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Report of Activities

# FISH CAPTURE COMMITTEE

by

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1993

**FOREWORD**

This Report of Activities for the year 1993 was compiled of the inputs from fifteen countries with members in the Fish Capture Committee. Selectivity remained the dominant study area in the field of gear research . Although the measurement of selection parameters continued for a variety of gears and species, more attention was directed towards species selectivity. Survival experiments are closely linked to selectivity studies. The aim is to gain more knowledge of the unaccounted mortalities associated with the fishing processes and their impact on stock assessment and the ecosystem. The investigations also aim at identifying and correcting the damaging mechanisms of fishing gears. Fisheries acoustics played an important role in the activities of many research institutes. Acoustic surveys and the analysis of data remains the primary task. Fundamental hydroacoustic research is carried out by several laboratories. The research covers many items of which target-strength measurement, classification and identification of fish schools and improvement of equipment and instrumentation are among the most important ones. Apart from the selectivity and survival studies, a limited number of environmental aspects of fishing gears have been investigated. Some initial work has been done on the prevention of catching marine mammals by pelagic trawls and seabirds by marine setnets. One laboratory studied the physical impact of beam trawls.
Next to these items fish capture research also involved:
- improvement of survey gear and methodology,
- deep water fishing,
- fish behaviour in relation to fishing techniques,
- computer assisted techniques for gear design and simulation,
- fishing gear model and full-scale relationship,
- fishing effort in relation to vessel and fishing gear parameters and performance,
- vessel technology and deck and fish handling equipment, work environment and safety.

An increasing number of research projects is carried out in cooperation between different institutes. This trend is greatly enhanced by the research programmes of the European Union.

# BELGIUM

(R. Fonteyne and H. Polet)

## GENERAL GEAR RESEARCH

General gear research aimed at the development of efficient fishing gear from a technical, biological and economical point of view. As a consequence this research is carried out in close cooperation with the fishing industry. The types of gears involved were semi-pelagic and high opening bottom trawls. The technical performance of a shrimp beam trawl with larger meshes in the top panel was compared with the traditional shrimp beam trawl.

Within the framework of a project sponsored by the Flemish Government twin trawls were tested in the *Nephrops* fisheries. The nets of Danish design have been used on the Outer Silver Pit, a traditional *Nephrops* fishing ground for the Belgian fishery. Attention was paid to the catchability and handling of the new gear, as well as to the measurement of the geometrical configuration and the fuel consumption.

In cooperation with IFREMER, model tests on six traditional Belgian fishing gears were continued in the flume tank in Boulogne. The aim is to find possibilities for improvement in both gear design and rigging and to provide material (models and video tapes) for demonstration. Also these experiments are carried out in close cooperation with the industry.

## FISHING EFFORT

The joint EC AIR research project "Investigation of the relative fishing effort exerted by towed demersal gears on North Sea human consumption species" was continued. This project deals with the relative fishing effort in relation to vessel and fishing gear parameters and performance. The project is carried out in collaboration with DIFTA (Hirtshals), the Marine Laboratory (SOAFD, Aberdeen) and the Seafish Industry Authority (Hull). Based on the analysis of the 1991 catch and effort data, the significant Belgian sub-fleets were identified. By means of an inquiry amongst skippers data were obtained on gear parameters. A first series of historic catch data (1989-1991) was analyzed. Gear performance trials on board representative beam trawlers were started.

## SELECTIVITY STUDIES

The development of a species selective beam trawl, with special emphasis on a substantial decrease of young roundfish discards while maintaining the level of flatfish catches, was the subject for the EC "FAR" research project "Improved selectivity in the North Sea Fishery - Beam Trawling". This project has been carried out in collaboration with the Netherlands Institute for Fishery Investigations (RIVO, IJmuiden) and the Seafish Industry Authority (Hull). The selective devices consisted of a complete square mesh top panel, a large escape opening in the top panel just behind the beam, a square mesh window in the aft net and of combinations of these devices. Good results were obtained in releasing haddock and whiting, but for cod the results were not yet consistent. No meaningful losses in flatfish catches were noted. The study has been completed with a financial evaluation of the selective gears, showing only a marginal decrease in returns.

A follow-on project "Optimisation of a species selective beam trawl" has been started in the framework of the European AIR-program. With again RIVO and Seafish as partners, the species selective beam trawls developed earlier will be optimized and tested on a larger range of vessels. There will also a closer collaboration with the fishing industry. So far model tests on improved designs have been carried out in the Seafish flume tank in Hull.

A first series of experiments has been carried out on the influence of towing speed on the by-catch of roundfish and the codend selectivity of a 4 m beam trawl. Codend covers with hoops of different designs were tested but appeared not to be able to withstand the harsh conditions in beam trawling.

An EC financed project on the selectivity of traditional Belgian *Nephrops* trawls and discarding practices in this fishery was finished. Together with the selectivity parameters of a 70 mm and a 80 mm codend the effects of the application of a square mesh window were investigated. The codend selectivity curves for *Nephrops* varied widely, with most of the variability attributable to the weather conditions. The 80 mm codend made of double yarn polyethylene netting proved to be less selective than the 70 mm polyamide single yarn codend. There was no strong evidence that *Nephrops* escape through the square mesh window but extra escapes for whiting included mainly marketable fish.

