separating species in the trawl. A final cruise completed a series of investigations of the light levels on fishing grounds and the reaction distances of fish in different conditions of water visibility. The Aultbea facility for the capture, handling and experimenting with mackerel has been used to study various aspects of their reaction ability including swimming performance, schooling behaviour and effect of light levels on behaviour.

A number of alternative experimental procedures for determining the effectiveness of manufactured baits are being compared. The nature and concentrations of stimuli necessary for bait acceptance are being studied in the aquarium using these techniques.

UNITED STATES

Fishing technology and fish behaviour studies are carried out by a variety of US institutions including colleges, universities, state governments, private organisations, and the federal government through the National Marine Fisheries Service. These studies are conducted on all types of gear on the Atlantic and Pacific coasts and on various species of fish from the Arctic to tropical waters in the Gulf of Mexico.

Several gear studies have used a Canadian remotely-operated vehicle for trawl observations. The vehicle is capable of operating at speeds to six knots and to depths of 100 fathoms. The system is equipped with pan and tilt, low-light-level television and film camera systems, and has a positioning accuracy of about 10 cm. Initial trials with the system have shown it to have considerable promise for aiding in identifying acoustic targets and for observations of fish and gear interactions. The vehicle, known as "Manta" has been used in the Gulf of Mexico in performance tests of a semi-pelagic squid and butterfish trawl. This four-seam 156 x 80 cm trawl has been developed for use with bottom doors. Rigged conventionally, it will provide vessels of 300-400 hp a means of effectively harvesting squid and butterfish to heights of 5 fathoms. Fitted

with a kite and extended droplines, the entire net can be fished well off bottom while the sweep remains on the seabed. Predictable heights can be achieved without the use of a netsounder. For use with this net, a simple kite design has been developed. The kite design is easily rigged, can be wrapped on the net reel, and is trouble-free during setting and in use. These kites are becoming popular for achieving additional headrope height or, by removing an appropriate number of floats, for establishing a constant fishing height and trawl geometry regardless of speed through the water.

A split-beam acoustic system is being developed to measure distances and azimuths from a vessel to fishing gear. The object is to be able to plot the size and shape of a trawl or other gear. This system could then replace those that require transducers mounted on the net.

Sablefish, Anoplopoma fimbria, catch comparisons have been conducted in Alaskan waters. The comparison was between fish pots and longline gear, with catch rates being similar, but median size being a few centimetres greater for the longline gear. Another comparison is concerned with inshore bottom sampling trawls. The study will observe and measure the performance of a variety of trawls and rigging conditions in order to compare the trawls and the fish sampled by them. Two projects concerning the by-catch of yellowfin sole trawls in the Bering Sea are being carried out this spring. Both will be using a "Manta" to observe the bottom trawls; one is to observe the interaction of halibut with the trawl and the other will look at the impact of the gear on king and tanner crabs. Gear and rigging modifications to reduce the trawl's effects will be tested.

Anchored Fish Aggregating Devices (FAD's) are the most significant new technology in Hawaiian fisheries for tuna and other pelagic species. The impact of FAD's on tuna behaviour and exploitation is being studied by tracking the movements of tunas outfitted with pressure-sensitive ultrasonic transmitters. Horizontal and vertical components of movement are plotted as a function of time and mapped against FAD location, bathymetry, temperature distribution, and other features of the tuna's environment. Results to date suggest that yellowfin tuna learn the location of FAD's and incorporate FAD's in their daily movement patterns, venturing away from FAD's at night and returning to them during daylight.

The Trawl Efficiency Device (TED) continues to receive much of the gear research and development attention in the southeast. The TED was developed to eliminate sea turtle captures in shrimp trawls. A major technology transfer effort was undertaken to encourage shrimp fishermen to voluntarily adopt the TED. Voluntary adoption was believed possible because of the fishing benefits shown for the TED, such as reduced bottom trash and finfish in the catch. Several hundred TED's are now in use in the shrimp fishery and at least two modified versions of the device have been developed, which also are gaining acceptance.

