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International Council for the
Exploration of the Sea

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Fish Capture Committee

REPORT OF THE WORKING GROUP ON FISHING
TECHNOLOGY AND FISH BEHAVIOUR

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Meeting Place: Tromso, Norway
Time: 20-22 May 1985

INTRODUCTION

In accordance with ICES Council Resolution 1984/2:2, the working group met in Tromso from 20-22 May, convened by Mr D N MacLennan and considered, in particular: 1) equipment and techniques for underwater observations of fish and fishing gear, and 2) the general arrangement, deck layout and equipment of fishing vessels in relation to stationary fishing gear and methods.

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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- 3.12 Fish Behavioural Aspects of Gear Design - C S Wardle (verbal)

4 RECOMMENDATIONS

1 PROGRESS REPORTS

The Convenor requested in his letter to delegates of 27 February 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 Ireland whose delegate was unable to attend. Following the precedent of 1984, the reports were not given verbally but time was allowed on 21 May for questions and discussion.

BELGIUM

Trawl Gear

In order to improve the catchability of flatfish beam trawls for coastal beam vessels, experiments were undertaken with a high opening beam trawl. The increase in catches (cod) was not regarded as being significant.

With the aim of making beam trawlers more versatile, a new semi-pelagic trawl fishing with the warps passing through the beam sheaves was tested on a commercial beam trawler. The experiments showed that the net drag was too high for the 500 hp-beamer, resulting in too low a fishing speed.

A new type of bottom trawl for fishing on rough grounds has also been tried out on commercial fishing vessels in the range from 300 to 500 hp. Good results were obtained once the rigging was adjusted.

Electrical Fishing

Experimental fishing with electrified beam trawls for flatfish and shrimps was continued on a commercial coastal beam trawler. A compact pulse generator was installed on board the vessel and the pulses were transmitted by cables to the trawl. Good results were obtained for shrimps. A newly designed battery powered underwater pulse generator will be tested in the near future.

Energy Conservation

Fuel saving is one of the principal aims when introducing new fishing gear or electrical fishing.

The comparative fuel consumption study on different types of otterboards carried out in 1982-83 resulted in a considerable increase of the use of oval cambered slotted boards (polyvalent).

A theoretical study on the possibilities of longlining for the Belgian fishery has also been carried out.

Mesh Shrinkage

A simple laboratory test for the study of mesh shrinkage due to sand absorption by the twines seems to suit comparative experiments. There is however a discrepancy between the results of the laboratory tests and the shrinkage observed in netting used in commercial trawls. It is assumed that the effect of sediments on mesh sizes depends to a large extent on the tension in the mesh bars when fishing.

Mesh Size Measurements

In view of the EEC Draft Regulation on mesh size measurement, a comparative study on the NEAFC - the ICES - and a newly designed EEC-mesh gauge was carried out. The EEC-mesh gauge, either operated by hand or by a weight of 5 kg, yielded the lowest mean mesh sizes for all netting materials and yarn constructions measured.

The difference between the ICES-mesh gauge with a preset stretching tension of 5 kg and the NEAFC-gauge with a 5 kg weight was only significant for the PES-netting. The NEAFC-mesh gauge operated by hand always gave greater mean mesh sizes than with a 5 kg weight.

Selectivity

Comparative fishing trials with a beam trawl equipped with 85 mm diamond and square mesh codends were started in March. The trials will be continued later this year.

CANADA

As usual, Canadian research and development in fishing gear technology has taken place both at Federal and at Provincial levels in government by centres based in St John's, Halifax, Moncton, Quebec and Vancouver.

The Newfoundland Provincial Government reports trials with Kevlar, both in netting and in cordage. A groundfish otter trawl made entirely of 2 mm diameter netting twine provided excellent fishing performance and adequate durability, probably resulting in fuel savings after the door size has been optimized. Kevlar bridles on demersal otter trawls proved to be very suitable in fishing trials and demonstrated a longer life span than steel wire rope.

The Federal Research Branch in St John's reports testing and improving a new design of vertical plankton sampler (VPS) which, despite its complicated nature, is now functional and enables more reliable field collections. They also report further work on trawls (this year a Yankee 41 shrimp trawl) to sample age 1 to 4 flatfish, including some use of the MANTA underwater photographic system to monitor gear performance.

The Federal Development Branch in Halifax reports a new design of scallop rake for reduced damage to the catch and improved fuel efficiency. They continue demonstration of automated longline systems and small-boat, pair, shrimp trawling. The fully powered rope reel which had been developed earlier for Scottish seining is now in commercial production and a prototype, dual-purpose reel system for trawling and seining has been designed and is under construction.

The Quebec Provincial Government reports work on a revised edition of their fishing gear catalogue for publication in 1985, including revised and new net plans, trawl doors and groundlines. They have acquired a net sounder for modification in 1985 to measure horizontal and vertical trawl-mouth openings. Trials with the semi-pelagic shrimp trawl gave good shrimp catches with very little juvenile redfish, and will probably be concluded in 1985. A selective design of pot for rock crab was found not to catch lobster in lobster fishing areas and will be tried in 1985 for the full season. Plastic laths with vents for escapement of undersize lobster gave promising results during limited trials in the commercial fishery and plans are for more extensive trials in 1985. Various trials were conducted toward optimization of longlines, hooks, etc. Bait trials started in 1983 were not continued in 1984 but are planned to resume in 1985. Demonstration trials with the Mustad miniline were not encouraging. Limited trials with jigging machines enjoyed mixed success.

The Federal Research Branch on the Pacific coast reports development of a new beam trawl for plankton which gave successful preliminary trials and is identified for further improvements. They also report contracts for development of 3-dimensional commercial fishing charts and an on-board computer display for tidal current data.

Three organisations report selectivity experiments with square-mesh codends. The Newfoundland Provincial Government confirms that with 140 mm meshes on a 50 m stern trawler, the square mesh is more effective than diamond meshes in releasing cod shorter than 50 cm. The Federal Development group in Halifax confirm that the amounts of immature fish and debris are considerably less in a square-mesh than in a diamond-mesh codend. Federal Development on the Pacific report construction of knotless, square-mesh codends for evaluation in commercial fishing operations in 1985. Federal Research in Moncton report selectivity experiments with herring gillnets, involving four mesh sizes, three colours and two twine types. Modal herring length was found to be dependent on mesh size but not on colour or twine type. Selection curves were analysed, but further work is planned to obtain more precise curves and to take a deeper look at possible effects of colour and twine type.

Three organisations report the use of towed bodies and underwater TV for observing fishing gear and fish behaviour. The Federal Development group in Halifax are assessing the performance of new trawl designs in a continuing project. The Federal Research group in Moncton (Gulf of St Lawrence Region) used an underwater television camera system to evaluate the performance of scallop drags, to observe the behaviour of lobsters in and around lobster traps and to evaluate the density of snow crab on and under seabed substrates. They also report using acoustic telemetry to monitor the short term movements of lobsters and snow crabs, with a full evaluation of acoustic tags planned for 1985. Federal Development on the Pacific report continuing observations of fishing gears and the reactions of fish to the gears.

Concerning theoretical studies, the Technical University of Nova Scotia (TUNS) reports completion of the thesis study of trawl doors in a wind tunnel for optimization at high angles of incidence, involving different aspect ratios and tip shapes, and a

novel method for comparing different trawl doors. Federal Development on the Pacific report development at the University of British Columbia (UBC), Mechanical Engineering, of a computer-based mathematical model to estimate drags of various trawl-components and of the total trawl.

In relation to fishing vessels, Federal Development in Halifax report design of a prototype propeller nozzle for installation on small vessels. Construction and trials are planned for 1985. Studies on antifouling coatings for wooden boats, hold insulation and bulbous bows were completed, and the Energy Information System, which contains over 3000 documents on energy and fish harvesting, has been completely computerized for ready access.

