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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**

Convenor: B van Marlen, RIVO, IJmuiden, Netherlands
Rapporteur: R S T Ferro, Marine Laboratory, Aberdeen, Scotland
Meeting Place: Hamburg, FDR
Date: 4-6 May 1987

INTRODUCTION

In accordance with ICES Council Resolution 1986/2.6 the working group met in Hamburg from 4-6 May, convened by Mr B van Marlen, and considered in particular:

1. size and species selectivity of fishing gear and its implications for fish stock assessment and fishery management.
2. engineering aspects of working procedures on fishing vessels.

This reports 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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 - 1.4 Selectivity of codends with different mesh configurations - J Valdemarsen and B Isaksen.
 - 1.5 How catch rates can affect the selectivity of shrimp in codends and a description of an alternative method to improve selectivity in shrimp trawl - J Valdemarsen.
 - 1.6 Sampling with pelagic trawl on bottom and with bottom trawl - W Dickson (verbal).
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 - 1.8 Investigating stock assessment surveys - P Stewart (verbal).
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 - 1.10 Low cost engineering to improve working procedures and safety onboard Dutch beam trawls - K Bouwman and B van Marlen.
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 - 2.7 Synergistic effects of different baits on the same hook in the longline fishery for hake (Merluccius merluccius) and tusk (Brosme brosme) - J Franco, A Bjordal and S Løkkeberg.

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- 2.11 Danish experimental fishing in the 1980s - E Larsen.
- 2.12 Development and initial testing of a trawl system for catch separation in low opening shrimp trawls - E Sørensen and S Yngvessen.
- 2.13 Commercial application of separator panels in Nephrops trawls - J Tumilty and K Arkley (+ video).
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4 MESH GAUGES

5 RECOMMENDATIONS

1 PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON THE SPECIAL TOPICS

1.1 Mesh selection experiments. (P Stewart - verbal)

Data on haddock and whiting selection experiments were reviewed. In addition to mesh size there were other design parameters such as length of extension and width in meshes which significantly affected selectivity. It would be necessary to specify codends more strictly if legislation was to be tightened. A case was reported in which hexagonal meshes had been used to avoid current mesh size regulations. A mathematical description of codend shape was also discussed.

1.2 Trawl sampling and acoustic abundance. (W Dickson - verbal)

Experiments were conducted to correlate trawl samples with acoustic estimates because trawl surveys had produced too low estimates of juvenile cod and haddock. Rockhopper groundgear was effective in retaining small fish. A pelagic trawl with rockhoppers was also found to be effective. Selectivity may be influenced by these changes. Improved data processing of acoustic signals allowed detection of fish to within 15 cm of the sea bed.

1.3 Influence of sweep length on sampling. (W Dickson - verbal)

It was found that the effectiveness of a trawl was dependent on sweep length. The sweep efficiency and net efficiency were calculated. The "effective" spread of the gear was greater than the net spread.

1.4 Selectivity of codends with different mesh configurations. (J Valdemarsen and B Isaksen)

Selectivity experiments were conducted on codends having upper and lower panels of different length, on codends having square mesh in the upper panel and diamond mesh in the lower panel and on square and diamond mesh codends. Reducing the length of the upper panel adversely affected selectivity as did the combination square and diamond mesh codend although they were easier to handle. The results for square and for diamond mesh codends were comparable to earlier results. No codend covers were used.

1.5 How catch rates can affect the selectivity of shrimp in codends and a description of an alternative method to improve selectivity in shrimp trawls. (J Valdemarsen)

An explanation of the observation that the length distribution of shrimp catches is not affected by mesh size was proposed. It assumed that shrimp do not actively avoid capture and that the water flow through the codend is strongly affected by the size of catch. Some funnel designs for codends were proposed and results suggested that fewer small shrimp are caught.

1.6 Sampling with pelagic trawl on the bottom and with bottom trawl. (W Dickson - verbal)

A comparison of catches using a bottom trawl, a pelagic trawl on the sea bed and a pelagic trawl was made. The bottom trawl caught more small fish; rockhoppers were much better than bobbins. It was demonstrated that the difference was mainly due to escapes under the groundrope. There was a need to extend these experiments to study day and night conditions.

1.7 Effect of gill net selection on survey results in the Greenland young cod survey. (H Hovgard)

Size distribution of cod in gill nets with different mesh sizes was compared with those of three other gears. It was concluded that size distribution was very dependent on mesh size. The selection process by which two distinct size ranges of fish could be caught in the same mesh size was discussed. Possible effects of selection on survey results were considered.

1.8 Investigating stock assessment surveys. (P Stewart - verbal)

Information on gear performance and fish behaviour is available. It has been used to explain the catching performance of a gear only in general terms. An attempt will be made to relate numerically the catch of a small version of the GOV sampling gear with measured parameters defining gear geometry and environmental factors. Towing speed and light level, for instance, may be as significant as fish distribution in determining catch.

1.9 Noise levels and sources onboard the Dutch fishing cutters. (F Veenstra)

Data on noise levels, particularly on beam trawlers, was presented and compared with international standards. The measurements showed that on almost all the vessels the noise levels exceed the recommended limits. The results and some solutions were discussed.

1.10 Low cost engineering to improve working procedures and safety onboard Dutch beam trawls. (K Bouwman and B van Marlen)

Some injury statistics from the Dutch fishing industry are quoted. Four major causes of these accidents; fatigue, winches, codend hoists and fish box landing arrangements are discussed and solutions proposed.

1.11 A Norwegian project studying working procedures on fishing vessels. (L Karlsen - verbal)

A project was described which reviewed the general health of fishermen, safety measures on ships and the working environment. Specific improvements which were being introduced were mentioned, such as antiskid surfaces, safety lines, high guard rails, rescue ladders, alarm signals and emergency stop devices for machinery, protective clothing and vessel roll reduction. Noise investigations and the registration of accidents were also discussed.

It was suggested that examples of publicity material on these subjects could be displayed in future. In safer environments accident rates may not reduce as much as expected because fishermen take less care when they feel safe.

2. PRESENTATION OF PAPERS AND VERBAL CONTRIBUTIONS ON GENERAL TOPICS

2.1 Progress with a computer model of fishing gear. (R Ferro - verbal)

A finite element model suitable for structures subject to large deformation was described. The model does not assume an initial shape but only a method of construction. Convergence can take several hours of computer time. Further work is required on empirical data for netting drag and water flow in a net. The method of fixing the frame ropes to the netting is a major factor in determining net shape.

2.2 Further wind-tunnel tests on otter boards. (K Lange - verbal)

Some data on cambered vee doors were presented. Results from wind-tunnel, flume tank and full-scale tests were compared. There were unexplained discrepancies and there was a need for exchange of models.

2.3 Experimental investigations on the dynamical behaviour of otter boards.
(H Daartz, M Paschen and H Stengel)

The lift and drag coefficients of Suberkrub otter boards were measured in a cavitation tunnel using a special rig which allowed the model to oscillate. The large fluctuations of the coefficients with time were considered to be caused by vortex shedding from the door. This mechanism may explain the variation in results obtained in wind-tunnels and flume tanks. Further work is continuing to determine the frequencies of vibration, mass moments of inertia and damping coefficients for the full-scale case.

2.4 Methods of achieving greater depths for towed gears. (B van Marlen - verbal)

Trawling at depths below 1000 m required new methods if excessive wire lengths or slow speeds were to be avoided. A multifoil depressor was found to be unstable. Alteration of the angle of the fore-aft strengthening plates to achieve greater hydrodynamic depressing force was not successful. Alteration of the vertical position of the towing plate and changing the rigging of the backstrops to reduce the inward heel of the doors both produced increases in towing depth.