In the northeast, a variety of projects have been carried out to assess the effects of drags on the bottom and the resource, particularly in the mussel fishery. This work is continuing and has resulted in proposed gear modifications. Underwater video work has been carried out to assess impacts of scallop harvesting by both draggers and divers. This work will continue in order to get a visual record of drag activity.

Several trawl model testing efforts continue with our comparison of the performance of one-tenth scale models of BMV oval doors and Portuguese polyvalent doors; full scale weight 460 kg and 470 kg, respectively. Results show the polyvalent doors spread slightly more, which is verified by full scale tests. In addition, cooperative trawl model studies continue at the David Taylor Naval Ship R&D Centre. This industry-sponsored research is designed to isolate the effects of a variety of net design variations through the model testing of a systematic family of nets. Results of the 1984 research have now been published. Also at the David Taylor Centre a programme of training courses is being offered using the circulating water channel. Three types of courses are offered, inshore trawls, offshore trawls, and advanced trawls (pelagic and semi-pelagic). Course duration has ranged from two to five days. Models are rigged with bridles only, allowing sixth-scale construction of most designs. Special techniques have been developed demonstrating the effect of codend loading, panel blockage, and uneven warp length. Dye injection is used to visualise flow patterns and simulate mud clouds when trawl doors are included.

Gear slectivity studies are of great interest throughout the US for a wide variety of species. A mesh-size selection study for codends of Aberdeen type high-rise rockfish trawls was conducted along the west coast. A trawl fishery in this area targets a mix of up to 8 to 10 rockfish (Sebastes) species that are managed by harvest quotas and trip limits. Codends made of 3", 5", and 6" mesh webbing and 3" square mesh webbing were evaluated. Preliminary findings show that each species has a different selection curve and, because the coastal distribution and species abundance is quite variable, selection of an optimum mesh size that would reduce the constraints of species-trip-limits regulations is unlikely. Additional square mesh codend evaluations are being conducted or are planned for cod fish and flounders in the northeast. Small mesh trawls used in the whiting fishery are a problem and the size selectivity of the webbing in the codend and body of these trawls has been investigated. In Maine, the design and testing of a northern shrimp separator trawl which eliminates the catch of juvenile flounder has recently been completed. Results show 95% of the juveniles are separated from the shrimp catch.

The size selection of the steel rings in the New Bedford scallop drag which is commonly used in the northeast is again being addressed as a result of falling catches and increased regulatory pressure on the fishermen. Scallop gear modifications will be tested on commercial fishing boats this summer.

Lobster pot escape vents have been used for several years in the northeast to make the pots more size selective. Now, experiments are being conducted to assess the benefits and feasibility of escape vents in lobster pots for the Hawaiian fishery. Early trials with rectangular vents were successful with spiny lobster, resulting in significant decreases in the catch rate of sub-legal lobster and, at some banks, an increase in the catch rate of legal lobster. A problem arises, however, in that the slipper lobster in recent years has come to comprise about 50 percent of the catch, and slipper lobster catch rates decrease dramatically in traps with escape vents. Past research investigated moving the vents to different areas on the trap but without notable success. More recently, circular and square escape vents are being examined to develop optimal configurations of escape vents for both species.

"Ghost" or lost fishing gear is also of concern and in 1987 the state of Maine will require biodegradable release mechanisms in lobster pots. In preparation for the law, additional studies on various candidate materials have been conducted. Also, ghost gill nets are being studied. A miniature submarine has been used to visit lost gill nets over a span of two years. And this year a remotely-operated vehicle will be used to observe the nets and the animals caught or associated with them.

Exploratory fishing for underutilized species in the Gulf of Mexico continues. Large-mesh bottom trawls for harvesting coastal herrings are beginning to show promise. Initial trials last winter and spring produced mixed results, partly because of difficulty in interpreting acoustic returns from fish and non-fish targets, and the apparent ease with which some of the fish were able to escape capture. However, recent catch rates have been up to 14 tons per hour. Modified gear designs and operational procedures will be tested this year.

Two exploratory fishing cruises conducted cooperatively with Japan in the northern Gulf of Mexico showed considerable potential for development of a Gulf butterfish fishery. These fish apparently concentrate during the fall and spring months along thermal gradients in waters 40 to 100 fathoms. The fish appear to be susceptable to capture with large-mesh, high-opening bottom trawls. Initial estimates suggest an MSY of about 50,000 mt.