DENMARK

1 Danish Institute of Fisheries Technology (FTI)

a) New facilities

The institute has acquired a package of instruments for measuring the performance of full scale gear at sea on board commercial vessels. The system comprises Braystoke towed log, Eilersen 10 ton deck load cells, Scanmar cableless spread, headline height and depth meters.

A materials laboratory has also been established including Schenck-Trebel 50 kN tensile breaking strain test machine, HEO optical twine diameter tester, Schroder turn counter and equipment to measure twine runnage.

b) Research projects

Trawl door design

Systematic tests have been made in the flume tank of 1:4 and 1:5 scale models of Vee doors of 6.4 m². The effects of alterations to door weight, towing chains, angle of attack, angle of heel, angle of Vee, aspect ratio, cambering and the fitting of slots have been investigated.

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 effect of material type, construction, twine diameter, mesh size and cutting rate are all being investigated. The water speeds at the elliptical entrance and exit are also measured. Comparison will be made between material towing resistance and knotted breaking strength.

Computer aided net design

A project has been started which is aimed at producing net drawings, design help, net costings and more accurate estimates of trawl drag. The computer programs are to be used by the Danish trawl manufacturers and the starting point has been the Gifford Technology/Marine Laboratory Cadnet package. Formatting is to be changed to

Danish commercial practice and the results of the previous project input to give more accurate drag estimates.

Selectivity studies

Work in this field has started with the testing in the flume tank at full scale of different designs of codend including square mesh codends. This work was done in partnership with Tromsø University. Both geometry and towing resistance with different amounts of "fish" (plastic bags filled with water) were measured. This work will be extended in the near future.

A separator panel for sorting fish into a separate codend in North Sea shrimp trawls has been designed in conjunction with the Marine Laboratory, Aberdeen. The design was finalised using a 1:3.3 model in the flume tank. The trawl will be tested full scale at sea by the Marine Laboratory in May 1985.

c) New commercial trawl designs

Testing of new trawl designs in the flume tank for net manufacturers has concentrated in three areas:-

Development of twin trawl systems for Nephrops and shrimp where three trawl warps are used. There has already been considerable commercial success with the Nephrops trawls.

The shrimp trawl system and a further new system for Nephrops where two trawls but only two trawl warps are used have been tested in the tank but are awaiting commercial tests at sea.

Development of improved large blue whiting trawls.

Development of large high opening (20 m) shrimp trawls for use at Spitzbergen where the optimal towing speed is only 1.5 to 2 knots.

2) The Danish Maritime Institute

Optimization of fishing vessel hull design and propulsion system

The Institute's work in this field began with the joint Scandinavian research project Oilfish. After completion of this project in 1984 work has continued in the form of detailed design studies commissioned by individual clients and with a joint project with FTI developing economic and technical guidelines for the design of future new Danish fishing vessels. The work has concentrated on improving the design of the bow of the vessel and on the correct matching of the propeller and surrounding hull profile. CAD/CAM programs are being developed on the basis of both model and full scale test results. It has been found in particular that considerable fuel saving and better seaworthiness can be achieved by fitting bulbous type bows to smaller fishing vessels.

Use of sails to assist propulsion

The Institute is currently making measurements in its wind tunnel testing the performance of different designs of sails which could be fitted on board fishing

vessels. These data will then be used to develop savings by correct matching of sail and motor power under varying steaming conditions.

3) Ministry of Fisheries

A cheap automatic (not random) baiting machine has been developed and tested at sea. Cost is circa 130.000 Dkr and the system is suitable for small hooks and thin lines. It has been specifically developed for Danish longline fishermen's needs and is used for roundfish with sandeels or herring pieces as bait. The system was designed by a private concern and will be used on boats of 17-18 GRT.

Tests have also been made of collapsible pots for crab fishing. The frame and netting are both steel.

FAO

Currently, 60 projects in fishing technology are being run in developing countries. Projects are mainly run by master fishermen with support from headquarters which also provides technical and training staff. Some of the main activities of interest are:

- 1) selective shrimp trawls; a conference is planned for 1986
- 2) inland fishing technology for Latin America
- 3) fuel conservation in small scale fisheries
- 4) the problems of fishing gear supply and replacement
- 5) publications: books on trawl performance and practical calculations for fishing gear design have been produced, plus some new training manuals. Books are planned on long lining, midwater trawling, bottom seining, model research, small boat trawling and purse seining, auxiliary systems, traps and lift netting. Authors are being sought for some of these topics.

FAROE ISLANDS

Trawl

Pair trawling has until now been exercised only in shallow waters (down to 400 m). During 1985, trials will be done down to 750 m with both pair trawlers and a single trawler.

In trawling on blue whiting each catch commonly reaches several hundred tonnes. In order to make the handling of the fish simpler and faster a hydraulic pump to be attached permanently to the codend has been developed commercially. The pump will be tested in July.

Observations on a Faroes trawl have taken place in April using the remote controlled underwater vehicle developed by DAFS, Aberdeen (manufactured by Seamatrix, Aberdeen) on depths from 80 m to 290 m.

Salmon

In order to attain knowledge on the salmon stock a "behaviour" study commenced early in 1985, in addition to a fishery by longline with a chartered commercial ship. Salmon were tagged acoustically and tracked by the ship. The tags transmitted information about the depth of the salmon. Further studies on this subject will be done. A paper on the subject will be distributed through ICES. The title will be, "Biological data and preliminary observations on the spatial distribution of salmon within the Faroese EEZ in February 1985".

FEDERAL REPUBLIC OF GERMANY

Most of the research and development work done by the Institut für Fangtechnik is devoted to promotion of energy saving fishing methods. In 1984, activities were concentrated on fishing with bottom-set gill and trammel nets as well as on longlining, Danish seining, electrified beam trawling and jigging.

Experiments carried out in the inshore area of the western Baltic have shown that, in autumn, gill nets with mesh sizes of 53-55 mm (bar length) yield at least twice as much marketable cod as those with the traditional mesh sizes of 60-70 mm. To reduce the "pollution" of the nets by weed, jelly-fish etc, it proved advantageous to set the gear only for a few hours at dawn and/or dusk. Since cod is known to be most active in the twilight, these short periods are decisive for the success of the fishing operation.

Trammel nets with mesh sizes between 45 and 53 mm (bar length) proved again most suitable for catching soles in the German Bight. Within this range, both average catch rate and degree of pollution were shown to increase with decreasing mesh size. Fishing tests with markedly smaller meshes (eg 40 mm bar length) resulted in still larger sole catches, but these contained a rather high proportion of undersized specimens and also a high amount of crustaceans, starfish and algae. Tests with meshes larger than 53 mm also proved unsatisfactory. In this case serious catch losses were recorded due to the fact that most smaller soles escaped through the meshes and that adequately sized specimens were insufficiently abundant in the German Bight. Results of tests with trammel nets of 1.20 m and of 0.60 m height showed equal efficiency for catching soles, but the lower nets were much easier and quicker to disentangle and to clear than the higher ones.

Experiments with different types of large-meshed gill nets used for fishing roundfish (near wrecks) or turbot, were continued.

As to longlining, the so-called "monoline" which has been shown already to be superior to conventional types in fishing Baltic cod, was also successfully tested in the inshore eel fishery of the western Baltic. In the North Sea, the effects of floats attached to the snoods of longlines were studied. Due to bad fishing conditions, the question of whether bait predation by scavengers can be reduced by lifting the baited hooks from the sea bottom, could not yet be answered. In 1984, an automatic longline system was purchased and successfully tested aboard FRV "Solea". The development of a semi-mechanized monoline-system intended for smaller fishing craft was continued.