2.5 Beam trawls. (E Dahm - video)

A 7 m shrimp beam trawl, an 8 m sole beam trawl and a heavy 4 m sole beam trawl were filmed on soft and very soft grounds. Film was also taken of the track of the beam trawl a short time after fishing. This showed the marks made by the shoes and evidence of fish being attracted by dead fish and shellfish.

2.6 Demersal trawls. (R. Steinberg - video)

The film started with shots of the remotely controlled vehicle and shooting and hauling procedures. A 540 meshes circumference balloon trawl was observed with fish reactions to different trawl components. Three different otter boards were filmed on sandy and rough bottoms. A gear fastener with subsequent net damage closed the presentation.

2.7 Synergistic effects of different baits on the same hook in the longline fishery for hake (*Merluccius merluccius*) and tusk (*Brosme brosme*). (J Franco, A Bjordal and S Løkkeberg)

A bait combination, on the same hook, of sardine (*Sardina pilchardus*) and mackerel (*Scomber scombrus*) was used to catch hake by semi-pelagic longline in the inshore fishery of the Basque Country. A different bait combination made with mackerel and squid was tried in a Norwegian bottom longline fishery. In both cases the bait combination showed significantly better catch rates than the traditional baits, although in the latter trial mackerel and squid baited every second hook was at least as successful as the bait combination.

2.8 Testing of a new hook design in the longline fishery for tusk (*Brosme brosme*) and ling (*Molva molva*). (A Bjordal).

Trials were conducted to compare the effectiveness of three types of hook: a tuna circle hook, the EZ-Baiter circle hook and a standard J-hook. It was concluded that both circle hooks were superior to the standard J-hook possibly due to more secure hooking and that the tuna circle hook would give slightly better catch rates than an EZ-Baiter hook of the same size.

2.9 Swivel connected gangions in mechanized longlining - effect on catch rates and operation. (A Bjordal)

Multifilament longlines with swivel connection between gangions and mainline were compared with traditionally rigged gear. The swivel-lines were adapted to the mechanized system without difficulty. The effect of the swivels was clearly positive, both regarding catch-rate (+15%) and easier handling.

2.10 Fishing experiments with an alternative longline bait based on nylon bags. (S Løkkeberg)

Trials were conducted on a new longline bait comprising a nylon bag closed at each end by a metal clip. The nylon fabric was found to have a negative effect while the clips had no effect on catch rate. Compared with natural bait the nylon bags containing minced herring gave higher catch-rates for tusk, ling and haddock but lower for cod.

The binder used to hold the bait together was found to affect catchability and shown to be an important factor.

2.11 - Danish experimental fishing in the 1980s. (E Larsen)

New techniques and developments in a range of fisheries are described including floating pound nets to replace stake nets, development of new stakes for the stake net fishery, the introduction of twin trawling in the Norway lobster fishery, a Norway lobster trawl for hard ground, the establishment of new fishing grounds and fisheries for Nephrops, crab and turbot, a gutting machine for white fish which does not damage the roe or liver and mechanization of gill netting.

2.12 Development and initial testing of a trawl system for catch separation in low opening shrimp trawls. (E Sørensen and S Yngvessen)

A trawl was designed to sort the targetted species (shrimp, angler fish and large haddock and cod) from the bycatch of Norway pout and small haddock and cod. Using a separating panel which varied in attitude from horizontal to almost vertical and contained two mesh sizes, the bycatch was guided to a top codend while the required species were retained in a lower codend. Good separation was achieved on a commercial trial.

2.13 Commercial application of separator panels in Nephrops trawls. (J Tumilty and K Arkley - video)

Trials on separator trawls identified the optimum position for separating panels in at least one design of trawl. They also showed that handling operations were satisfactory and that the need for catch sorting was reduced with a corresponding improvement in quality of the landed fish.

2.14 Midwater and bottom trawls for cod and herring. (E Dahm - video)

In collaboration with Finland two types of Swedish trawl door were used on two Finnish midwater trawls to catch cod and herring. Film of herring in the after part of the trawl was shown.

2.15 Icelandic demersal trawls. (G Thorsteinsson - video)

Film of demersal trawls with bobbin groundropes was shown, particularly over hard ground with large boulders. Fish escape from 155 mm codends was shown.

2.16 Position prediction of herring shoals in purse-seine capture situations. (O Misund)

Sonar observations of herring schools in the North Sea and along the Norwegian coast revealed a rather constant swimming behaviour of individual schools in purse-seine capture situations. On the basis of this a method for position prediction of herring schools was being developed. The method might give the opportunity for position prediction on true-motion sonars in real capture situations.

2.17 Developments in underwater TV vehicle cable links. (D de Haan - verbal)

Methods of reducing the number of cores required in a power and communication cable including a multiplexing digital system were described. For example, 19 cores could be reduced to perhaps 12. Some film of demersal trawls was also shown.

2.18 Recent trends in fishing gear design in the Pacific Northwest. (C West)

Developments in the US fishery in this area included the design of more specific trawls, of large mesh trawls and rough ground trawls and trawls to cope with large catches. Research had been done on the reduction of bycatch and on selective gears.

2.19 1986 Bering Sea Manta Project. (C West)

The impact of bottom trawling on red king crab and other demersal species and the benthic habitat was evaluated. It was found that significant lengths of the bridle and sweeps were held off the sea bed by the towing strain. Bobbin and disc ground gear had substantially less bottom contact and reduced the catch of crabs, starfish and trash but appeared to capture fish as effectively as a solid groundrope. Red king crabs, caught by the trawl and held in the codend with small fish catches for short periods (less than one hour), suffered relatively low rates of injury. Poor visibility prevented filming of the trawl in areas where crab could be found.

3 PROGRESS REPORTS

Prior to the meeting the Convenor had requested that each country should provide written progress reports on recent work on fishing technology and fish behaviour. The reports were not given verbally but questions were called for on 6 May as time permitted. Reports were received from each participating country and from FAO and Italy and are reproduced here.

BELGIUM

Trawl Gear

The research on trawl gear was mainly aimed at the reduction of towing resistance. Existing nets were redesigned on the basis of larger mesh sizes of a more appropriate matching to available engine power.

A high opening bottom trawl, based on the Marine Laboratory's four-panel trawl, has been tested onboard a 225 hp beam trawler. In this experiment the warps were lead through the blocks at the tip of the booms, as is common practice in semi-pelagic fishing by small Belgian beam trawlers, especially when operating on sand ridges. The catches were rather poor compared to those obtained by trawlers using the traditional nets. Trials will continue this year with a changed rigging and a heavier groundgear.

Beam Trawling

Measurements preliminary to the installation of a new developed overload protection system for the beam trawl fishery were made. The system automatically opens the brakes if a previously set overload in one of the warps is reached, in case of a maximum load difference between the two warps, or of a sudden, well-defined increase in load in one of the warps. The use of flip-up ropes has been introduced in the Belgian beam trawl fishery. Comparative experiments with this protective system have been carried out onboard a 1200 hp beam trawler. Although the nets were already equipped with stone mats considerably less damage, due to stones and other debris, was caused to the net with the flip-up ropes. A catch analysis showed that there were no significant differences in sole and plaice catches.

Electrical Fishing

The electrical field in the front part of an electrified trawl was studied.