Continued work with bottom-longline fishing for deepwater grouper has shown that the longlines are effective. This research has been done using a manned submersible which permits direct assessment of grouper and tilefish through point and line-transect counts. The submersible observations in conjunction with bottom-longline sets were used for estimates of catchability coefficients, which were verified this past summer in a submersible study off Puerto Rico and the Virgin Islands.

Two projects concerning fishing vessels are ongoing. In one, field techniques have been developed for obtaining a detailed understanding of the towing power of trawlers. Pull measurements while towing a 15' diameter drogue are combined with bollard pull and free-running data to provide graphs of pull versus speed for each RPM of interest. Measurements have been taken on a variety of local trawlers. Data will be compared with theoretical techniques to improve their predictive accuracy. The data is also useful to fishermen and net makers in specifying proper net size. In the second, bulbous bow retrofits on trawlers are being investigated. Extensive model tests have been conducted to determine the effect of bulb diameter and length on hull resistance. Models of 76', 119' and 164' trawlers have each been fitted with 12 different bulb sizes (all cylindrical) and resistance measured over a range of speeds. The best bulb for each hull was then evaluated in sea-keeping tests. Predicted SHP reductions of up to 24% at normal steaming speeds were found. Sea-keeping was also improved under headseas. Full scale bulbs have been installed and sea trial data will be available in the future.

2 PRESENTATIONS OF PAPERS AND VERBAL CONTRIBUTIONS ON THE SPECIAL SUBJECTS

2.1 Applications of Energy Saving Concepts in Dutch Fishing Cutter Design and Operation (F A Veenstra)

A review of energy saving measures capable of implementation in the flatfish beam trawling fleet was presented. Dutch beam trawlers have dramatically increased in horsepower and gear dimensions over the past few years and the scope for energy saving is considerable, particularly at the design stage in the matching of engine, propeller and hull characteristics and the use of heavy fuel oils. A comparison of two beamers, one built in the seventies, the other in the eighties, illustrated the fuel saving potential. Further developments, such as decreasing gear drag by using electrodes rather than tickler chains, were also discussed.

2.2 The Use of Residual Fuels in the Dutch Fisheries (A Molijn)

The use of residual fuels on board Dutch fishing vessels was discussed, together with the advantages and disadvantages of such fuels and the equipment required. An economic evaluation based on a comparison between the use of fuels of 30 and 180 CST viscosity was also presented. Gross savings of up to 29% in fuel costs were attained.

2.3 Economy in Design and Operation of Fishing Vessels (H R English - verbal)

Gear and fuel costs of various types of fishing were discussed. Fishing gear alterations could be implemented swiftly and could drastically reduce drag but a review of propulsion systems on existing vessels is also required. Examples were given of pair trawlers in towing and steaming modes. Readily available fuel saving devices such as Kort nozzles could save 10-15% of fuel costs. Training fishermen in the efficient use of fuel should become more important. During the discussion on training it was pointed out that an FAO manual explaining the matching of engine and gearbox to vessels is in preparation.

2.4 Methods to Reduce the Fuel Consumption of Fishing Vessels (S M Calisal and R H McIlwaine)

A computer program based on a fishing operation profile was described which incorporates actual fuel consumption estimates of major engines popular in Canada. Hull resistance is estimated by a variety of algorithms and a suitable algorithm for a given hull is selected by the user. Possible fuel savings by speed reduction, nozzle installation or controllable propeller applications are presented in the output. An optimisation procedure minimising actual operational costs establishes the most efficient vessel for a given operational profile by identifying six parameters of the vessel.

2.5 Direct Observation Experiments with the 28.9/37.1 m JCB Trawl (J Main - verbal)

A video film was shown to illustrate fish behaviour observations made on the JCB trawl, a small version of the GOV trawl used on young fish surveys. A paper on this subject (ICES CM 1985/B:9) was presented to the working group last year.