Some progress was made in reintroducing Danish seining into German fisheries. As in the preceding year, four cruises of FRV "Solea" were mainly devoted to the exploration of suitable fishing grounds. During these cruises, in addition to the Danish

method (anchor-dragging), the Scottish method (fly-dragging) was applied for the first time. By means of a fuel consumption measuring device (econometer), the difference in expenditure of energy between these two methods could be exactly measured. Seining was also performed during four trips of a chartered cutter. The results obtained were so promising that the skipper intends to continue Danish seining at his own risk in 1985.

The electrification of the beam trawl has reached a stage which allows its use on commercial vessels. In 1984, it could be demonstrated that a 440 kW cutter which has to exhaust its full engine power in order to tow the conventional gear with tickler chains, needs 185-220 kW only when towing the electrified version. The saving of energy was accompanied with flatfish catches which were higher in quantity and quality and also less mingled with rubbish than those obtained by normal beam trawling.

In the North Sea, experiments with two different types of jigging machines were continued. It could be confirmed that the occurrence of dense fish concentrations, eg near wrecks, is necessary for the successful employment of this fishing method.

With regard to the design of fuel saving trawls, the knowledge of the interaction of net shape and water flow has to be improved. For this purpose, mathematical models were developed and subsequently supported by full-scale experiments with a commercial midwater trawl. The aim of this work is the development of a CAD-system for trawl design.

Tests with different types of midwater trawls used by German near-water trawlers were performed in the Baltic during a cruise of FRV "Solea".

Further progress was made in developing a echo integration system. In 1984/85 the system was used for a standard survey of Krill in the Antarctic. The system which up to now has been only used in Antarctic krill research, will be modified for acoustic fish stock assessment in the North Atlantic.

In 1984, a low light level underwater TV camera was used for observations of gill and trammel nets and concentrations of cod at wrecks in the German Bight.

In order to complement the selection data collected during December 1982 and 1983 in the winter cod fishery of the German Bight, a third bottom trawl selection experiment was carried out in December 1984. In May of the same year, the selectivity of anchor-dragged Danish seines was investigated for the first time. The data obtained for German Bight dab and cod indicate that the selectivity of this gear is much better than that of bottom trawls.

FRANCE

General

Created in 1984 by the merging of ISTPM and CNEXO, IFREMER (French Research Institute for the Exploration of the Sea) is now operational from 1 January 1985. A new department for "fishery and mariculture engineering" is set up to deal with the three following fields:

fishing technology
marine aquaculture technology
instrumentation (eg acoustics and underwater visualization).

The staff is 22 in total, of which 13 are scientists and 9 technicians, located in Boulogne, Brest, Lorient, Nantes and Sete.

In addition, there is in Brest, attached to another department, a team of 2 naval architects and 1 hydrodynamician in charge of a programme in naval technology. A part of this programme is devoted to fishing vessel technology.

Moreover, other staff and facilities in Brest for underwater equipment testing or calibration and instrumentation development (in particular, for acoustics and underwater observation), working in close connection with the fishery engineering department, are to be mentioned.

With regard to flume tanks for gear testing, a project is presently under consideration for replacing the Boulogne tank (built in 1967) by a new one of larger section (4 x 2 m) and better performance (particularly for speed uniformity).

Techniques for Underwater Observations of Fish and Fishing Gear

Trials of bottom set gill nets and trammels were carried out in September 1984 in coastal waters off Banyuls in the Mediterranean. Organized in cooperation with the National Centre of the Sea in Boulogne, this operation comprised underwater observation by mean of a colour TV camera of 19 nets of different types and construction. The two video films (one for general public and the other for professional fishermen) prepared show the visibility of the various netting material, the net attitude and aspect depending on its rigging and mounting, and some reactions of fish to the gear.

Several underwater observations with a TV camera were made on different types of mechanized dredges for sand buried molluscs, incorporating pumps for sand digging by water ejection and for aspiration of molluscs, mechanical separation of sand, as well as an air lift system for getting the catch on board. The observations conducted off Brittany have greatly facilitated the development of prototype dredges, better adapted to local conditions, which are to be tested soon under commercial fishing conditions.

A towed vehicle of the "wet" type with 2 divers (SEAKITE system) was used last year off southern Brittany for observing the behaviour of a special type of beam for bottom sampling survey. These trials were not conclusive due to unfavourable weather conditions. Further observations of the same gear, conducted in May 1985 with a TV camera fixed to the gear, were more successful with regard to information on the gear attitude and performance.

Fishing Vessel Technology

Although there is no specific programme for the study of fishing vessels in relation to stationary fishing gear and methods, it might be of interest to mention other activities related to fishing vessel technology.

Conducted with the support of the government a programme for the study of safety, working conditions and rationalization of work on board inshore fishing vessels (12-19 m long) of various types (including stationary gear) was initiated by the IUT (University Institute of Technology) in Lorient. The team of fishing technologists in Lorient is participating in this programme with regard to observations at sea of fishing operations, vessel equipment and deck layout. For illustration of the study, TV films and photographs are regularly taken at sea under commercial fishing conditions.

The programme "rationalization of design and equipment of fishing vessels" is a participation in the activities planned by the team of naval architects in Brest. These activities are mainly related to:

the improvement of performance of selected types of inshore fishing vessels (up to 25 m long), in particular by means of tank tests, in order to obtain systematic series of hull design;

the study of dynamic behaviour and stability of small fishing vessels (including experimentation at sea with stability computers);

the utilization of computer systems for the design and construction of fishing vessels in small shipyards;

a contribution to industry projects concerning deck auxiliaries, vessel general arrangement, improvement of catch handling and treatment on board, etc.

ICELAND

Direct Observations

Most effort was made to observe different designs of shrimp trawls and the behaviour of shrimp and juvenile fish with an underwater television mounted on a towed vehicle. Recent observations on crabs in relation to crab pots have been made. In July observations on Nephrops and fish species in relation to Nephrops and fish trawls have been planned.

Selectivity

The selectivity of haddock in Danish seines was dealt with in comparative fishing trials. Experiments with covered codends were not feasible as the fish were gilled in the wings and square in big quantities. As a result of these experiments the minimum mesh-opening of Danish seines was decreased from 155 mm to 135 mm.

The selectivity of haddock in bottom trawls is under investigation.

Fuel Consumption

Measurements on fuel consumption were carried out to investigate the efficiency of different propulsion machinery, propeller size, the effects of different side thruster mountings and hull fouling. The results of these investigations showed that considerable fuel savings are possible in the Icelandic fishing fleet.

ITALY

The fishing efficiency of different types of pelagic trawls has been compared using an acoustic method. For this purpose 80 hauls were carried out in May and in August 1984. During each haul, a computer, through an electronic instrument, sampled both the echosounder and the netsonde signals.

All the data collected were stored on magnetic tape in digital form. Later in the Institute, these data were processed to extract those considered valid from the whole set: ie the data relative to the echosounder signals produced by the fish present in the layer sampled by the trawl, and the netsonde signals produced by the fish detected between the headline and the footrope at the bosom.

These data were correlated with the fish effectively caught in each haul by the different trawl types. The echosounder data were used to determine the total gear fishing efficiencies, whereas the netsonde data were used to determine the pure trawl-net fishing efficiencies. In both cases a good linear correlation has been proved to exist.

Even if the results have to be confirmed by further tests, the fishing efficiency does not seem to be affected by meshes of different size in the front part of the trawl or by the use of the ropes. Other parameters seem to be of greater importance, such as the horizontal opening and the noise produced by the vessel when the fishing layer is not deep enough.

These tests will be continued in 1985. The data acquisition phase will be improved so as to select the echoes in real-time and to record only those considered valid.