Experiments were carried out with an electrified shrimp otter trawl.

Selectivity

Comparative fishing trials with a beam trawl alternatively equipped with a diamond and a square mesh codend were carried out. Only a limited number of hauls yielding rather poor catches could be studied so that no conclusions on differences in selective properties could be drawn. Selectivity experiments with both types of codends will be carried out onboard a commercial beam trawler later this year.

Mesh Shrinkage

The study on mesh shrinkage due to bottom sediments was completed. In total seven types of netting have been submitted to the influence of sand and mud under laboratory conditions. The experiments showed that considerable shrinkage may occur, depending on the type of netting material and yarn construction.

CANADA

Trawl Catch Monitoring System

Federal Development Branch in Newfoundland began a project to develop a trawl catch monitoring system intended to give the operator reliable, high-resolution, real-time information on catch quantity. The system will be composed of a catch indicator, transducers to measure headline height and spread, otter board spread, trawl depth, water temperature, and associated shipboard receiving, processing and display equipment. The system is intended as a major improvement over the existing systems,

with primary emphasis on reliability, cost effectiveness, data quality, information accessibility and display. The same organization reports development of an outboard motor powered pot/line hauler.

Scallop Rake, Underwater TV and Square Mesh Selectivity

The federal Fisheries Development Branch, Scotia-Fundy Region's trial of a new scallop rake continued in 1986. Two more versions were built and tested with encouraging results regarding rejection of rocks. The group also acquired the underwater "Mermaid Explorer" camera system. Trials resulted in excellent video recordings of both scallop rakes and otter trawls. The system will be used extensively in 1987 to document fish behaviour with various gear types. Evaluation of codend selectivity experiments conducted previously indicated significant differences in the ability of juvenile cod and haddock to escape from square mesh codends.

Net Drag Matched to Vessel Power

The Faculty of Engineering and Applied Science of Memorial University, Newfoundland, reports completion of a Master of Engineering thesis on trawl gear performance and net drag analysis, with application to small trawls and vessels. A procedure was developed to determine engineering performance which was used to compare vessel power and gear drag for small inshore trawls. The same study also involved towing tank drag measurements on small polythene nets, including an investigation of the relationship between mesh orientation and net drag to explain the reduced drag of square mesh vs diamond mesh nets.

Trials on Trawls, Longlines and Floating Herring Nets and on Propellor Nozzles

The Province of New Brunswick's Technical Services group indicated successful trials with the following gear: a net drum and Mogere polyvalent doors for shrimp trawls; a "rock hopper" foot rope with Bison doors; a high lift trawl; a pair bottom trawl; and a Ball net hauler for longlining mackerel shark. A floating herring net was also tried, with results to be evaluated in 1987.

The Nova Scotia Department of Fisheries reported the following work: continued development of longlining gear for sharks, including trials with swordfish drums; evaluation of propellor nozzles, both alone and in combination with CPP on small (up to 55 ft) longliners; and trials with net storage reels on small draggers to determine positioning for greatest effectiveness.

In the area of fishing gear development for scientific purposes, the Pacific Region reports the development of a surface beam trawl. The gear is designed to sample the first 10 m of the water column for juvenile pink and chum salmon. It will be tested during 1987.

Acoustic Survey Techniques and Target Strength

The Marine Ecology Laboratory, Bedford Institute of Oceanography, Dartmouth, used an underwater vehicle (BRUTIV) to identify and observe haddock in conjunction with its ECOLOG acoustic system. Acoustics recorded the presence of fish both day and night, while BRUTIV's video camera recorded fish only at night, apparently due to avoidance of the towed vehicle by day.

Acoustic research at MEL also included a study comparing their ECOLOG system with a Biosonics dual-beam system. The Biosonics algorithms rejected more than 99% of the fish targets observed, resulting in much higher variances around its estimated target strengths. Biases due to fish reflectivity appeared to be comparable in the two systems. A comparison of ECOLOG counting estimates of density with integration estimates suggested significant biases in the latter which is correlated with fish size.

Work continued at the Biological Station, St Andrews, New Brunswick on developing methods for estimating in situ herring target strength. Estimation from pulse counts and integration products proved unfeasible due to high fish densities. Initial work with a prototype high frequency sounder system showed that individual herring could be resolved, but the downward-looking sounder recorded few fish and high noise levels. Improvements are planned in 1987.

Lobster Selectivity and Research on Snow Crab

The Federal Department of Fisheries and Oceans, Gulf of St Lawrence Region (Invertebrate Research Section) reported the development of a mathematical model for retention of lobster caught in different types of lobster traps with different escape mechanisms. This model allows the determination of the optimum size and configuration of escape mechanisms for each of the fishing districts in the Gulf of St Lawrence.

The movements of snow crabs carrying ultrasonic transmitters were tracked during the spring mating season on the west coast of Newfoundland by using a stationary hydrophone array monitored by a microcomputer.

A comparative study of size frequency distribution and sex ratios of snow crab (Chionoecetes opilio) caught by different types of bottom trawls (Nephrops, shrimp and beam trawls) is currently being conducted in order to define optimal sampling method for surveying growth and spatial distributions.

DENMARK

Development of Improved Trawl Designs

Contact person: S Yngvesson

New large mesh trawl designs with rope wings have been developed, model tested in the flume tank and introduced to the new class of high towing power "supertrawlers" based in Esbjerg. The designs have had good fishing results when used in midwater for blue whiting, horse mackerel and pilchards. The designs have been developed in close cooperation with net manufacturers and fishing skippers with financial assistance from the Fisheries Ministry.

The same procedure has also been used to develop improved single and twin trawl systems for smaller vessels plaice fishing. Again the new net designs have given extremely encouraging fishing results. In addition a separator panel has been developed which can be inserted in the shrimp trawls used in the North Sea Fladen ground fishing. The separator panel has been tested at sea onboard an Esbjerg trawler working a twin trawl system. Preliminary results given by the skipper are encouraging.

Trawl Drag Studies

Contact person: D Wileman

The measurements of the drag of elliptical cones of netting taken in the flume tank last year have been analysed and compared with the predictions made by different hydrodynamic and empirical models. It was found that much better agreement between measurements and predictions was obtained if it was assumed that the drag of the netting bars is proportional to the sine squared of the angle between the water flow and the netting bar rather than the sine cubed as predicted by cross-flow theory. Furthermore it was found that the drag of the netting increased dramatically with the mesh opening making formulae based on twine surface area alone virtually useless for many Danish net designs where the mesh opening is very different in different parts of the trawl.

Further work is now being done using large scale models to determine if the geometrical shape of trawls is changed significantly when energy saving net sections with less resistance are inserted. This work has been sponsored by the Danish Energy Ministry.

Measurements of the Full Scale Engineering Performance of Fishing Gear at Sea

Contact person: T Berg

Measurements of the towing geometry have been obtained (using Scanmar sensors) for an anchor seine, traditional and improved pout trawls and a herring pair trawl.

The Abrasion of Netting Materials

Contact person: T Berg

An initial appraisal has been made of several different methods for simulating in the laboratory the processes which cause wear in netting materials. The worn material has been compared with netting used at sea both in terms of physical appearance and reduction in material strength. The work has been completed in cooperation with five net and rope manufacturers and although there is a large variation in the strength of a given sample after the wear tests it has been decided to try and proceed further with the development of a representative method for testing and comparing the effects of wear on different materials. The work has been funded by the material manufacturers and the Teknologirådet.