2.6 The Effect of Different Bridle/Sweep Lengths on Length Composition of Bottom Trawl Catches (A Engas)

Norwegian bottom trawl comparative fishing trials in the Barents Sea and Svalbard areas were carried out with three different bridle/sweep lengths, 40, 80 and 120 m. The results demonstrated a bridle length dependent herding effect. Short bridles resulted in higher catches of small fish while for big fish the reverse was the case. A difference between day and night fishing was also indicated.

2.7 Full Scale Instrumented Gear Trials on the ICES Young Fish Sampling Trawl (R D Galbraith)

Following a recommendation of the 1984 working group meeting at Nantes engineering performance measurements were made on Chalut GOV 36/47. Polyvalent otterboards, two different sweep lengths and three different groundgears were used. A preliminary analysis of the data was presented together with underwater video film of the gear in action.

2.8 A Note on Selectivity Experiments with Square Mesh Codends in Bottom Trawls (B Isaksen)

Experiments to compare the selectivity between square mesh and diamond mesh codends were described. Both the covered codend method and a variant of the alternate haul method, the "trouser-trawl", were used. The results, particularly the similarity of length distributions between codends and the small differences in selection factors and ranges, were somewhat different to previous studies, and provoked a discussion on the merits of the techniques used. The meshing of redfish in the square mesh codend was thought to have caused a dramatic drop in selective properties. A video film was also shown to demonstrate codend arrangements.

2.9 Factors Affecting Codend Selectivity (R S T Ferro - verbal)

Various factors, such as mesh size, catch, towing speed, visibility, net design, all influence codend selectivity. Results of experiments with (a) long and short and (b) narrow and wide diamond mesh codends indicated that the longer, wider codends retained a higher proportion of haddock, yet legislation specifies only a minimum mesh size. Techniques on how to measure selectivity were discussed and the point was made that environmental and other factors such as light levels, towing speed, materials used may influence results and should also be measured.

2.10 Fishing Efficiency Comparison Between Different Pelagic Trawls (L Fiorentini, E Paschini and G Cosimi)

The efficiency of three nets, a small mesh (200 mm), large mesh (800 mm) and rope trawl was investigated using electro-acoustic techniques. Statistical analysis of echo-sounder and netsonde data did not show any appreciable difference between the nets tested. Further investigation will be required to establish the source of variance for echo-sounder data.

2.11 Fishing Experiments with Square Mesh Codends in Norwegian Shrimp Trawls (L Karlsen)

Comparative fishing trials were carried out to examine the size selection of deep water shrimps in square mesh codends compared to diamond mesh codends of the same mesh size. The results clearly indicated that square mesh codends reduce catch rates of undersized shrimps and fish but many legal sized shrimps also escaped. During the discussion which followed it was thought likely that a reduction in miminum mesh size would be required if square mesh codends were to gain acceptance by fishermen.

2.12 Further Experiments with Sorting Panels in Shrimp Trawls (R B Larsen)

Studies of shrimp trawl geometry, using 1:3 and 1:10 scale models with sorting panels, were carried out in Hirtshals flume tank. Underwater television was used to study full scale V-sorting panels at sea, together with associated fish behaviour. Results from fishing experiments with four different sorting panels were presented. The most effective sorting ie release of fish was found when using a 60 mm V-sorting panel, while the 60 mm and 80 mm HH-sorting panels gave the lowest loss of shrimps. Funnel sorting systems were also discussed.

2.13 Effectiveness of the RMT8 System for Sampling Krill Swarms (I Everson and D G Bone)

The work of the British Antartic Survey with regard to stock assessment of krill was briefly described. The 8 m Rectangular Midwater Trawl is used and a study of the effectiveness of this gear as a sampling tool was carried out by observing the behaviour of swarms in the vicinity of the net using echo-sounders. Large scale avoidance was observed by day but not at night. By day krill layers dispersed to such an extent that few krill were present less than 10 m below the net. Limited avoidance by night indicated that the krill were acting on visual clues of the net's presence.