Cooperation has been given to the FTFB-subgroup dealing with the design, performance and analysis of selectivity experiments.

## TECHNICAL/ECOLOGICAL ASPECTS OF TRAWLING

The EC FAR project "Environmental impact of bottom gears on benthic fauna in relation to natural resources management and protection of the North Sea" was finished. This project was carried out in collaboration with institutes from the Netherlands, Germany and the UK. On the research vessel BELGICA the tracks of a 4 m beam trawl were studied by means of side scan sonar techniques and *in situ* inspection by divers. The pressure exerted by the sole plate of the beam trawl on the bottom was measured. For this purpose an instrumented beam trawl head has been developed. The pressure of the trawl heads on the sea bottom measured varied between 1.7 and 3.1 $N/cm^2$, depending on the towing speed. Under normal commercial fishing conditions the maximum pressure of a 4 m beam trawl will be about 2 $N/cm^2$. At the same time changes in the benthos population due to fishing operations as well as survival of the organisms caught were studied by the Dutch institute NIOO_CEMO.

# CANADA

(S.J. Walsh)

Canadian researchers have been involved in a variety of activities related to the fish capture process. Here is a list of activities, the institute involved and a contact person.

**Survey Fishing Gear Technology Project**

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Research is focusing on the standardization of procurement, construction, and repairs of all 3 groundfish survey gears used at the institute. All groundfish survey trawls and components are now subjected to a rigorous Quality Control (QC) inspection prior to acceptance from the manufacturer. Prospective suppliers are required to meet pre-defined tolerances levels on critical dimensions and specifications, where required parts are tested for conformity using the institute developed protocols. This program has greatly increased the quality and consistency of gear supplied to the department. While administered by NCSP Fishing Gear Technology inspections are performed by the Marine Institute under contract.

Work is progressing on assessing survey gear requirements for the new research vessel. Calibration focused on a comparison of the standard survey trawl, Engel 145 otter trawl, rigged with a rockhopper with the Campelen 1800 shrimp trawl equipped with the same size rockhopper gear. This involved considerable flume tank testing of models (at the Marine Institute), underwater cameras and acoustic trawl mensuration. Testing was carried out on a 17 day cruise, January/February 1994. Initial work was also carried out in designing and testing a restrictor rope attached ahead of the trawl doors to achieve constant swept area.

During the past year 12 Research Vessel surveys were instrumented with SCANMAR hydroacoustic instrumentation. Mobilization, testing and sensor calibration services were provided before each trip. A full back-up system and spare mounting hardware was provided for each mission. The data logger aboard R.V. Wilfried Templeman has been upgraded in speed and now performs automated tape back-ups of data. Specialized edit

criteria has been developed to clean SCANMAR survey trawl data of acoustic noise and system specific error codes through a contract with SEACONSULT Ltd, St. John's. A data atlas describing gear and vessel performance during each survey set has been produced for all groundfish surveys in the SCANMAR database. The data atlas merges set details with a statistical summary of all logged variables and a graphical plot of SCANMAR output to present a "first look" guide to the data and its quality, one set per page. While RoxAnn seabed classification data continues to be collected little progress has been made in calibration.

A underwater low light (ISIT) camera system has been tested for the study of trawl performance and fish behaviour. Comprised of two camera's (ISIT and CCD technology deployed separately) tethered to a programmable video recorder, pressure rated lights and batteries and a mounting frame the system is designed to be trawl deployed. Initial deployment and retrieval trials were carried out on the R.V. Shamook and R.V. W. Templeman.

The institute is an active member of Atlantic Canada's Survey Trawl Mensuration Working Group. During the past year this group has been active in developing protocols used in calibration of SCANMAR acoustic sensors. The Working Group conducted 5 days of experimental testing at the Canadian Defense Research Establishment Atlantic hydroacoustic test facility in Nova Scotia. Results are to be published later this year.

## Commercial Fishing Selectivity Programs

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## DEEP WATER TRAWLING/ EXPLORATORY FISHERIES ON WEST COAST SEAMOUNTS

With traditional stocks under constant pressure, the need for larger trawlers to diversify operations into deeper waters has become a priority in the Pacific Fishery. However, the sector must establish the potential of deep water species to support a fishery and develop the capability to harvest fish in this difficult environment. Expansion into deep water provides new economic opportunities for large operators, at the same time reducing harvesting pressure on traditional species.

Commercial resources surveys (10-day trips) were conducted on seamounts in deep water off the British Columbia coast in May 1993 (Report available). This initial survey shows excellent support potential for commercial fishing of non-traditional resources. The results of the first phase were used as the basis for an opportunity to assess the commercial potential of a move to deep water.

Proposals have now been put forward to the Science Council of British Columbia for project funding to develop the fishery on a commercial basis. Preliminary discussions with Science Council representatives have been positive, and a decision regarding support is expected by the end of March. Due to the fact that this fishery is new and commercially viable, industry on the west coast is very enthusiastic of this initiative, as potential benefits include: additional new stocks of renewable high value deep water fish species; reduced pressure on existing fishing grounds; and expended export product to meet a rising global food demand; and, economic benefits to Canada and Canadians.