Computer-Aided Trawl Design

Contact person: K Hansen

The first CAD system aimed specifically for use in commercial net lofts has been completed and marketed within Denmark. The system gives design help relating to matching/altering different mesh sizes, calculates netting weights and costs, produces scale drawings of net specifications and stores the specifications on floppy disc. Routines for estimating trawl drag and matching with vessel towing power and otter board size are to be developed in the future for standard Danish trawl types.

Trawl to Vessel Acoustic Links

Contact person: T Berg

Due to the interest from Danish electronic firms in the development of new trawl instrumentation an appraisal has been made of the problems associated with the transfer of data from fishing gear to the towing vessel using acoustic links. A mathematical model has been developed to stimulate the sound paths under different hydrographical conditions and with different locations of the sender and receiver. The work has been made jointly with the Danish Institute for Marine Research and Aalborg University and has been sponsored by the Teknologirådet.

FAO, FISHING TECHNOLOGY SERVICE

Publications

Recently FAO produced a new Fishing Manual, Calculations for fishing gear design, written by Fridman, edited and enlarged by Carrothers. A Fisheries Technical Paper, Small scale fishing with drift nets, by Karlsen and Bjarnason, was also published in 1987. In the FAO Training Series, the last issue in 1986 was Finding fish with echosounders. This document is available in English and Spanish, with the French edition now being printed.

Other publications on fishing technology will be issued most probably before the end of 1987: in the FAO Training Series, Light attraction, Purse seining with small boats and Shallow water FADS. An FAO Manual on trawl performance, catalogues of fishing gear of Cameroun, Gabon and Cape Verde and a report on fishing gear and methods of Latin-American inland waters, are in advanced stages of preparation. A Guide de poche du pecheur (Fisherman's pocket guide) will be published in French (the English and Spanish versions will be available later in 1988). In the summer of 1987, Fishing News Books will publish a new edition, revised and enlarged, of the FAO Catalogue of Small Scale Fishing Gear. For 1988, the FAO Fishing Technology Service is preparing two Fishing Manuals; one on FADs and one on Purse seining.

Continuing FAO Field Activities

Masterfishermen and fishing technologists working on FAO field projects in countries such as Benin, Brazil, El Salvador, India and Indonesia, continue to spread the use of effective fishing gear. They work to adapt effective technologies to local conditions, training local technologists and fishermen in improved gear construction, rigging and maintenance. Concentration is usually on technologies most appropriate for small scale fisheries, with passive gear such as gillnets and longlines. For gillnets, the relative efficiencies of different materials (monofilament, multimono and multifilament) were tested in India and Pakistan. For longlines, improved rigging for shark line fishing was introduced in the Caribbean, Indonesia and Mozambique. Enlarged liftnets with larger mesh in the top sections were tried in East African lake fisheries (lake Kivu, Rwanda). Improvements in trawls and trawling were developed in several countries. For example, in El Salvador and Brazil, small trawls for shrimp and fish were developed or improved for use on vessels in the 10 metre length range. In India, FAO has done considerable work with high-opening bottom trawls for small vessels.

Artificial reefs were established in Malaysia, FADs were set in the Comoros and Mauritius (in Mauritius, several FADs set over a year ago in depths from 1000 to 2000 metres continue to be used productively). Many different catching methods have been tested around these aggregating devices. Variations on line fishing seem to be the most efficient, giving mean catches around 60 kg for trips of a few hours duration. The FAO Regional Project of Bay of Bengal has recently published a document Experiences with Fish Aggregating Devices in Sri Lanka (ref: BOBP/WP/54).

Expert Consultation on Selective Shrimp Trawl Development

This consultation was held in Mazatlan, Mexico, 24-28 November 1986. Thirty-four experts from 22 countries participated, presenting 21 papers on the status of shrimp fisheries in different countries. Trawl research and development were discussed.

Detection and Navigation Aids

In many countries, utilization of fish detection and navigation aids is increasing in order to allow development of advanced fisheries further from shore, in less exploited areas. In recent years, this trend has been reflected in increasing interest in the preparation and use of fishing charts. An FAO expert is now preparing a document on remote sensing and fishing charts. The approach is to take an admiralty chart and enhance it with data from satellite imagery, adding to it information of value to local fishermen, as a relatively cheap way of benefitting from high technology. The trial exercise is being carried out in Maldives Islands. A UN/FAO training course will take place this month in Venice, Italy, on Applications and Remote sensing in Marine Fisheries.

Engineering Aspects of Fishing Vessels

Particular emphasis has been given to fuel saving with studies of fishing fleet operations and in the production of text material for a Manual on Fuel Saving which is expected to be published in 1988. In the field of small artisanal fishing craft, inboard diesel installations for beachable craft using both tunnel sterns and a lifting propeller device have been tested and have shown significant fuel economy over that of the regular petrol outboard engines used in many artisanal fisheries. Comparative trials have also been carried out with 4-stroke petrol outboards which have shown worthwhile fuel savings over the commonly used 2-stroke.

For the increased use of hydraulics in small craft a third in the FAO Engineering Applications series of technical papers is under preparation entitled "Hydraulics for Small Fishing Vessel".

FEDERAL REPUBLIC OF GERMANY

As in previous years investigations on energy saving fishing methods occupied a large part of the research work done in the Federal Republic.

Due to the very poor stocks of cod at present in the Western Baltic and in the German Bight, experiments with gill and trammel nets for cod were stopped in favour of those for other species, which might at least partly replace cod in the commercial fishery. Thus, field work with herring gill nets was started in the Baltic in order to promote the

selective capture of large-sized and, therefore, marketable individuals of this still abundant species. Because of the unfavourable length composition of traditional trawl and gill net catches, the herring prices paid are so low that this fish is not very attractive to German fishermen. Also in the Baltic, experiments for catching flatfish were undertaken with gill and trammel nets which were modified to reduce the bycatch of rubbish (mainly jellyfish and seaweed). The latter seriously hampers or even prevents the use of these gears in summer and autumn.

In the North Sea differently coloured trammel nets for the capture of soles were tested. The best results were obtained from steel-grey and dark-green nets, whereas blue and light-brown ones yielded very poor catches. Because of the lack of recruitment in 1986 the most efficient mesh size for sole trammel nets was slightly larger than in the year before.

In the past years an electrified beam trawl has been developed, which meets all the requirements of commercial employment. But recent experiments proved that the shape of the beam trawls used hitherto is not adapted in the best way to the reactions of fish in the electric field. Therefore, the construction of the trawls was improved accordingly.

A recently purchased low-light underwater TV camera was used successfully during trawling experiments in order to observe the function of flexible kites made of canvas which increased the headline height of a bottom trawl by a factor of 1.6 compared to standard headline floats. Video tapes were also taken from rubber bobbins when crossing obstacles.

Interesting records could be made with regard to the behaviour of fish within the trawl and the process of mesh selection within the codend. Further investigations focussed on technical properties of the remote controlled towed vehicle (RCTV), the knowledge of which is a prerequisite for its safe handling. During cruise no 228 of FFK "Solea" observations of beam trawls were performed especially the effect of this type of trawl on the structure of the sea bottom.

As in the years before, selection experiments were carried out during the winter cod fisheries in the German Bight. On this occasion, a new type of polypropylene multifilament recently introduced into German deep sea fisheries was investigated.

In the Baltic, square mesh selection experiments were undertaken during pelagic pair trawling for herring. The main purpose was to make use of the well-known extremely narrow selection range of square mesh codends. It is hoped that by means of this the proportion of easily marketable gradings in the herring landings can be increased.