2.14 Escapement of Fish under the Norwegian Bottom Sampling Trawl (A Engas and O R Godo)

Previous experiments with a two level trawl had shown small cod and haddock enter the lower part of the trawl mouth, so netting bags to collect escaping fish were fitted to the standard sampling trawl between fishing line and footrope. The results indicated that the escape of cod and haddock under the fishing line showed considerable length dependence. No difference in catch was found between bags used on wings and bosom.

3 PRESENTATIONS OF PAPERS AND VERBAL CONTRIBUTIONS ON GENERAL TOPICS

3.1 Computer Aided Trawl Design for a Range of Types of Demersal Trawls from 20-600 hp (C Radcliffe)

A suite of computer programs to perform net design calculations was demonstrated. Parameters such as vessel horsepower, footrope length and fishing circle for over 200 trawls were collected and relationships between parameters for six net types established. These relationships form the basis of the design system and the operator can specify variables such as mesh size, cutting rates, number and length of panels. Output data is presented either in tabular form or as a net drawing.

3.2 A Laboratory Study on the Effect of Bottom Sediments on Mesh Size (R Fonteyne)

Six netting samples of different materials (polyamide, polyester and polyethylene) and construction (twisted, braided, single and double twine) were submitted to the influence of bottom sediments such as sand and mud under laboratory conditions. The variation of mesh sizes with time at three hourly intervals was presented together with final mesh sizes after 60 hours of testing. The results indicated that significant shrinkage of netting can occur due to the influence of bottom sediments and mechanisms involved in the shrinkage process were discussed.

3.3 Measurements of the Headline Heights of Gill Nets in Tidal Flows (P A M Stewart)

The use of self-recording manometers to measure gill net height in the sea was described. Records of height variation over tidal cycles were presented and correlated with water current measurements. These results demonstrated that nets can be significantly reduced in height and during spring tides reach full height for only short

periods. Means of improving performance were discussed eg less bulky nets would have lower drag and be less easily flattened by water pressure.

3.4 Danish Net Design Techniques (D A Wileman and S R Yngvesson)

Different design concepts which have led to increased profitability for Danish fishermen were discussed. Examples of pelagic, semi-pelagic, demersal and multi-trawl developments were presented together with results of research carried out on scale models in the Hirtshals Flume Tank. Several rigging techniques were demonstrated, including deliberate distortion of the trawl netting to obtain maximum opening.

3.5 Fisheries Technology in Newfoundland (C Campbell - verbal)

The work of the Marine Institute, St Johns was described together with plans for expansion into new fields. These plans include aquaculture as well as marine fisheries and a new flume tank will be completed by March 1987. A symposium on fisheries will be held at the official opening of the flume tank in September/October 1987 and contributions were invited.

3.6 Fish Behaviour Studies Related to Fish Capture (J Main and G I Sangster)

This paper, together with video tape examples, was presented as a synopsis of recent fish behaviour work carried out at the Marine Laboratory, Aberdeen. Separator trawls, behaviour of Nephrops to groundgears and of fish in the path of the trawl were all discussed, together with studies on damage to fish escaping from codends. However it was pointed out in discussion that the results on damaged fish must be treated with caution because of the stress induced by captivity.

3.7 Nephrops - Gadoid Separator Trawl Design; - Where Next? (J P Hillis)

The problems of the mixed Nephrops/whiting fishery in the Irish Sea were discussed with regard to codend mesh size. The optimum design and construction of separator trawls which had already shown good separation between these species was debated and the views of the working group sought. Different mesh sizes in upper and lower codends was suggested as a legislative measure to facilitate the escape of immature gadoids while retaining saleable Nephrops.

4 RECOMMENDATIONS

1 The working group accepted an invitation from Dr K Lange to meet in Hamburg and discussed various topics for consideration as special subjects. Consequently the working group recommends that the next meeting should be held in Hamburg, from 11-13 May 1987 and that it should consider, in particular:-

(a) size and species selectivity of fishing gear and its implications for fish stock assessment and fishery management.
(b) engineering aspects of safety and working conditions on fishing vessels.

2 The working group recommends that member countries engaged in Nephrops fisheries, where there is a significant bycatch of demersal fish, actively consider the mandatory introduction of separator trawls with different minimum mesh sizes for finfish and Nephrops in the top and bottom parts respectively.