## HALIBUT BY-CATCH IN GROUNDFISH FISHERIES

The purpose of this project is to reduce or eliminate halibut by-catch in trawls through the use of horizontal separator panels or semi pelagic nets (Report available).

The horizontal panel was used to indicate whether halibut enter into the upper or lower half of the trawl net and whether it would be possible to deflect them into a specific section.Other benefits derived from this experiment included information on how fish swim into the net and whether there is any sorting of species within the net. Testing took place in March, 1993. Results indicate that the trawl net was effectively split horizontally by the experimental panel. Two codends (upper and lower) retained fish as they entered either the bottom half of the net. Approximately 70 to 80 percent of the catch, mainly pacific cod and flatfish (halibut, sole) species entered the bottom half of the trawl and were retained in the lower codend. Species composition in the two codends were nearly identical, however, catch rates were low.

As well, video recordings showed avoidance behaviour differed among species. In general, cod moved laterally in front of the net while flatfish species tended to keep moving forward in front of the footrope until they seemed exhausted and were either captured by the net or passed underneath it.

A second phase, using a horizontal panel and a combination of grates, has recently been completed and the project data is being analyzed.

LAKE ERIE: SELECTIVITY TRIALS

The purpose of this experiment were to analyze the utility of a selectivity grate and a square mesh panel in the fresh water fishery of the Great Lakes.

This experiment was conducted by the Department of Fisheries and Oceans (DFO), in association with the Ontario Fish Producers Association (OFPA), and the Ontario Ministries of Natural Resources and Industry, and Trade and Technology in 1992. It was a two-phased experiment to evaluate the utility of a Nordmore Grate and square mesh panels in mobile gear (Report available). The target species for the first phase of the project was smelt. Results indicate that without the Grate, by-catch levels were very high. With the Grate, virtually the entire catch was smelt. There was, however, some loss of smelt, but a 95% screening rate for alewife and an almost 100% screening of by-catch overall.

The second phase of the project saw a 3 3/4 inch square mesh panel inserted into the trawl. Again, results were promising as the catch contained larger, more uniform fish.

The positive results indicate that the selectivity grate and the square mesh panels are economically and technically feasible ways in which responsible fishing can become a reality in the Great Lakes of Canada.

NORTHERN SHRIMP: MESH SIZE SELECTIVITY EXPERIMENT

The purpose of the experiment was to develop effective methods of preventing the by-catch of industrial (small) shrimp and of other (non-target) species, without incurring unacceptable losses of market-sized shrimp and associated revenues.

This project was conducted on a pan-Atlantic basis and was designed to reduce the ratio of industrial shrimp in the catch without incurring a loss of larger shrimp. Codends constructed of mesh larger than Canada's regulation size (40 mm) have been tried elsewhere, and there was much interest in the new 55 mm codend mesh regulation introduced in April 1993 in Greenland. The objective of this experiment was to investigate, under commercial conditions, the selectivity characteristics and catch implications of codends constructed with mesh sizes of 45, 50, and 55 mm.

Results indicate that there was very little difference recorded in the catches of shrimp (amount or size) taken by the 45, 50, and 55 mm codends compared to the control codend. Analysis of the combined tows carried out in daylight and darkness, or in a specific location, show only slight differences in selectivity between the three mesh sizes. A separate

commercial assessment of production results, using data taken from those tows where commercial catch rates were obtained, showed that the impact on production of increasing mesh size from 45 mm to 55 mm in the codend is minimal.

Calculated catch value differences from each of the codends proved insignificant compared with vessel costs and total catch revenues. Variations arising from factory deck production decisions to meet market or other needs has a very large effect in comparison to the small changes which result from the use of 45, 50 or 55 mm codends.

## Newfoundland Commercial Selectivity Program

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An eel fyke net selectivity project was conducted from four locations. A 127 mm rubber band was placed around the guiding funnel in each fyke net, stretched tight to close off the funnel and tied. Catches with the rubber band were compared to the catches when the rubber band was removed. The results indicate that the rubber band significantly reduces the proportion of the by-catch that enters the end of the fyke net and it increases the proportion of the by-catch that remains in the forward section of the net, where the probability of survival is generally higher. Overall, it appears that the rubber band, as a by-catch reduction device is effective.

A cod trap selectivity project was carried out during the summer of 1993. Two modified Newfoundland cod traps, two long shore cod traps and a small mesh control trap were monitored for 30 fishing days. The results indicate that increasing the mesh size in the drying twine from 92 mm to 102 mm will reduce the amount of small cod retained. Only 3.2% of the fish caught in the cod traps with 102 mm mesh in the drying twine were 41 cm or under while the traps with 92 mm mesh size in the drying twine retained 21.5% small fish (41 cm or under). The mean length of cod retained in the traps with the larger mesh drying twine was approximately 3 cm greater than the mean length of cod retained in the traps with the smaller mesh drying twine. Selectivity curves developed clearly demonstrated that the traps with the 102 mm drying twine retained fewer small fish with no increase in the loss of larger fish.

Commercial fishing trials for Iceland scallops (Chlamys islandicus) were undertaken over a wide area of the Grand Banks. Twelve inshore vessels ranging from 13 to 20 meters

participated on an intermittent basis. Landings amounted 1.1 million pounds (round weight). It is anticipated that approximately 20 inshore vessels will fish the area in 1994.