By means of wind tunnel tests the effect of camber on the lift and draft coefficient of V-form otter boards was investigated. Thirteen percent camber gave an increase of C_L by 50%.

FINLAND

Two Finnish midwater trawls of the type commonly used by Finnish fishermen were observed underwater with the aid of a remote-controlled towed vehicle equipped with a low-light-level television camera. The observations were carried out jointly by the Institut für Fangtechnik (Hamburg) and the Finnish Game and Fisheries Research Institute onboard the German research vessel "Solea" in July in the Åland Sea in the northern Baltic. These underwater observations were primarily made to check the functioning of the trawls during operation and to obtain a detailed picture of the shape and geometry of the different panels, selvedges and seams of these nets. The trawls could be observed from the mouth to the codend, and the vehicle could be manoeuvred even deep inside the trawls. Both trawls showed a good shape, and only small areas of stress were observed at the lower square corners of the smaller trawl. Inside, the nets had a good round shape down to the end of the extension piece. The visual image or brightness contrast of the large mesh panels in the front part of trawls was much more distinct than that of the small mesh panels in the rear part. Besides these technical parameters, some interesting observations were made of the behaviour of Baltic herring and cod swimming inside the trawls. The Baltic herring showed a strong tendency to swim out of the trawl through the netting in the rear.

In autumn the catches of Finnish trawlers off the southern and south-western coast of Finland consist mostly of small-sized Baltic herring. Preliminary studies were made of the effects of the mesh size in the front part of the trawl and towing speed on the size distribution of the herring catch. The mesh size in the front part did not have any effect on the size distribution (70 mm and 800 mm half mesh compared). When the towing speed was increased by about 10% (from 3 knots to 3.3 knots), the mean length of the herring in the catch increased by about 4%. However, on the basis of these few hauls no definite conclusion can be made, and the results will have to be verified with further tests.

Increasing the effectiveness of herring trapnets requires information on the behaviour of fish in the vicinity of the gear. As yet very little is known of the pattern of behaviour and reactions of Baltic herring when the fish come into contact with the trap. The diurnal activity and swimming depth of spring-spawning Baltic herring were followed with an echo-sounder in the vicinity of a herring trapnet in May and June in the south-western archipelago (ICES subdivision 29). According to the preliminary results the herring are most active at the time of sunrise (02:00-05:00). Most herring approached the trap in midwater, at a depth of 3-5 metres. This experiment will continue with two echo-sounders, one of which will be mounted close to the bottom, with the transducer directed upwards.

FRANCE

Gill Nets

Tuna fishing has been operated with drifting gill nets. The mesh size was up to 240 mm.

Different mesh sizes have been tried on trammel nets for sole fishing. The selection factor and the relation between mesh size and gill perimeter will be estimated.

Trawls

Twin and three wing trawls have been tested at sea and in the flume tank.

In cooperation with the Marine Laboratory of Aberdeen, two trawls have been observed by TV. The first trawl was a bottom trawl with bridles and fork riggings. The second one was a pelagic trawl (800 mm mesh size).

A mathematical analysis of a trawl has started. The first steps are the choice of a method of description of the netting and analysis of net shape and the flow inside.

Dredges

Two dredges for Venus have been studied: one is based on the Magnus effect which is working well, the other is fitted with a screw-like device.

GERMAN DEMOCRATIC REPUBLIC

Basic Investigations

In 1986 further work has been carried out in the field of discretized towing systems referring to static and dynamic processes as well as technical facilities. It has been the aim of this work to prove other applications for these methods which provide very good solutions for the calculation of fishing gear and fishing gear systems despite being very expensive.

In 1986/87 a programme for calculating the shape and the forces acting on a fixed bottom net has been developed for the static case. The first results suggest that ideas on fishing gear based on simple methods must be changed.

The following programmes have been developed for static problems:

- a calculation programme for calculating the time-dependent shapes and corresponding loads of a net cage being moved in a seaway; first results have confirmed the applicability of this method;
- a calculation programme has been developed and tested successfully for calculating the path of a towed body which is towed from a ship by a system of wires.

Furthermore preliminary experimental tests have been carried out in the cavitation tunnel on the dynamics of otter boards. The results show that under certain circumstances the models of pelagic otter boards tend to oscillate naturally. In this connection considerable variations of forces and moments were noticed. Further experiments are planned for 1987.

ICELAND

Following direct observations with an underwater TV camera on Nephrops and Nephrops trawls in summer 1985 experimental trawl designs were tested and observed in May 1986. The new trawl designs showed good performance and increased the catch rates with reduced towing resistance. This experiment consequently resulted in better rigging of commercial Nephrops trawls. A video film has been published on the most interesting results of this cruise.

In July the behaviour of cod and some other bottom fish species in relation to bottom trawls was studied. A video film made on the highlights of these observations was found very interesting by the fishermen. Such observations and fishing gear experiments will be continued in 1987.

Some further observations were made on other fishing gears (seine, dredge, trap) and animal behaviour in relation to those gears.

A video tape dealing with model tests of shrimp trawls in the flume tank in Hirtshals was prepared for the fishing industry.

A new design of scallop dredge with improved rock rejection for less damage to the scallop has made a good appearance in the scallop fishery.

The conversion of a 28 m long fishing vessel for black quahog hydraulic dredging was completed. Experimental fishing will be started in early 1987.

Measurements on fuel consumption of fishing vessels were continued and proposals of energy saving projects were presented.

IRELAND

Most research at the Fisheries Research Centre with Fisheries Technology aspects has been directed to comparing the effect on the catches of 60 mm and 70 mm mesh in the Irish Sea fishery by parallel haul experiments. The larger mesh yielded catches of approximately 85% of those obtained with the smaller mesh, and slightly larger numbers of Nephrops at the top end of the length range.

Design studies are underway to produce prototype separator/codends with separator panels for comparison with sets of two separate codends (upper and lower) in use on separator trawls, in view of the fact that some reservations have been expressed by skippers about the handling properties of sets of two codends in poor weather.

ITALY

A series of hauls was carried out on an Italian bottom trawl. Two different lengths of the sweep (80 and 200 m) were alternately used in order to vary the door distance and the horizontal net opening. The aim was to show their influence on the catch of different fish species.

During every haul, the horizontal and vertical openings of the net were measured by means of our instrument system. Length frequency distribution and weight of the most important species caught, were also measured.

The door distance was estimated by means of a mathematical formula. This formula was positively verified in some hauls, when it was possible to use the Scanmar Distance-Meter transducers mounted on the doors and our instruments on the net.

The Scanmar equipment was also used on the traditional bottom trawl of a commercial vessel, employed during the trawl surveys in the Channel of Sicily. The door distance was measured at different water depths from 50 to 350 m.

A1:6 model of the Italian bottom trawl was tested in the Flume Tank of the Danish Institute of Fishing Technology. Two other models were successfully built. These models were modified in order to simplify in the construction of the traditional net.

NETHERLANDS

General

Due to the increased necessity for contract research a lot of discussions were held with the Dutch fishery industries, especially ship-yards, and maritime research institutes like TPD-TNO (ship-acoustics) and Marin (ship model tank). Various project proposals were made to raise funds via the "National Foundation for the Coordination of Maritime Research in the Netherlands" (CMO). Two ICES papers "Use of heavy fuels in the Dutch Fisheries" and "Application of energy-saving concepts in Dutch fishing cutter design and operation", have been written and were presented at the Hull meeting in May 1986.