IRELAND

A Nephrops trawl escapement experiment took place during September 1984. Two subjects were investigated.

- a) escapement from all areas of the trawl
- b) escapement during hauling

Findings under a confirmed previous results, namely that the bulk of escapement takes place through the wing bases. Under b, it was found difficult to obtain clearcut findings, but indications were that escapement during hauling is not a problem.

No underwater observations or work on stationary gear was carried out.

NETHERLANDS

Salt Water Electro-fishing

The new pulser designed in 1983 has been tested thoroughly in the electronics laboratory and on the FRV "Isis" prior to tests on a commercial boat (UK 141) for a period of 12 weeks. The capacitors were built in a specially adapted beam, instead of using a cylindrical housing to be mounted on top of the beam. The fishing net was redesigned to obtain a square stimulation area with electrodes of equal length and

tested in the Hirtshals' flume tank before trials at sea. With the new pulser and the new net, catches in day and night time will be 10-50% higher than those of the conventional tickler chain gear. The total fuel saving is estimated to be some 20%, taking into account the extra power needed to generate the electric field. With a better hydrodynamical shape of the beam and a lower optimum fishing speed the gross saving is expected to be ever higher. Research in 1985 will be aimed at the relation between fishing speed and catches, with an emphasis on energy savings. The project enters the phase of commercial introduction, for which the reliability and endurance of the electrode system need to be further improved. Participation with private companies to overcome financial difficulties will be essential.

Electrical Barriers for Freshwater Fish

Research on the development of electrical barriers for juvenile freshwater fish has been terminated with a final report (TO 84-08). The major conclusion is that barriers of this type are not to be recommended. The theoretical effect of the barrier is strongly negatively influenced by different natural processes, eg wind speed, wind direction, growth of algae and wave formation. Furthermore, the damage and additional costs caused by fish passing the barriers are small compared to the costs of installation and maintenance of the barrier.

Freshwater Electro-fishing

Results of experiments done in 1981 and 1982 have been analysed. Catches of eel were improved 20-fold with a decline in by-catch of bass by a factor of 2 to 3 compared to the non-electrified net. Placing the electrode array 3.5 m further aft in the net did not improve the selectivity. Reduction of net height affects both the catches of eel and bass.

Safety

An inventory of problems concerning safety and possible solutions was sent to various organisations with little response. A more direct approach to the industry will follow.

Fish Landing

The new method with a separate beam and small winch, reported last year, has been installed on several vessels.

Warp Endurance

The life span of warps can be doubled by the use of especially designed shells on the drums to guide the warps when coiling.

Storage in Refrigerated Seawater

This method has been applied on the new vessel UK 173 (3500 hp) resulting in substantially improved labour conditions and easier handling procedures. Quality aspects need to be studied further to come to a final conclusion.

Fish Sorting

A machine to sort fish using known weights as a reference proved to work well on the

UK 173 beam trawler. The total routing of fish using this machine can still be improved. Possibly the sorting procedure will be done ashore in the future.

Noise

Noise was reckoned as an important problem at a conference concerning the integrated safety of fishing vessels held in May 1984 in Lorient and organised by the European Communities. A survey of the situation onboard Dutch vessels will be carried out during 1985.

Energy Costs

Research on heavy fuels has been done on the beam trawlers GO 38, GO 26, GO 31, UK 67, UK 253 and UK 95. Technical improvements and proper care can reduce the additional costs of maintenance of the auxiliary systems needed to treat the heavy fuels. These are estimated at Dfl 4000 per annum. With a range of fuels varying from 30 m²/s (cSt) to 180 mm²/s (cSt) viscosity a skipper can be more flexible in his choice and pick out the cheapest fuel. A comparison of fuel costs of two nearly identical vessels proves heavy fuel to be beneficial even when there is no price difference with light fuels.

Auxiliaries

Several machinery-room lay-outs have been compared for a 1300 kW beam trawler from an economical point of view. Lowest costs will be obtained with one main engine using power-take-offs for the winch generator. The generator for the power supply can be driven by a separate auxiliary engine and a spare set can be formed by one auxiliary engine of half the power of the ship's system and winch generator.

Electrical Installation

The installation on the HD 22 (1300 kW) has been analysed thoroughly (report TO 84-04). Several user groups of power can be distinguished such as: machinery-room, gear and fish handling, navigation, and light and heating. Most boats use DC power substantially. The use of power-take-offs for driving AC and DC generators can be beneficial from an energy point of view.

Measurements on Machinery Installations

Several new fishing boats are using condition monitoring equipment in their machinery installation. Parameters such as temperatures and pressures can be measured and printed out. Satellite transmission of data from the vessel to the office ashore (SATCOM) is becoming popular. RIVO participates in measurements on the UK 173 using a TRACOR condition monitoring computer.

Towed Fishing Gear

Research on the big meshes midwater trawl has been extended to circumference sizes of 3600 and 4320 meshes round (nets denoted as GM2 and GM3 respectively). The development has been started with flume tank trials in Hirtshals on scale 1 to 25 prior to full scale construction. Comparative fishing trials on net GM2 (3600 meshes) provided good results on herring and mackerel. The FRV "Tridens" could handle this gear easily with shaft powers ranging from 1300 to 1500 hp. Full scale measurements

on drag and geometry of both the GM2 and GM3 and a commercial net of 3060 meshes circumference have been done in Portugese waters in November and December 1984 and will be analysed and reported during 1985. A new type of multifoil-door, based on the Suberkrub design, for both midwater and bottom trawling has been tested successfully in midwater. The spreading power turned out to be insensitive to speed variations. The doors performed very well during shooting and hauling, while the spread fluctuation usually found with Suberkrubs turned out to be negligible. Performance on the bottom still needs to be investigated.

New Type of Beam Trawl Mechanical Stimulation

A beam trawler bottom scraper to stimulate flatfish, replacing tickler chains, has been tried out in fishery trials on the FRV "Isis" during several weeks. A number of pins were attached to a second beam in two rows with the possibility of adjusting the pressure on the seabed. Abrasion problems could be avoided by a special hardening layer of tungsten (Wolfram) on the lower part of the pins. Catches were poor at first but gradually improved by modifying and adjusting the gear. The effect was best on soft muddy grounds, which may be a special application for this gear. Further development is needed for a final conclusion. The use of spoilers to press a beam on the bottom and compensate for a smaller weight, ie with ticklers removed, turned out to be very effective. Future application in electro-fishing may be interesting.

Low Energy Fishing Methods

The idea of using very large mesh sizes to herd pelagic fish species inside a net can also be applied in pair trawling. On the boats UK 141 and UK 271 a small number of hauls were done with the 2700 meshes circumference net reported in 1981 (GM1). Results were encouraging and further research will be carried out using a specially designed net for this purpose.

NORWAY

Fish Behaviour and Reaction

Studies of fish behaviour and reaction towards smell and taste stimuli have continued, the main objectives being to develop alternative baits for commercial longline fishing and to increase the catching efficiency of gill nets.

For full scale testing of different kinds of bait materials, small nylon bags have been found very useful, and a suitable method has been developed for determining the rate of stimuli emission from baits. Species specific differences in the acceptance of different bait types have been demonstrated.

Bait bags attached to gill nets give significantly increased catch rates in bottom gill net fishing for cod, saithe, ling, tusk and Greenland halibut.

Investigations of fish behaviour in relation to different light stimuli have been started, and the establishment of a field facility for fish behaviour studies in general is in progress.

In a 5600 m³ net cage the effects of light, sound and shadow stimuli upon fish have been studied by using transducers, integrator, acoustic tags and positioning systems together with UTV.