To assess lastridge rope hanging ratios an otter trawl selectivity was carried out from a 16.6 meter commercial fishing vessel for a 17 fishing days. The primary objective of the project was to test the effectiveness of shortened lastridge rope on otter trawls as a method to reduce the catch of small (<41 cm) cod. A standard 300 mesh otter trawl was modified by installing a 40 mm vertical panel which extended from the centre of the headrope and footrope back to a trouser codend. For three phases of the experiment, one leg had 130 mm mesh with lastridge rope hung at 72%, 80%, or 85%, while the other leg had a 141 mm mesh with a 43 mm mesh liner. The fourth phase compared a 130 mm mesh with lastridge ropes hung at 80% to the 141 mm mesh counterpart of a twin codend. The codend with lastridge ropes hung at 72% had the lowest percentage of small fish (1%) and the shortest selection range (5.6 cm). Lastridge ropes hung at 80% had an average of 3% small fish, and a selection range of 7.6 cm. Ropes hung at 85% had an average of 4% small fish, and a selection range of 7.3 cm. The 142 mm mash without lastridge ropes retained 8% small fish. An underwater video camera was used to observe the trawl with lastridge ropes hung at 72% and 80%. Small fish were observed escaping through the meshes with little difficulty.

A cod/plaice separator trawl project was carried out during two 10-day fishing trips to 3NO in June and December, 1993. A traditional flounder trawl was modified to accommodate Nordmore grates with horizontal and vertical bar spacings of 51 mm to 203 mm. A retainer bag was placed over the fish outlet to measure escapement.The most positive results were obtained with the 127 mm bar spacing; 88% of the cod were excluded with a combined plaice and yellowtail loss of 8%. Following trip #1 industry outfitted twenty vessels with these grates and continued using them until the year end. Reports of grate performance have been mostly positive with a significant decrease in cod by-catch.

Nordmore grates with bar spacings of 22 mm, 25 mm, and 28 mm were tested during 54 fishing days on a northern shrimp trawler from January to March, 1993. Direct comparisons of a commercial shrimp trawl and a experimental trawl with the Nordmore grates were made. The 22 mm grate was also tested using a retainer bag over the fish outlet to measure shrimp loss. Results indicated a significant reduction in all by-catches, especially cod and redfish. When the retainer bag was used two out of 14 sets produced shrimp losses of 35% and 43%. These coincided with a severe reduction in grate angle as indicated by Scanmar sensors. Shrimp trawlers fishing northern shrimps are now required to use Nordmore grates with bar spacings of 28 mm or larger. Some fishermen use the grate at

all times and report that, in addition to groundfish reduction; it works well as a groundshark excluder.

**Newfoundland Dept. Fisheries Fishing Gear Research**

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Sea trials using a mid-water trawl configured to fish as a semi-pelagic trawl were conducted to determine if the by-catch of cod usually encountered during the redfish fishery could be reduced to an acceptable level. An aggregate of 38 sets were made with a total of 229,816 pounds of redfish and 8,4848 pounds of cod resulting in less than 4% by-catch of cod.

Most of the vessels owners involved in this fishery could not afford to convert to mid-water trawling or their vessels were under powered. A standard ground trawl was rigged the same as a semi-pelagic trawl and used successfully to harvest redfish without the usual by-catch of cod.

Successful sea trials using the above mentioned method of rigging a shrimp ground trawl (for fishing shrimp) were conducted in an effort to reduce the damage to the trawl when fishing shrimp on very rough and bottom conditions.

A study of cod traps was under taken by the Canadian Centre for Fisheries Innovation under contract to the Department of Fisheries. The purpose of the study is to provide a comprehensive description, analysis and projections related to the cod trap fishery in Newfoundland. The study will estimate the impact, under various scenarios of regulation, operation and stock condition, on the long term conservation and growth of the resources as well as the socio/economic effect on fishing enterprises.

Exploratory fishing survey for spiny crab were conducted in the areas of Ramea and Hermitage to determine if they were in sufficient quantities to support a commercial fishery in each area. The final report is currently being compiled.

## Scotia-Fundy Region Selectivity Research

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Silver Hake Separator Grate

Further experiments were completed on using grates to separate silver hake from haddock and pollock. Three grate spacings were examined (40 mm vert. 50 mm vert. 40mm horiz.) The results showed that for the current populations the 40 mm grate was best. 90-95% of the CHP could be released with less than 5% loss of silver hake. The grate is now mandatory for all vessels fishing silver hake.

## Quebec Region Selectivity Research

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Research in the Quebec region was mainly dedicated to exhaustive testing of cod selectivity using lateral lastridge ropes in the mobile gear fleets. on the trawlers this technology performed better than that found from increasing mesh size. The number of juvenile cod retained was 14% in number regardless of the catch composition, which varied from 50 to 500 kg per hour. However, on Scottish seiners the results were not as clear. With high catch rates the selection performance was similar to that derived from the trawlers.