Much technical advice has been given on potential projects in development countries. A six week mission to Tanzania concerning fishing gears followed in one case.

Safety and Working Conditions

Although fishermen say that they are aware of safe working procedures, there still appears to be a reluctance to apply them onboard.

Onboard UK 95 and GO 41 a prototype portable warp greaser was tested. Two advantages of this unit are the ability to grease different warp diameters and to transfer the equipment between fishing vessels. In cooperation with a Dutch firm attempts were made to commercialise the system.

Onboard the beamers GO 38 and GO 41 tests were done on a new greasing and preserving remedy "Break free". This greaser is especially suitable for stationary fittings onboard vessels, like watertight doors and escape hatches. After six weeks they did not sieze up.

In 1986 more noise level measurements were done onboard nine Dutch beamers. The results were almost the same as found in 1985.

In cooperation with TPD-TNO (Institute for Ship-acoustics) systematic noise measurements were made onboard representative 1500 kW and 220 kW beamers to try to reduce the noise levels.

Reducing Energy Costs

Because of low fuel prices this year and a minimum price difference between light and heavy fuels, less attention has been paid to the use of heavier fuels (up to 380 mm²/s (cSt.)) onboard Dutch beamers.

Often a fall-back in the overall quality of bunkered fuels stressed the need for more guidance and advice to the Dutch fishing vessels. Discussions with fuel suppliers, engine manufacturers and skippers resulted in the formation of a Working Group to improve the fuel specifications used on Dutch fishing vessels with continuously varying diesel loads.

As a follow-up to the UK 173 (1985) programme, power and fuel measurements were made onboard the 2200 kW beamer GO 26, one of the few Dutch beamers with a controllable pitch propeller. These trials resulted in a useful manual for power measurements describing the data-loggers, required data and frequency, the accuracy of the sensors, preparation for participation in the weeks trials and also the analysis procedure on the RIVO computer. Due to calibration failures only rough conclusions could be drawn. On the GO 26 also experiments were done with the fuel catalyst CP 3500. These experiments will be concluded in 1987. This catalyst should prevent carbon deposits in the engine and reduce the fuel consumption.

Design of Fishing Vessels

In view of the changing fishery conditions in the Dutch fisheries (TAC, quota, laying-up) there is even more need for an optimised fishing vessel. The low fuel prices were very helpful but this will not be structural for the future. Study of the existing and potential energy-saving methods in Dutch fishing cutter design and operation, shows that up to now only those aspects which did not interfere too much with the daily fishing operations, such as the choice of the propulsion machinery, fuel oils and electrical power generation, had been applied.

With a careful reconsideration of the energy-saving possibilities for Dutch beamers a potential 15-25% fuel savings can be achieved, although a techno-economical cutter design approach is required.

As necessary design improvement studies the following cooperative projects were started: systematic noise level research with TPD-TNO, systematic hull form model tank tests with Marin and a database for vibration levels.

Electrical Fishing

Following the tests of December 1985 modifications in the electrical circuitry were designed and constructed, aiming at a higher reliability of the system. During March and April comparative trials were done on both FRV "Isis" and a commercial boat GO 65 using the RIVO system and one designed by a Mr van de Vis of Texel. Results were encouraging for the RIVO-system with higher sole catches, while the other system fell short in this respect. Both systems failed to match the catches of plaice using conventional tickler chain gear.

In 1987 it is hoped to attract outside companies to take over further development of a commercial product.

The rest of the year's programme was dedicated to identifying the catching efficiency of several components of the system, such as the electrodes and the net itself without the use of electric stimulation.

Finally the year was closed with a series of measurements on the energy transmission through the system, as it was felt that substantial unnecessary losses took place.

Towed Fishing Gear

Midwater trawling

Sterntrawler skippers are seeking ways to increase the depth of their gear without a reduction in fishing speed. An initial idea of changing the door attitude toward the flow, in order to gain depth was tried on FRV "Tridens" in March with only minor success. Apparently bigger downward forces have to be applied either by weight or a hydrodynamic device to reach significantly greater depths.

Direct observation

Initial trials were conducted in March on FRV "Tridens" in order to learn to operate the underwater television vehicle system and to test the self-built rotor control unit. The purchase of a new camera (SIT OE-1223) enabled a far better picture quality. Later in the year some shots were taken on a bobbin trawl with very useful information on the behaviour of measuring equipment on the net. The next step will be to minimize the number of electrical conductors in the cable and to combine both signal transmission and towing function in one cable.

Model research

Four different designs of beam trawl nets were tested in the Hull Flume Tank at scale 1:4 in April with three designs of big meshed midwater pair trawls (scale 1:25). The beam trawl nets were intended to be used with a rake type of stimulation, where the problem was to minimize the distance between the rake pins and the footrope without a loss in bottom contact. From the tests two types were chosen to be used at full scale. The aim with the midwater trawls was to find a net with similar vertical opening but bigger wingspread and to create a square aft part (four equal panels), which was believed to avoid the problem of substantial numbers of fish meshed as found in existing nets. One of the gears tested was an enlarged version of big meshed trawl CM3 as reported in 1985. The gear featured simple taper ratios at the frame lines to cut the costs in production and to ease repair. This simpler cutting resulted in distortion of the meshes close to the frame lines with low stress in the bosom and high stress at the selvages. Apparently good trawl shapes can only be found with a frame line design not too different from the theoretically calculated shape assuming equal loads in the bars.

Rake trawl

Extended trials were done in May/June on FRV "Isis" with two different beam trawl nets in combination with the rake trawl used in previous years. One of the nets was constructed with four shark teeth, while the other was based on a round footrope. The reference gear was a conventional tickler chain gear. With both rake trawl gears

lower catches of sole, turbot and plaice were made compared to the conventional gear. Furthermore the expected decrease in towing resistance did not occur, while many of the fish became scratched by the pins. Conclusively the rake trawl concept was proven not to be an improvement in comparison with the conventional gear and will not be investigated further.

Pair trawling in sand-ridges

Trials were done on commercial boats with nets number TO-795 (German type) and number TO-748 (Danish type) in order to identify the best rigging for fishing over sand-ridges. Good results were obtained with warps of 100 fms length, weights of 500 kilos, sweeps of 50 meters with adjacent split bridles of 36 metres. On some occasions the net got stuck in a ridge but never to such an extent that hauling-in was necessary.

Beam trawl drag reduction

Apart from replacement of tickler chains by a low drag stimulation system (electrical stimulation e.g.), other ways can be found to diminish trawl drag such as hydrodynamic shaping of beams and shoes and alterations in the nets themselves. Tests on a so-called "trouser net", with a considerably smaller twine area were done on FRV "Isis" in December. The net consists of two small beam trawl nets next to each other, attached to one footrope on one beam. The catching efficiency turned out to be promising with a slightly smaller drag. Handling both codends simultaneously was no problem. Further studies on such methods of trawl drag reduction are planned for next year.

Information

A new computer system was installed in the middle of 1986. Special attention was paid to the installation of new users and applications on this system. A campaign was started to decrease the time needed for debugging of application-programs written by the several users of the systems. The availability of the computer systems for production was about 97%, which is experienced as quite satisfactory.

NORWAY

Fish Behaviour and Reaction

Studies of fish behaviour in relation to different light stimuli have been continued. The investigations have shown that scattered layers of herring may be concentrated and guided by means of underwater light. Using a light positioned underneath a school, herring were observed immediately to ascend to the surface when the light was switched on.