Selective Fishing

Investigations have been carried out comparing selection properties of Danish seine gears with traditional diamond mesh codend to gears with square mesh codends. Both field experiments and studies in a flume tank have been done. The results confirm earlier findings of improved selection properties of square mesh codends.

Shrimp-fish separation experiments have been continued with improved versions of belly mounted sorting panels in shrimp trawls. The method works satisfactorily in gears operated at moderate speed, but needs further improvement when applied in high-speed off-shore shrimp trawling.

Selection experiments in shrimp trawls with square mesh codends have been started and have given promising results. The work will be continued.

A new "Siamese-twin" shrimp trawl design has been tested and found to improve the catching efficiency for shrimp with reduced bycatch of small haddock and less towing resistance than the standard shrimp trawl.

Another system for reducing fish bycatch in the shrimp trawl fishery has been tested with encouraging results. This consists of a trawl section made of large square-shaped meshes with two fine-meshed tunnels inside, inserted in the aft belly part of the trawl.

A towed underwater TV vehicle ("Ocean Rover") has recently been acquired to be used on board "Kystfangst" for studies of the performance and effect of different separating devices in shrimp trawls.

An investigation has been started to develop species specific trawl gear/methods, mainly for cod and haddock, by utilizing their differences in vertical reaction movements. Initial trials with a round fish trawler in the Barents Sea suggest that such differences as have been found for various gadoids in the North Sea are also prevalent in the northern areas and may be utilized for species selective trawling of Arctic cod and haddock.

Improvements of Fishing Gear and Methods

Further work on hook design has confirmed the importance of hook form or shape, and has also shown that the dimensions and sharpness of hook point and barb are markedly affecting the catch rate in longline fishing. Snood floats lifting the baits off bottom reduce bait loss and may contribute to additional improvements in catching efficiency.

A system combining a simple random baiter with a tub-based hook stacking arrangement has been developed and found suitable for mechanised line handling on small vessels.

Measurements of purse seine sinking speed and net depth for various combinations of net types, mesh sizes, lead weights and hanging rates have been continued, to provide an empirical base for establishing the relative impact on purse seine sinking performance of the different factors.

A mechanised net stacking system for small purse seiners has been fully developed and tested, and work is in progress on an addition to the net stacking systems currently in use on large seiners, which will totally eliminate man-handling of the heavy ground line.

Work is also in progress with a numerical model for stimulating purse seine stereometry during all phases of operation in relation to hydrodynamic and other relevant forces.

A study on the bottom trawl as a sampling gear for resource assessments has been started. The aim is to develop sampling gear and methods with improved and calibrated selectivity and catching efficiency.

Detailed catch statistics from the Lofoten cod fishery and data and observations of diurnal fish distribution and behaviour in relation to a local gill net fishery in North Norway have given input for the development of a numerical model of gill net fishing, and an evaluation of the catching efficiency of fishing gear in general, and how this is effected by various environmental as well as fish and gear related factors.

A study of the causes of wear and damage in fishing gear has been started with the objective of reducing these through suitable strengthening designs.

Vessel Technology - Marine Engineering

During 1984 an Inter-Nordic 4 years research programme on fuel saving was completed with the main thrust on vessel design and vessel operation.

For dissemination of available knowledge a major information campaign has been prepared and will be implemented during 1985. The campaign employs an array of instruments such as:

- teaching aids
- brochures
- video cassettes
- practical training courses
- lectures and seminars

A new type of bulbous bow has been tested in full scale on the vessel "Kystfangst". Reduction in fuel consumption of 20-30% was achieved.

Model tests have been carried out on hulls for a new generation of purse seiners, with excellent results.

A considerable number of vessels have been retro-fitted with new propulsion systems. The changes have included such things as very low speed propellers, high-reduction gearboxes and complete changes of the underwater part of the stern.

A computer model for preliminary vessel design based on operations research has been developed. A number of designs have been prepared in cooperation with fishermen and consulting companies, some of which is now under construction.

To improve the safety and working conditions on fishing vessels a program has been in operation for several years with activities aimed at

- clarifying the reasons for accidents
- developing measures for accident prevention
- analysing consequences of such measures
- practical testing and evaluation of the measures under operating conditions on board fishing vessels.

In order to identify problem areas a major survey is being prepared to determine standards for safety and working conditions in the fishing fleet. The field work is to be carried out in 1985 on about 600 vessels. A pre-test has been carried out in the district of Finnmark.

During 1984 a study was carried out to identify available knowledge on the strain on humans when working on moving platforms and the ergonomics of such work.

Activities concerning testing of accident prevention measures have continued in 1984, such items as emergency stops for winches and haulers, safety boots and "no-skid" deck coverings have been tested.

On selected "project vessels" several measures have been tested simultaneously, such as roll reduction, noise suppression, improvement of gear handling, combined with ergonomic analysis of the work stations.

PORTUGAL

I During 1984, the Fishing Gear and Methods Department of the National Institute for Fisheries Research of Portugal (INIP) was involved in the following activities:-

- 1 Conduct of fishing experiments onboard RV "Noruega" using PA MONO Ø2.5 mm vertical drifting longlines directed to deep sea species capture. These experiments were aimed at the detection of Aphanopus carbo (black scabbard fish) fishing grounds, and the occurrence of this species was confirmed in Unicorn Bank (Madeira sub-area), S Vicente, Sines, Cascais, Peniche, Figueira-da-Foz and Aveiro (Continental sub-area), besides the areas formerly searched;
- 2 Participation in a cruise carried out by Dutch FRV "Tridens" in Madeira sub-area, involving fishing experiments with large mesh size pelagic trawl nets;
- 3 Experiments on the 1000 mm mesh size pelagic trawl net of the RV "Noruega" in order to test its behaviour and improve its operative conditions. A preliminary net behaviour table was obtained.

II During 1985, the Fishing Gear and Methods Department programmed to carry out on board INIP research vessels, the following works:

- 1 RV "Noruega"
 - a) Prosecution of exploratory fishing at great depths (500 m) mainly for the detection of eventual new fishing resources and new fishing grounds on the Portuguese coast. The trial and improvement of gears are also within the scope of these works.
- 2 RV "Mestre Costeiro"
 - a) Fishing experiments during which an improved arrangement and handling of drifting longlines will be tested: two or more drifting longlines will be simultaneously launched from the ship in a way that they are expected to

operate parallel one to another in order to cover a wider area than that obtained with the traditional one. If suitable sea conditions are found, these experiments will also be tried at great depths;

- b) Several experiments with gill nets involving comparative fishing with different types of traditional gears;
 - c) Fishing tests with fish traps drawn and made in INIP (which are the result of previous experiments) aiming to complement the detection of deep fishing grounds and to test their efficiency on fishing areas unsuitable for other kinds of gear. The experimental fishing of Nephrops norvegicus occurring on rocky bottoms near traditional fishing grounds or where this species is usually detected, is also going to be tried with these gears;
 - d) Complementing these works, first steps will be attempted on the study of fish behaviour in relation to those gears, mainly to improve the efficiency of the gears involved.
- 3 In cooperation with other INIP Departments, and proceeding from those made last year, two acoustic surveys will be carried out by RV "Noruega" on the Portuguese coast this year:
- the first one will take place in August to estimate the abundance of sardine by acoustic methods during the recruitment season, off Portuguese coast;
 - the second one will be held in December to study the behaviour and distribution of sardine during day and night time and their significance in the evaluation of the survey data and, if possible, to study the spatial distribution of blue whiting and its availability for abundance estimation by acoustic methods.

SWEDEN

Gears and Trawl Doors

There are ongoing projects on improving pelagic trawls for both pair and single trawlers. The trawls are designed for catching herring and cod.