# DENMARK

(D. Wileman)

## DANISH INSTITUTE FOR FISHERIES TECHNOLOGY AND AQUACULTURE (DIFTA)

**Selectivity in Nephrops Trawls**

Three CEC funded experiments were carried out on a 775 HP Danish commercial trawler operating in the Skagerrak IIIa and North Sea IVa measuring selectivity parameters for nephrops and the principal bycatch species Haddock and Whiting.
Experiments were made with a 110 mm trawl body as used in combined fish/nephrops fisheries and an 80 mm trawl body (of equal dimensions) as used in directed nephrops fisheries. A twin trawl system was used.

Attempts were made to measure whole trawl selectivity by comparing catches in the commercial trawls with those of a 40 mm small mesh trawl of equal dimensions. The small mesh trawl repeatedly filled up with mud and only 1 valid haul was given with the 80 mm trawl and 70 mm codend where the selection factor was 0,78. It was however possible to produce selection curves describing whole trawl selectivity of the 110 mm trawl with the 80 mm trawl as reference showing that there was substantial nephrops selection in the main trawl body.

Codend selectivity parameters were determined using the hooped covered codend technique for a matrix of 3 different mesh sizes 70.85 and 100 mm and 3 different codend circumstances 7, 8.5 and 10 m. For the smallest mesh size and circumference 100 open meshes x 70 mm the selection factors obtained were nephrops 0,39, whiting 4,0 and haddock 3,4 with a decreasing trend as circumference is increased.

The final experiment compared the codend selectivity parameters for a standard 110 mm trawl with 70 mm inside mesh extension piece and codend against those of an identical trawl fitted with a 90 mm square mesh panel in the extension. Hooped codend covers were used. The measured selection factors were

| | Standard | Square mesh panel |
|---|---|---|
| Nephrops | 0.5 | 0.52 |
| Whiting | 4.2 | 4.7 |
| Haddock | 3.4 | 3.7 |
| Cod | 3.4 | 4.0 |

**Selectivity in Demersal Roundfish Trawls**
Codend selectivity parameters for haddock and whiting were measured on a Scottish trawler of 550 HP as part of a joint FAR Project investigating the survival of escaping fish carried out together with SOAFD Marine Laboratory, Aberdeen. The hooped covered codend technique was used and codend mesh sizes of 70 mm, 90 mm, 100 mm and 110 mm. Selection factors were in the range 2.9 to 3.2 for haddock and 3.1 to 3.4 for whiting. Fish girths and lengths were measured and selectivity parameters also evaluated in terms of girth then related to length. There was no significance difference in the results compared to relating directly to measured length.

**Codend Mesh Size and Square Mesh Window Experiments in Deep-water Shrimp (Pandalus Borealis) Fisheries**
Comparative fishing experiments were made on 2 Danish commercial shrimp trawlers of 455 HP towing 2 trawl systems at Fladen Ground. Codend mesh sizes of 35 mm and 40 mm were compared with and without a 90 mm square mesh panel. Increasing mesh size to 40 mm gave 8-9 % loss in shrimp catch with only 4% reduction in bycatch. Insertion of the panel gave 34% less bycatch. Use of the panel gave significant reduction in haddock and whiting catch whereas use of 40 mm codends did not.

**Mesh Size Experiments on Baltic Cod**
Comparative fishing experiments were carried out in Baltic sub-areas 22, 24 and 25 on 3 commercial trawlers of 175, 290 and 549 HP using twin trawl systems with codend mesh sizes of 105, 120 and 130 mm and 4 gill net vessels using mesh sizes of 105, 110, 120 and 130 mm. Effect on landed cod and discarded cod catch rates and on cod catch length distribution were measured.

The gill net vessels were found to catch cod in a relatively narrow length band either side of an ideal wedging length which increased from 45 cm at 105 mm mesh size to 55 cm at 130 mm mesh size. Catch of discarded cod was small and did not decrease with increasing mesh size.

For the trawlers the larger mesh sizes gave substantial reduction to the catch of discarded cod of 60% to 90% but overall discard rates for the 105 mm trawl were often low between 1% and 20% for the different trips. Reductions in landed cod catch of 20% to 60% were given. Increased codend mesh size had most effect on cod in the length range 30 to 45 cm.

**Alternative North Sea Cod Management Strategies**
In partnership with DIFMAR, Charlottenlund, experiments were carried out on board 4 commercial Anchor Seiners and 4 Gill

netters. Each vessel was used for 2 periods. In one it fished under a conventional cod kg quota allocation using normal mesh sizes. In the other it fished under a special number of individual fish quota and was encouraged to use large mesh sizes. The effect on catch and discard rates and catch fish length composition was measured.

**Species Selective Whiting Trawl**
A joint FAR project carried out together with SEAFISH, Hull, was concluded. A trawl was developed where a codend extension piece was inserted which split the trawl into an upper and lower compartment. Access to the upper compartment was gained via a 90 mm square mesh panel and led to a 70 mm whiting codend. The lower codend was 100 mm designed for haddock, cod and flatfish. Trials were carried out on a 550 HP Scottish twin rig trawler. An average separation of 53% of whiting to the upper codend but only 19% of the haddock was achieved. Compared to a standard 100 mm trawl marketable whiting catch was increased by a factor of 4 but catch of undersized haddock was increased by a factor of 3. Separation of cod and flatfish was close to 100% The trawl would be suitable for directed fishing on whiting provided there is not a high proportion of small haddock in the fish population.