The behaviour of herring in relation to vessel and gear in purse seine fisheries has been investigated.

The 675 kHz imaging sonar (SIMRAD/MESOTECH Model 971) has been used as a trawl-sonde on a number of pelagic and bottom trawls. This has displayed (1) the three-dimensional shape of the trawl gear, from the doors to the codend, (2) the shape of

the sand cloud, behind the doors, and (3) fish positions at the entrance and at different sections along the inside the trawl gear. Such measurements, made during the day and at night, are being used to quantify trawl effectiveness and to study trawl geometry.

Selective Fishing

Work to improve the size and species selectivity of shrimp and round fish trawls as well as size selectivity of Danish seines has been carried out.

Further studies were conducted to evaluate the selective performance of bottom trawls used in Norwegian demersal fish surveys. A modification of the radial escape section (RES) utilizing the filtering effect of the funnel meshes and the forward herding and upward escapement reaction for fish, proved to increase loss of small shrimp and escapement of fish through an opening in front of the funnel entrance.

Size selectivity of square mesh codends has been compared to diamond mesh codends both in roundfish trawls and Danish seines. Improved selectivity was proved, but heavier meshing of redfish in square meshed codends reduces its application in the Barents Sea. To avoid problems with emptying a big catch from square mesh codend, a codend composed of square mesh in the upper panel and diamond meshes in the lower was designed and tested. The selectivity of this codend design was somewhat poorer compared with the ordinary square mesh codend. Initial experiments with square mesh codends in Danish seines gave encouraging results compared to traditional diamond meshes.

The sampling trawl studies have proved length dependent escapement of cod under the fishline, and that the sweep length affects both the size and species composition of the catches. Relatively more small fish are caught with 40 metre sweeps than double the length of sweeps (80 metres). Long sweeps, however, catch relatively more large fish.

A project on selective shrimp trawls will be terminated during 1987.

Improvements of Fishing Gear and Methods

A new hook design (EZ-Baiter) has been tested in comparative longline fishing trials. This hook which is a modified circle hook design adapted to mechanized longlining gave significantly higher catch rates for all main target species (cod, haddock, tusk and ling), when compared to traditional hooks. The development of a "tea bag" longline bait has been continued, (minced raw material in nylon gauze bags). Bait with herring as raw material has given comparable catch rates to traditional longline bait for tusk, ling and haddock. The development of a simple mechanized longline system has been completed. The system, which is based on random baiting and storing of the line in tubs is already installed on several vessels from 30 to 50 feet.

Mechanized net stacking systems are now in common use on most of the larger Norwegian purse seiners.

Development of new hauling and stacking systems for lead and float lines onboard larger purse seiners have continued. The systems will hopefully eliminate manual handling of the heavy lead and float lines.

Acoustics and Behaviour

Development of a multi-frequency echo sounding system for measuring the density and size composition of zooplankton in situ continues.

For theoretical determination of the target strengths of walleye pollock (Theragra chalcogramma) and roach (Rutilus rutilus), anatomical measurements have been completed.

The target strength of haddock (Melanogrammus aeglefinus) has been measured in situ with the SIMRAD split-beam echo sounder.

Vessel Technology - Marine Engineering

The research program "Safety and Working Environment" was completed in 1986. The results from the program have played an important role as background material for government safety regulations and a "Whitepaper" on Safety in the fishing fleet. This research program will be followed up by an information project now being prepared. The work on "Safety standards in the Fishing Fleet" will continue. This is a survey covering about 600 fishing vessels. Preliminary results indicate serious shortcomings in several sectors of the fleet.

The research activities on "Fuel Saving and Fuel Economy" were also completed during 1986. The final year was mainly used for winding up the activities and finalizing research reports. The information and education project that formed part of the program was completed also. During 1986 an educational simulation program for fuel saving for use on personal computers was made operational, and the "Ecopilot", an industrial project for developing devices for automatic optimization of main engine and cp-propellor tilting was also concluded from a research point of view. A bow tank for pitch reduction on fishing vessels was model tested with encouraging results.

A project involving "Future"-research was commenced, with the aim of producing scenarios for the Norwegian fisheries of the future, with particular emphasis on the fishing fleet and vessel technology development. This work continues in 1987.

A pilot project on "Information Technology in the Fishing Fleet" was carried out in 1986, with emphasis on information analysis and the scope for the use of information technology onboard.

In general, there is great interest in technology for processing at sea, and plans for research in adapting technology for use onboard were prepared in 1986.

An analysis on damage, stability and safety on smaller fishing craft concluded that improvements can easily be gained by use of watertight bulkheads and floating elements in the rail.

UNITED KINGDOM - ENGLAND (SFIA)

Trawl Gear

Separator trawl

Further trials of the separator trawl were carried out this year from the NE coast port of North Shields. This is a continuation of work that started some four years ago following initial investigations carried out by DAFS Marine Laboratory.

The work has continued to concentrate on the Nephrop fisheries where trials have shown that it is possible to achieve 90% separation between Nephrops and fin fish bycatches. The optimum position of the panel has been identified, and the handling of the modified nets have proved no more difficult than with the normal trawl. The main improvement has been the significantly easier deck sorting operation; this was seen by the crew as a distinct advantage. The fin fish bycatch has also been of significantly better quality as it had not been subjected to abrasion in the lower codend and mixed with the Nephrop catch. The objective of this year's trials was to obtain commercial acceptability of the principal of the separator trawl and at present the trawl is being used by a commercial vessel from North Shields. The work is to be continued in this year's programme with a view to having the gear accepted by a wider number of vessels.

Twin Trawls

Sea trials were carried out this year to determine the engineering parameters governing the use of twin trawl rigs. The trawls used in these trials were designed by Seafish staff and were initially observed underwater courtesy of the DAFS (Department of Agriculture and Fisheries for Scotland) diving team. The same trawls were subsequently taken to sea by a commercial vessel fishing for Nephrops in the North Sea. The engineering parameters checked and catch rates monitored. The trials highlighted the advantages and some of the problems that can be encountered, particularly in handling when using this system.

Electric Fishing

Sea trials of the Seafish electro-trawling system were carried out last summer on the Brixham based beam trawler ZUIDERKRUIS over a period of approximately one month. During the trials period the vessel was fishing on a commercial basis and catches compared reasonably favourably with vessels of a similar size and horsepower with a reduction of about 30% in fuel consumption. The system performed reliably for the whole of the period with the exception of the initial few days when problems were experienced with the failure of the cable winches keeping pace when hauling with the main winch. Although the catch rates compared favourably with other vessels and with the vessel's previous record of catches there was some doubt during the trials about the efficiency of the chain electrodes. There has also been a significant decline in commercial interest in taking up the system due to the considerable fall in oil prices last year.

Static Gear

Pilchard drift nets

The work to revive the pilchard drift net fishery in the South West of England continued this year. Several different types of synthetic netting materials were rigged up in the traditional way, some treated with a bituminous solution to enhance the

stiffness of the material and tested alongside each other. Although due to bad weather it was not possible to carry out the trials until the end of the season some interesting results were obtained. The knotless material that was used showed the most promise both from the point of view of catching and clearing the fish. The results were sufficiently encouraging for further work to be carried out this year which will include minor modifications to the trials vessel to accommodate a full fleet of nets. There has also been encouragement on the marketing side for a supply of quality drift net caught pilchards.

Longline mechanisation

The Seafish Autoclip System was installed aboard a Grimsby vessel for trials to assess its commercial performance using small illex squid as bait. The profitability of lining has been much improved by the adoption of small squid as bait and it was considered that mechanised lining would now be viable and beneficial.