Further improvement of round trawl doors eg Lindholmen type, has been carried out. A rectangular trawl door with the same type of slots as the Lindholmen type has been constructed. The rectangular type has been increasingly used both for bottom and pelagic trawling. Both types of trawl door are made in different sizes for use with trawls ranging from Nephrops trawls to large blue whiting trawls.

Demersal pair trawling with long sweeps and gear of mainly Danish construction has been tried in the fishing fleet with promising results.

A comparative fishing experiment with Nephrops traps is ongoing. Preliminary results suggest that a rectangular trap of Norwegian origin is more effective than a Scottish type. In spite of this, a commercial fishery with the Scottish trap has started and interest is increasing due to good catches and high prices.

Fish Behaviour

Telemetric studies on the reaction of salmon and eel to stationary gears suggest that sound generated by the gear could be an important factor for fish location and avoidance. A new project to study the effect of sound on catching efficiency has been started.

Underwater Equipment

A group of institutes has purchased a remote controlled underwater vehicle capable of diving to about 300 m. Movements and directions are controlled with 8 propellers and the maximum speed is about 3 knots. The vehicle is equipped with UTV and other cameras.

UNITED KINGDOM - ENGLAND (SFIA)

a) Trawl Fishing

Application of selector panels in trawls

Work on the principle of a selector panel in a trawl has been carried out for some time by DAFS Marine Laboratory, Aberdeen with support from the SFIA. The principle is to fit a horizontal panel of netting to a trawl extending from the twin codend to the mouth. During the summer months the IDU, using the flume tank, designed separators for two trawls currently popular with Ulster fishermen engaged in the Irish Sea prawn and whiting fishery. The trawls were a 23 fathom prawn trawl and a 520 mesh dual purpose trawl, both designed for towing by vessels of about 250 hp. Trials were carried out in September 1984 on grounds to the west of Ardglass, Co Down.

The results showed that mature whiting of 23 cm or more could be clearly separated from prawns thus substantially reducing damage to the whiting and giving a better product. The selector panels were 90% effective with whiting but less so with cod and other demersal fishes. An added benefit was the reduced work on deck separating the prawn catch from the whiting and, mainly for this reason, the two trials vessels are now using the selector panel trawls regularly and results are being monitored.

New trawls

Model and full scale trials have been carried out on a 2 seam trawl suitable for vessels up to 1700 hp and working on hard ground especially of the type found to the North and West of the British Isles. The sea trials were carried out on the Aberdeen trawler "Clarkwood" and the trawl had modified wings and was attached to rockhopper groundgear. The data is available for any vessels wishing to fish successfully on these grounds. No further development work is planned however.

Model full scale relationships in trawl design

Studies have continued in this complex subject to establish some of the elementary relationships between the behaviour of a model netting structure in the flume tank and the full scale structure at sea. The long term aim is to be able to predict the performance of a full scale trawl from a model with greater degrees of confidence. Because the irregular shape of a trawl and its interaction with the seabed introduces

other factors, it was decided to proceed with simple conical shapes. Some 12 of these, with variations in mesh size and taper angles were made up and their behaviour and resistance measured on board the Dutch research vessel "Tridens" in December. The analysis of this work is yet to be done and the tank models are to be made and tested during 1985.

Electro-fishing

The trials continued on the "Zuiderkruis" and included a device designed to protect the beam trawl and the electrode array from seabed boulders. A feature of the Western English Channel is the large number of boulders, and the orthodox beam trawl is protected from these by a chain mat. The trials were dogged by bad weather but this had the advantage of fully testing all the components under severe conditions. Unfortunately the trials vessel winch failed as a result of circumstances out with the trial and the vessel was taken out of service for some months, thus terminating the 1984-85 programme. The work is to continue during the coming year.

b) Static Fishing Methods

Improvement of gill net efficiency

Both DAFS and IDU are progressively increasing their knowledge of fish behaviour in relation to gill nets. Trials carried out by the IDU in the 1983-84 programme have been used as a basis to produce some modified gill nets. The modifications included a strip of non-buoyant braided nylon fitted to the headline to deter fish from escaping over the headline. Others included tying the headline down to 70% of its normal height to allow it to curve and finally an anti crab device on the false foot rope. Sea trials on the 16 m Grimsby vessel "Kelly" were carried out in February 1985 and gave most encouraging results when compared to the standard nets. These cannot be taken as conclusive because of the limited amount of fish available, but further trials are planned for May 1985.

Further development of monofilament longline

More experience has been gained with the monofilament lines both on the "Samantha Rose" in the Cornish fishery and the "Gannet" from Whitby.

The trials on the "Gannet" have proved the potential of the semi pelagic monofilament lines to provide a more efficient line fishery for this section of coast. Firstly in the strong tides they can be fished over longer periods since bottom set lines become entangled and have to be hauled and then reset. The Yorkshire line fishery too, is a winter fishery and ceases in the spring and early summer when the fish come off the bottom. The semi pelagic nature of the monofilament lines may help to extend the season and even create a summer cod fishery. These results, however, are speculative based on the limited trials carried out so far.

Review of requirements for small boat static fishery techniques

The main activity has been to examine the suitability of high speed craft in certain static fisheries such as potting and lining. There are certain advantages which must be weighed against fuel cost and limitations imposed by the design.

As there is such a wide range of high speed boats available, six different boats of 8 to 12 m length and up 2 x 212 hp twin engines, were tested, representing five different hull forms. All were supposed to be planing craft in that at a certain speed the hull lifts in the water and skims over the surface and is then able to sustain this speed at a reasonable power level. To achieve this needs a very fine control of weights on board and all the boats fell far short of their expected performance.

The study shows that there are merits in high speed craft in that more ground can be covered on day trip fishing and more pots or lines serviced, but there is a need for a specialised design of fishing craft with a target speed of say 12 to 14 knots rather than attempting to achieve unrealistic speeds of 18 knots or so and paying the price in extra fuel and an inflexible design of craft.

Fish aggregation devices

Limited work has been undertaken on fish aggregation devices (FADs) which will continue during 1985-86. Clusters of FADs have been purchased from the USA and set in the North Channel near the Ardtoe Marine Farming Unit. This type of FAD, which is made from PVC, has been reasonably successful in tropical fisheries but little work has been done in temperate waters. The clusters will be visited by divers from the MFU during the spring months to determine empirically if there is any colonisation.

c) Fuel Conservation

System design for fuel economy on Scottish seine net vessels

During the 1983-84 programme, sea trials were carried out on the Scottish seiner trawler "Acorn" 24 m 575 hp in order to fully evaluate the power demands on main and auxiliary machinery during fishing and free running. This data has now been analysed and published. It was also presented in February at a seminar to the boat building and fishing industry at Aberdeen.

The "Acorn" is a good example of a fuel efficient vessel but there is excess power in reserve for trawling. The power requirement when seining was 370 hp and the skipper exercised restraint when steaming limiting power to 325 hp. This last point reduced the annual fuel bill by some 8%. The electrical generating capacity at 27 kw was also excessive for the seining mode and 15-20 kw would have been adequate.

The study also investigated the use of deck equipment and the variable power demands as the seining sequence took place. A rope length counter has also been designed and installed.

In the same context, further work has been done on the fuel consumption when using a cp propeller. Although the cp propeller is of significant advantage during the seining sequence, at other times best fuel economy is achieved with maximum pitch and reduced engine speed. Sea trials on the "Acorn", together with those on the seiner trawler "Traveller III" over a 2 year period, have conclusively demonstrated this. The work on the "Traveller III" has also demonstrated the importance of correct matching of the propeller to the vessel requirements. After modifications to the propeller, the daily fuel consumption was reduced by about 5%.

Investigation of towing efficiency of trawlers

Two study areas have been investigated.