**Fishing Effort**
A 3 year CEC AIR project carried out in partnership with SOAFD Marine Laboratory (Scotland), SEAFISH (England), RVZ (Belgium) and DIFMAR was initiated. Fleets targeting demersal roundfish and flatfish with towed gears in ICES IVb and IVc are being studied. Sub-fleets of vessels in a given horsepower range using the same type of gear have been identified and their gear design characteristics analyzed. Sea trials on representative vessels are being carried out to measure gear swept areas and volumes and towing resistance. The relationship between fleet catch rates, gear performance parameters, gear design parameters and vessel parameters will be examined.

**Development of Fuel Saving Demersal Trawls**
This is a CEC FAR Project carried out in partnership with IRPEM (Italy). Engineering trials have been performed on 2 experimental and 2 traditional trawls used in the Danish and the Italian demersal fishing. The objective of the project is to develop more fuel efficient trawls by

. Using new design principles.
. Utilising greater mesh sizes.
. Implementation of new netting materials of high strength and low diameter.

The trials show that a reduction in towing resistance can be

achieved, even when increasing vertical openings, when the above options are implemented in the design of demersal trawls.

The fishing efficiency of the experimental trawls will be tested in 1994 on board commercial vessels.

**Model Full Scale Relationships**
An EC funded FAR research project for analysis of the model to full scale relationships in fishing gear has been completed. The work has been carried out together with RIVO (Holland) and SOAFD Marine Laboratory (Scotland). Engineering trials have been made on a pelagic trawl in varying scale ratios from full scale down to scale 1:40. The test data shows that the Froude scaling normally used when estimating the model speed gives too high model speeds. Regression made on the test data gives as result:

$$V_{model} = V_{full\ scale} * (\text{Scale ratio})^{0.6}$$

when the twine area is scaled by the linear scale squared and the external forces are scaled by the linear scale ratio lifted to the third power.

**Development of a Computer Assisted Trawl Simulation System**
A computer program for simulation of trawl performance has been developed together with IFREMER (France) in a CEC FAR project. A prototype version suitable for demonstration of the systems capabilities is implemented on a personal computer.
The results from the computer program have been compared to results from flume tank tests performed on both pelagic and demersal trawls. The development of the man-machine interface will be continued in 1994.

**GREENLAND FISHERIES RESEARCH INSTITUTE**

**1. Alternate Hauls Experiment**
During 16 - 30 August 1993 16 alternate hauls with two shrimp trawl gear were carried out by R/V Pamiut in NAFO Divisions 1BC as part of a standard survey for shrimp and fish by Greenland Fisheries Research Institute. A 45 mm diamond mesh codend was compared to a 20 mm diamond mesh codend in a " SkjervÝy 3000/20" trawl equipped with Perfect doors, weight 2200 kg. The results are expected to be presented at the April 1994 FTFB meeting in Montpellier.

## 2. Experiments with Grid Devices and Mesh Selection in a Shrimp Trawl

During 5 - 12 September 33 hauls were carried out by R/V Pamiut with a SkjervÝy 3000/20 shrimp trawl with the following riggings:

a) "trouser codend" trawl: 45 mm square mesh versus 20 mm diamond mesh,

b) "trouser codend" trawl: 55 mm square mesh versus 20 mm diamond mesh,

c) "trouser codend" trawl: 55 mm diamond mesh versus 20 mm diamond mesh,

d) grid device: a grid divided in two parts, 12 mm and 25 mm bar distance allowing larger fish and other larger items to escape after passage over two grids, were mounted with collecting bags behind all three openings.

The experiment is part of a project financed by Nordic Minister Council with Greenland, Iceland, Faroes, Norway, Sweden and Denmark as participants. It is planned to present results from the experiment at the FTFB meeting in Montpellier in April.

# FAROE ISLANDS

(J. A. Jacobsen)

## FISH TECHNOLOGY

In July 1993 the second and final survey to study the survival of saithe (*Pollachius virens* L) escaping through 145 mm trawl meshes was undertaken. The investigations were founded by *The Nordic Minister Council*. The goal is to estimate the percentage of saithe that survive after escaping through the cod-end meshes at bottom. The results in 1992 indicated a survival of approximately 93% and this years result gave a survival estimate of nearly 100% The combined results of the experiments indicate that more than 95% of the escaped saithe survive the contact with the trawl. In addition estimates of *Sebastes viviparus* indicate a very high survival percentage. The results are reported in a Nordic Minister Council publication.

During 1993 experimental trawling in deep water (500-1500 m) continued in the southern Faroese water, on Hatton Bank and on Reykjanesridge. The target species to investigate was orange roughy as well as other deep water species as grenadiers, smooth-head fish, black scabbard fish and sharks. The results of this research will be reported in 1994.

## ACOUSTICS

One blue whiting survey was made in spring 1993. The southern part of the Faroese EEZ was surveyed to investigate the migrating postspawning blue whiting on its way northwards in relation to sea temperature. The recorded abundance in the area was less than in the two previous years, most likely this is due to the mismatch in the timing of the survey and the period of the main postspawning migration of blue whiting this year. The 1989 year-class is still dominating in the biomass. The results were reported to the ICES Blue Whiting Assessment Working Group in 1993.