Development work was required to enable the baiting mechanism to handle the squid but although the system functioned well, the fishing performance was poor due to the loss of bait from the hooks.

It is concluded that the lack of mechanical strength of small illex squid render it unsuitable for mechanised baiting.

However in view of the good mechanical and baiting performance, the Autoclip is a viable system provided mackerel or the larger loligo squid is used.

Otter board model tests

A system has been developed for testing model doors in the Flume Tank so that the lift and drag force coefficients may be obtained.

A single door of approximately 1:4 scale is supported using a warp and bridle.

Measurements of the warp and bridle tensions and angles are taken as well as the door angle, so that the required force coefficients can be calculated.

The angles of the warp, bridle and door are measured using an overhead mounted video camera, and tensions measured by underwater load cells.

Data has been obtained for flat and vee doors at varying angles of attack and heel. This enables the angle of attack for maximum spreading force and maximum efficiency to be obtained.

It is hoped that novel designs of otter board may be tested in the near future to compare with the data for flat and vee doors.

Model/full scale correlation

As part of the ongoing process of improving agreement between full scale fishing gears and Flume Tank models, tests were conducted on a 1:10 scale pelagic net model.

The full scale data was obtained from sea trials conducted by DAFS and was considered to be accurate and reliable.

Model trials were intended to give measurements of bridle tensions, not geometry and mesh setting angles.

However, shortcomings in instrumentation accuracy were found when measuring the small loads involved and so more accurate load cells are being installed before further trials are carried out.

Standard towing tests for trawlers

A sea anchor type drogue has been developed in the Flume Tank, to act as a drag device when testing the towing ability of trawlers.

The drogue is of four panel construction towed by four bridles.

Full scale trials were conducted on a prototype which was found to have some weakness at the seams.

The first drogue was strengthened and a second smaller drogue constructed. Trials were then carried out on a 100 HP trawler to produce a test procedure and obtain full scale drag data.

These tests were successful and so it is planned to design drogues for trawlers up to 500 HP.

Further Flume Tank trials are to be carried out on three more drogue designs similar to the first prototype. The intention is to economise on material content and also reduce the weight requirement for keeping the drogues submerged.

UNITED KINGDOM - SCOTLAND

Further comparative fishing experiments using small mesh covers confirmed that codends with fewer meshes round their circumference increase the 50% retention length for haddock and whiting. Observations of square and diamond mesh codend covers showed that there is slightly more clearance between codend and cover in the square mesh case. This may reduce the masking effect of conventional covers. Preliminary trials with a new design of vertically divided trawl (two nets on one headline) were performed to investigate the possibility of comparing two codends without using small mesh covers.

A new project has been started to study the effect on catch size of the factors which are thought to determine the efficiency of sampling gears. The major parameters to be measured will be towing speed, light level and gear geometry.

A proposed design for a small 600 hp version of the standard ICES Young Fish Sampling trawl was tested to make careful comparison of its geometry with that of the normal size (GOV chalut 36/47).

Engineering data were obtained on the relatively new Scottish pair seining method in which the gear is shot by one vessel, towed for a considerable time by both before the ropes are passed back to the first vessel for hauling. Vessels of about 250 hp were used.

A preliminary series of observations using television and instrumentation were made on a 240 hp seine net vessel. More detailed information on the geometry of the ropes is now possible and a further trial is planned in 1987 with enhanced instrumentation for monitoring swept area.

Engineering trials on flat and vee-type otter boards have been concluded. The effects of ground friction and changes in wire attachment position have been measured with instrumentation and recorded on film over a range of speeds. One aim is to improve the matching of door size to net size.

A final series of measurements was made on the drag of different ground gears on hard and soft seabeds. The analysis of a large body of data on the drag of two panel demersal trawls has been started with the aim of developing a net drag formula. Different designs of these trawls may need to be considered separately.

The computer model of a trawl is being extended to include demersal nets and the wires ahead of the net. A theory of flow through nets is being developed and further work has been done on the drag coefficients of netting at small angles of attack.

Further experiments, using direct observation techniques, have been made to investigate the damage to commercial species of fish escaping from codends. A new study began to investigate fish behaviour to and performance of single vessel twin-trawls using different rigging arrangements and similar and dissimilar nets. Work on separator trawls continued to assess species separation and selection utilizing different mesh sizes in the upper and lower codends.

A three year study of swimming performance has established figures for maximum speed, minimum speed and endurance at intermediate speeds for mackerel (30-40 cm). The endurance for similar sized herring and saithe has also been measured. The results have been found to give explanations for the increase in tilt angle of mackerel when light level drops and the changes in behaviour observed in the mouth of a trawl net.

Conclusions from the studies of fish reaction to trawls at night are that below certain light levels (10^{-7} lux) and with low levels of bioluminescence and deck lights off, haddock, whiting, cod, saithe and sandeels have been observed to show no reaction to the parts of the trawl until touched.

A pattern recognition test has been found successful in helping to show food preference in cod. This technique may be useful in speeding up tests selecting better synthetic baits and experiments are continuing.

4. MESH GAUGES

In order to ensure a continuing supply of ICES mesh gauges information was required on the likely demand for the gauges in the medium term of perhaps five to ten years. The Chairman of the Fish Capture Committee agreed to canvas opinion at the Statutory meeting in Santander later in 1987 and to report back to the Convenor of the Working Group on Fishing Technology and Fish Behaviour.

5. RECOMMENDATIONS

The Working Group accepted an invitation from Mr R Fonteyne to meet in Ostend. Topics for special subjects, symposia and study groups were discussed and the following recommendations made:

1. The Working Group on Fishing Technology and Fish Behaviour (Convenor: Mr B van Marlen) recommends that the next meeting should be held in Ostend from 18-20 April 1988, possibly in conjunction with the Fisheries Acoustics, Science and Technology Working Group to consider in particular:
 - a) size and species selectivity of fishing gear with particular reference to fish stock surveys and methods of quantifying effects of fish behaviour on gear performance.
 - b) engineering aspects of working conditions on fishing vessels.
2. The Working Group recommends that a symposium on "Fish (animal) Behaviour in Relation to Fishing Operations" should be held in 1991 with Professor S Olsen as convenor at a venue to be decided. A scientific steering group consisting of Messrs D MacLennan, C Nedelec and B van Marlen will be established to assist the convenor in planning the symposium.
3. The Working Group notes that the Marine Institute (Newfoundland) has proposed an international symposium on "Fishing Gear and Fishing Vessel Design" to be held in October 1988. Having regard to the significant advances being made in fishing technology and the length of time since any similar symposium, the Working Group supports this proposal. It is therefore recommended that the Fish Capture Committee should consider whether ICES sponsorship of this event would be appropriate.
4. The Working Group notes the increasing use of computer aided design techniques for fishing gears in several countries and the need for more detailed specifications of survey gears to maintain international standards. The Working Group considers that the introduction of a standard method of drawing net designs is highly desirable.

The Working Group therefore recommends that a Study Group be formed with the following terms of reference:

- a) to review the draft ISO standard 3169 on net drawing and current practices in net design and manufacture, paying particular attention to computer aided design conventions.
- b) To recommend an international standard for drafting net plans.

The Study Group should meet in Ostend on 20-21 April 1988 immediately after the Fishing Technology and Fish Behaviour Working Group meeting, with Mr B van Marlen as Convenor and other membership to be decided.