Measurement of the towing power of a trawler has always been inexact and both DAFS and IDU believe a more effective definition than horsepower is needed. The towing power depends on the thrust of the propeller at towing speed and this in turn depends on several factors which include horsepower delivered to the propeller shaft, propeller speeds and propeller design. There is also an overall efficiency factor of the water flow to the propeller which is difficult to measure. For a vessel of a given horsepower, these can vary quite considerably with the results that one vessel will obtain better results when towing a certain trawl than another of the same power. These problems have been investigated and a conical netting drogue was suggested as a means of measuring the loads and tried on the 230 hp "Ocean Reward" from Bridlington.

This is not an entirely satisfactory solution as the drogue size for the larger powers may be unweildy which would defeat the objective of obtaining a quick measurement of a new boat's performance. The investigation is continuing to develop a modified drogue from models in the flume tank and also to test alternative solutions.

UNITED KINGDOM - SCOTLAND

Modelling and Basic Studies

Data collected on the panel shapes of a pelagic trawl have been used to develop a computer program to calculate net shape. Progress has been encouraging and work is continuing to refine the program. It has been found that by adjusting the relative tensions of the selvages and netting the program can predict net shape accurately. It is also proposed to use the full scale data to investigate scale modelling in a flume tank.

Work has begun on investigating water flow in codends in a flume tank. It was found possible to track small particles through the meshes by observing a laser illuminated slice with a TV camera. The camera output is recorded and can be replayed frame by frame allowing particle speed to be measured.

Further analysis has been done on the drag of codends using the data previously presented to ICES. Statistical analysis shows codend drag to be dependent mainly on mouth circumference, the number of meshes round and water speed. It is hoped to publish the present analysis soon and to extend the study. Analysis of collected data on wire and cable drag is continuing.

Gear Performance Measurements

More measurements have been made on the performance of pair trawls. Data has now been obtained on net performance and on warp and sweep shape for two sizes of gear. The sweeps were found to be digging in deeply close to the gear and to leave the bottom not far from the net. Ground friction may be a significant component of total gear drag. A computer programme has been developed from the collected data to analyse pair trawl performance.

Improvements in instrumentation over the last decade should enable more accurate data to be collected on otterboard performance. A new project has been started with

the aim of producing systematic performance data for various types and sizes of board. Measurements have been made on two sizes of flat and Vee boards on the 600 hp research vessel "Clupea" using a two-panel demersal trawl. It was found that the Vee board performance was sensitive to small changes in the rigging. In parallel with this work the SFIA will investigate the performance of model boards.

The drag of groundgear is a highly variable component of the drag of demersal gears. Drag depends on bottom type and groundgear type. To investigate this factor the drag of a small two-panel net was measured with various groundgears on sand and mud. Further measurements will be made on larger gear. Results are not easy to obtain as netting drag is the largest component of the drag measured on the bridles.

Observations have been made on variations in the height of gill nets set in a tideway, using specially constructed manometers. The limited amount of data collected shows that height can vary dramatically over a tidal cycle. It is proposed to collect more data. Video-tape records have been made of more types of bottom set gear.

Selectivity

More comparative fishing experiments have been carried out to assess the selectivity of square mesh codends. The data has supported earlier work on haddock and whiting, using seines and trawls, which found that square mesh codends had higher selection factors and smaller selection ranges than traditional diamond mesh codends. A large amount of data has now been amassed and is being analysed and prepared for publication. Square mesh codends have now been used for Nephrops and better selectivity was achieved. To investigate methods of further improving the selectivity of square mesh codends observations have been made on codends of reduced diameter and tapered construction.

The performance of standard survey gears (GOV trawl and Isaacs-Kidd midwater trawl) has been investigated and further work is planned on the GOV trawl.

Fish Reaction to Trawls

More evidence that vision is the major stimulus to fish reacting to approaching trawls was gained in a cruise on "Clupea" during February. During several dark evenings in the week following the full moon light levels lower than 10-8 lux were estimated and with nearly no measurable bioluminescence haddock, saithe and sandeels were observed at a depth of 80 metres in the mouth region of the trawl. With all lights switched out on the remote controlled vehicle and all the deck lights switched off on the "Clupea", these fish were observed on flash photographs showing no orientation reaction just before collision with the trawl groundgear. It should be noted that the light attenuation of the water at night was measured by shining one 1000 watt flood lamp over the side of the ship towards a light meter lowered to the seabed. In many conditions significant light levels will be created at the seabed by deck lights on the fishing ship. It was also found that the TV (SIT) camera, often used for fish observation in fishing gear, stops operating at around 10-3 lux, a light level well above the level at which fish cease reaction.

Experiments with mackerel in our Aultbea tank this year showed that they are able to swim as a synchronised school in light levels as low as 10-7 lux and at light levels just lower than this the school breaks up and each mackerel swims slowly unable to react with others to form a school. These experiments suggest that we are underestimating

the ability of fish to see and react to gear at low light levels and that we must improve the techniques available for measuring the light level and visibility when observations of the reactions of fish to gear are made. Existing photomultiplier based light meters are the most sensitive, but the common forms that are portable cease to work at 10^{-4} lux. Measurement of lower light levels must be achieved by making a surface measurement, with no lights on and at the time of fishing and then estimating the underwater light by using the depth attenuation curve. This can be obtained, either by shining an artificial light source towards the meter at known depths from the surface or by measuring the change of light level with depth during daylight in the same water mass. Bioluminescence should also be measured, it may be present at all times of the year and can vary greatly with depth.

Mackerel Swimming

The exceptionally fast swimming of mackerel has been recorded by using a 200 frames per second high speed cine camera. They can swim at 5.5 ms^{-1} (11 knots) with a stride length of 1 body length and they can cruise for long periods (200 min +) at 3.5 lengths per second 2-2.5 knots.

Separation Observations

Direct observations supporting the development of the techniques for the separation of species during trawling has continued. It has been found that careful study of the behaviour of each species as it reacts to the trawl gives clues to ways of separating them during capture. A carefully adjusted horizontal panel was observed to separate pout which went mainly into the lower codend and herring which rose mainly into the upper codend. Preliminary experiments have shown that pout and shrimp (*P. borealis*) can be separated during capture and attempts are being made to develop this theme. A separating panel with a design suggested by the direct observation of the reaction behaviour of shrimps and pout has been tested in a cooperative programme with the Hirtshals flume tank. The behaviour of these animals in the resulting separator net will be observed at sea shortly.

Damage to Escaping Fish

More details have been gathered about the damage to haddock and whiting as they pass out of codends. It has been found that up to 60% of the scales of fish (up to 0.26 m length) can be lost as they emerge through the mesh. Fish inside the codend show less damage. Experiments are planned to look at survival of these damaged fish in sea cages.

Underwater View of Netting

New illustrations of the appearance underwater of pieces of coloured netting, ropes and floats etc were successfully made in March this year. An illustrated report showing these effects is being prepared and will aim to help those interested in applying the appropriate coloured materials in the construction of trawls. This work indicates that trawls can be designed to stimulate more reliably the required visual reaction behaviour from the fish in the varying underwater conditions.

2 PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON THE SPECIAL SUBJECTS

2.1 The Aberdeen Underwater Observation Technique (C S Wardle - verbal)

The history of the development of manned and remote controlled underwater vehicles at the Marine Laboratory was described and illustrated. Simple towed vehicles for divers in shallow water have proved successful and superior to expensive and complex pressurised manned vehicles. Improvement in the performance of low-light underwater TV cameras has enabled gear observations to be made in deeper water with a remotely controlled vehicle. Magnus effect rotors have been used for steering the vehicle. Improved instrumentation and the use of still cameras were described (ICES CM 1985/B:10).