# FINLAND

(P. Suuronen and E. Lehtonen)

Several experiments were carried out in the northern Baltic Sea proper (ICES SD 29 N) to study the escape behaviour and survival of Baltic herring escaping from a diamond mesh codend and through the rigid sorting grid devices. The escapees were captured into a small-meshed netting cage which was released from the trawl and then transferred into a holding cage where the fish were withheld for two weeks. The recent results confirm the high mortality of juvenile herring escaped from the codend. Main part of herring seem to die regardless the mesh-size and modification of the trawl. The mesh-size of codend or the shape of meshes won't affect on the survival of herring. The possibilities to increase the survival of herring escaped from the codend seem to be fairly restricted in practise. The construction of the rear part of the trawl belly and the codend design should be remarkably changed to attain better survival results !

The selectivity and survival experiments on vendace (Coregonus albula L.) escaping through the codend of a pelagic trawl were continued in Lake Puulavesi. The survival of juvenile vendace varies in different circumstances. The affecting factors are for example the fish size in relation to mesh size of the codend, catching moment, towing speed and the water temperature. Some preliminary tests with rigid sorting grid devices were also conducted.

The catching performance of a small meshed and large meshed wing-netting of an under-ice winter seine were compared with help of a three-winged seine and sonar observations. The small meshed section turned out to catch more effectively than the large meshed one.

The new design of a trap net for salmon with large, four-cornered bag net (bar length 35 mm) was under construction. The aim of the study is to clarify the possibilities to ease the examining the trap net and to keep the salmons alive possible long periods (Especially the undersized individuals to be released back to the sea).

Migratory whitefish were tagged with ultrasound tags. The behaviour of the fish near trap net fishing gears was observed with an automated hydrophone system placed in a vessel. The movements of the tagged fish was estimated on the basis of one hydrophone only. The system will be completed with a second hydrophone. The whitefish followed the leader arm of a trap net swimming back and forth. The results of the primary expe-

riments proved that the movements of whitefish in the vicinity of standing gear on open coast can be monitored with ultrasound tagging. Small tags suitable for under 1 kg fish were also introduced.

Testing of the effect of the simulated winter conditions on the breaking strength of the materials was continued. Freezing and thawing in general did not weaken the netting. On the contrary, some of the samples examined gained strength. However, all the nets that were made of nylon multifilament yarns showed decreased strength after exposition when testing was made in frozen state. The analysis is to be continued.

# FRANCE

(G. Massart)

## I - TECHNIQUES DE CAPTURE

### 1.1 - Chaluts et apparaux associés

#### 1.1.1 - Conception des chaluts assistée par ordinateur

Le projet mené par l'IFREMER en collaboration avec le Danish Institute for Fisheries Technology and Aquaculture et le Danish Maritime Institute (programme FAR) est en principe achevé. La représentation des chaluts pélagiques et de fond est correcte (écart entre valeurs mesurées en bassin et valeurs calculées des dimensions et des tensions le plus souvent de l'ordre de 10 %). Les vérifications sont faites en comparant les résultats des calculs aux mesures faites en bassin (à Hirtshals) sur des modèles de grande taille.

Pour maintenir le temps de calcul dans des limites acceptables, il faut simplifier la description du chalut en diminuant le nombre de mailles. Cette diminution est faite en remplaçant plusieurs mailles adjacentes par une maille hydrodynamiquement équivalente (côté de maille plus grand, diamètre de fil plus fort, même coefficient de filtration), sans changer les dimensions des pièces de filet.

Pour éviter ces successions de calculs nous avons développé un mailleur automatique qui autorise des taux de réduction du nombre de mailles très importants, et nous avons vérifié que ce mailleur n'introduisait pas d'erreur dans la représentation du chalut. Pour cela, nous avons comparé les mesures faites en mer (ouvertures et tensions de funes) sur un chalut de fond (GOV) et un chalut pélagique à grandes mailles. La représentation est très bonne dans le cas du chalut de fond (écarts là encore de l'ordre de 10 %), et cela prouve que le calcul accepte un taux de réduction du nombre de mailles très important sans perdre de sa validité. Par contre, la représentation est devenue impossible dans le cas du chalut pélagique à grandes mailles, le maintien de la forme générale des mailles et le raccordement correct entre zones de maillages différents n'étant plus possible simultanément.

Nous étudions donc maintenant un autre mailleur automatique.

## 1.1.2 - Travaux sur la sélectivité des chaluts

- Sélectivité des chaluts à baudroie

La baudroie est essentiellement capturée dans une pêcherie multispécifique dirigée à la fois sur la baudroie, la cardine, le merlu et les raies et pratiquée avec un chalut dont le maillage, adapté au merlu, entraîne la capture de juvéniles de baudroies. Une simple augmentation du maillage, en faisant perdre trop de captures accessoires intéressantes, serait inacceptable, nous avons donc essayé de séparer les baudroies des autres poissons dans un chalut à deux poches grâce à une grille. Nous avons essayé des grilles à barreaux horizontaux et des grilles à barreaux verticaux, pour analyser la séparation par la taille et par le comportement.

Pour le moment, le système le plus efficace pour protéger la baudroie entraîne la perte de trop de merlus pour être acceptable et les travaux devront continuer en 1994.