2.2 Experience with Direct Observation Techniques on Square Mesh Codends (presented by F Veenstra)

In a joint project between RIVO, IJmuiden and the Marine Laboratory, Aberdeen the Remote Controlled Towed Vehicle (RCTV) was used on FRV "Tridens". Two bottom trawls and 10 codends of various designs were studied with underwater television. A video-film was shown of diamond and square mesh codends of different shapes. The exercise demonstrated the value of an RCTV for fishing gear and fish behaviour investigations (ICES CM 1985/B:34).

2.3 High Speed Vessels in Commercial Fisheries in the UK (H English)

The potential for constructing high speed vessels which can "plane" was discussed. The hull form chosen and the need to specify operating methods and machinery requirements accurately are critical if high speed operation is to be achieved. Increases in loading above the original specification produce vessels which have higher running costs than planned. For this reason the concept has not yet been successfully applied in the UK.

2.4 Trials of Long Line Mechanisation System for Small Coastal Vessels (R Skeide - verbal)

A system has been designed which is simpler and cheaper than existing equipment and is intended to be more attractive to small vessel owners. An effort has been made to construct the equipment from cheap components. Each magazine can hold up to 220 hooks and the snood length is variable. The hooks are drawn through a random baiting device with 90% success. A hydraulic bait chopper is used with 75% mackerel and 25% squid. The system is being tested commercially on a 12 m vessel using a total of 6600 hooks in 6 lines.

3 PRESENTATIONS OF PAPERS AND VERBAL CONTRIBUTIONS ON GENERAL TOPICS

3.1 International Standards for Fishing Gear (P J G Carrothers)

The development of the International Organisation for Standardisation (ISO) is outlined with particular reference to the activities of the sub-committee on textile products for fishing nets. The resulting ISO standards are listed and two remaining items are identified. Lists are included of the ISO standards on Cordage, basic textile standards

and standards on non-textile products used in fishing gear and for fishing. The Canadian National Standard on Fishing Yarns, Netting and Nets has been metricated, revised and enlarged into general agreement with the ISO standards. The content and arrangement are described and two points of difference with ISO are identified (ICES CM 1985/B:2).

3.2 Flume Tank Testing of Different Types of Vee Doors (D A Wileman)

Measurements are described on 1:4 and 1:5 scale models of 6.5 m² Vee doors. A new technique was devised to study the performance of a single door in the flume tank, using short lengths of wire rigging. The dependence of spreading force and drag on towing chain configuration, angle of Vee, aspect ratio, cambering and slots was investigated. A wide range of performance data is given. Some discrepancies were found with earlier wind tunnel data and there is scope for improving the simulation of bottom contact forces.

3.3 Model Tests at Varying Spread with GOV 36/47 trawl (D A Wileman)

Detailed measurements are presented on the performance of a 1:10 scale model GOV trawl. The data were used to assess the accuracy of the drag predictions made from a theoretical analysis which treats the net as an elliptical cone with a cylindrical codend. Reasonable agreement was obtained although the calculated dependence of drag on velocity increased more rapidly than the measured dependence. There is scope for improving the theoretical model to fully describe net shape.

3.4 Codend Attachments and Small Mesh Covers (P A M Stewart - verbal)

Video-films were shown on these topics. The attachments to codends permitted by the EEC regulations were observed, filmed and photographed. The obstructive effects of various lifting aids, chafers, strengthening ropes and flappers were illustrated. Small mesh codend covers of square and diamond mesh netting, rigged in various ways were observed. The clearance between codends and covers was noted and found to be adequate for the type of cover recommended by ICES (ICES CM 1985/B:12).

3.5 Fish Vision and Reaction to Gear (C S Wardle - verbal)

A video-film was presented giving the latest information on fish reaction to fishing gear. The visual field of fish was described and new data presented on the reactions of a school of whiting in a tank to a towed object. The fish moved so as to keep the object in view. This pattern of movement, controlled by the limits of the field of view, explains fish movements around trawl boards and within gears.

3.6 Observations on Crab Pots (O Einarsson - verbal)

A video-film was presented showing the behaviour of spider crabs around baited conical pots. The crabs found it difficult to locate the entrance on the top and improvements are possible. The observations demonstrated the value of underwater TV in behaviour investigations.

3.7 Report on the Direct Observation Experiment with the 28.9/37.1 m JCB Trawl (presented by C S Wardle)

This trawl is a small version of the GOV trawl and it was observed by divers and with the RCTV. It was fished with and without the headline kite and with 30 m and 55 m

sweeps. Measurements of the gear geometry were obtained with the various rigs. The reactions of fish in relation to the components of this net were described together with some suggestions for improving the sampling efficiency (ICES CM 1985/B:9).

3.8 Electric Stimulation of Flatfish (presented by F Veenstra)

Commercial trials of the latest Netherlands electrical fishing system were described. A more powerful pulse generator and a larger rectangular electrode array were used. An electrified beam outfished a conventional beam with tickler chains by 50%. The catch rate increases with voltage but no significant size selection was found. A longer lasting material is needed for the electrodes. The effect of fishing speed on the catch rate has still to be investigated (ICES CM 1985/B:36).

3.9 Report Seminar Electro-fishing at RIVO-IJmuiden on 24 January 1985 (presented by F Veenstra)

The report summarises the activities of the Netherlands, England (SFIA), FDR and Belgium on electrical fishing. Equipment specifications are listed and the technical problems encountered are described. The objectives of each country are described and means of introducing electrical fishing to the beam trawling fleets were discussed (ICES CM 1985/B:37).

3.10 Tests on a Rake Trawl on Fishery Research Vessel "Isis" (presented by F Veenstra)

A rake trawl, with pins scratching the seabed, has been tried in comparison with a conventional tickler chain beam trawl. Catch rates were low at first but increased over the experimental period. Especially on soft muddy grounds the rake trawl may become a good alternative. The drag of the rake trawl may be lower. The distance of the pins to the footrope seems to be critical and further catch improvements may be possible. Damage to benthos and fish seems not to be excessive (ICES CM 1985/B:35).

3.11 Headline Height Measurements on Gill Nets (P A M Stewart - verbal)

A self-recording manometer has been developed to measure headline height variations in gill nets. The headline unit contains a compressible bag to absorb water pressure and it is linked to a recording unit on the solerope by a very narrow bore plastic pipe. Recordings made in weak and strong tidal flows were shown. These demonstrated that gill nets can be severely reduced in height by strong tides.

3.12 Fish Behavioural Aspects of Gear Design (C S Wardle - verbal)

The optical properties of materials used in gear construction were described and illustrated in relation to fish vision. Variation in the relative contrast of materials with depth, visibility and angle of view was illustrated and methods of reducing gear visibility were discussed. The use of netting and components of different colours, background contrast and patterns in the different sections of a trawl to enhance its visual effect was discussed.

4 RECOMMENDATIONS

- 1 The Working Group accepted an invitation from Mr H English of the Sea Fish Industry Authority to meet in Hull and discussed various topics for consideration as special subjects. Consequently, the Working Group recommends that the next meeting should be held in Hull, from 12-14 May 1986 and that it should consider, in particular:-
 - a) recent applications of energy saving concepts in the design of fishing vessels, deck machinery and propulsion systems.
 - b) engineering and behavioural aspects of the selectivity of fish sampling gears.
- 2 The Working Group, taking note of the progress made by several member countries in the development of electrical fishing systems, and having regard to the need to develop fishing gears which conserve energy, recommends that member countries continue to investigate and exchange information on electrical fishing techniques, in particular, those related to beam trawling.
- 3 Having regard to the need for standardisation in the development of computer aided methods of net design, the Working Group recommends that the International Organisation for Standardisation be encouraged to complete and issue an international standard on the drawing of fishing nets (ISO draft DP 3169).