- Influence de la vitesse de remorquage sur la sélectivité des chaluts.

Nous avons tenté de mettre en évidence une influence de la vitesse de chalutage (donc une variation de tension dans les mailles et dans leur résistance à l'ouverture) sur la sélectivité d'un chalut utilisé pour la pêche au merlu. Pour une variation de vitesse de 2, 5 noeuds à 4 noeuds, nous n'avons pas pu constater d'influence significative sur la sélectivité des chaluts.

## 1.1.3 - Instrumentation et équipement des chaluts et filets droits

Les capteurs autonomes à mémoire et horloge interne capables de stocker des informations acquises in situ sur les engins de capture (capteurs d'efforts, capteurs d'immersion et de température, capteurs d'immersion différentiels) sont maintenant commercialisés par la Société MICREL (Hennebont, France).

Un capteur d'immersion modifié pour être déclenché automatiquement au-delà d'une immersion de 3 mètres et pour être inviolable sera prochainement proposé aux administrations et organismes professionnels chargés de contrôler le temps de pêche de certains engins (par exemple, en France, les dragues à coquilles St Jacques dont la pêche est très contrôlée et limitée dans le temps).

Le système télécommandé par voie acoustique de fermeture des culs de chalut, permettant l'identification de certaines détections et d'éviter les mélanges de capture ou de ne mettre

le chalut en pêche qu'à un moment déterminé avec précision, est maintenant opérationnel et commercialisé par la Société GENISEA (Toulon, France) .

## 1.2 - Etudes sur la sélectivité des filets maillants

Nous avons réalisé une étude bibliographique sur la sélectivité des filets maillants et un document sur l'analyse des méthodes de mesure sur la sélectivité des engins passifs.

Nous avons, en collaboration avec la Seafish Industry Authority et l'Université de Loughborough, participé à une étude sur la sélectivité des filets maillants et emmêlants utilisés en Manche Occidentale par les pêcheurs britanniques et français. Nous avons analysé les captures (par espèce et par taille) faites par les fileyeurs français, et essayé d'observer des filets droits en pêche par 100 m de fond au sonar latéral (mis en oeuvre par nos partenaires anglais) et avec notre engin remorqué d'observation des chaluts lors d'une campagne à bord du N/O GWEN DREZ menée conjointement avec un fileyeur anglais. Seul le sonar latéral a pu donner une image du filet, trop peu précise pour déterminer correctement sa position sur le fond. Cette campagne a permis d'identifier les difficultés d'observation de filets droits calés à une profondeur de l'ordre de 100 m ; une expérience menée quelques mois auparavant avec un ROV à ombilical mis en oeuvre depuis un navire ancré à proximité du filet n'avait pas donné de meilleurs résultats, la mobilité du ROV étant trop limitée par la traînée de son ombilical.

Une étude sur la sélectivité des filets maillants menée en collaboration avec la SFIA et le DIFTA (programme AIR II) du Sud de la Mer du Nord au Golfe de Gascogne reprendra les méthodologies mises au point lors de l'étude limitée menée en Manche Occidentale.

## 1.3 - Protection des mammifères marins

Après avoir participé à la préparation du projet ECHONET (programme AIR II) qui n'a pas été retenu par la CEE, nous avons participé à la préparation du projet CETASEL visant à prévenir les captures accidentelles de dauphins dans les chaluts pélagiques, proposé dans AIR III par le RIVO.

Nous avons également engagé une collaboration avec un laboratoire du VNIRO à Moscou pour analyser les connaissances disponibles en Russie sur le comportement des dauphins et tenter d'en tirer des voies de recherches sur les systèmes qui pourraient éloigner les dauphins des engins de pêche.

### 1.4 - Analyse de la pêche à la senne en Méditerranée

Dans le but d'améliorer l'efficacité du travail fait à bord des thoniers senneurs et de définir le cahier des charges d'une nouvelle génération de thoniers méditerranéens, nous avons réalisé plusieurs campagnes d'analyse des opérations et de contrôle des temps à bord des senneurs pêchant le thon rouge. En particulier, la mesure de la vitesse de chute de la senne et de la profondeur atteinte a apporté des informations fort différentes de ce qui était communément admis. La fermeture de la poche se fait à une profondeur plus faible que ce que l'on pensait, ce qui devrait permettre de revoir la conception de la senne pour la rendre moins onéreuse et plus facile à mettre en oeuvre.

## II - AMENAGEMENT DES NAVIRES

### 2.1 - Renouvellement de la flotte de recherche halieutique française

Le navire construit pour la recherche halieutique en Méditerranée vient d'entrer en service. Ce catamaran de 29,50 m et 940 CV, baptisé EUROPE, a fait la preuve de ses qualités marines lors de son transit d'Atlantique en Méditerranée en hiver, pendant lequel il a rencontré des conditions de mer extrêmement dures. Son aptitude au chalutage (point discuté pour un catamaran) s'est révélée très correcte puisqu'on a pu remorquer à 5,5 noeuds un chalut pélagique qui serait celui mis en oeuvre par un chalutier monocoque de 800 CV environ. (Soit un chalut de 111 m x 87 m et 115 m2 de surface de fil). Une autre qualité appréciée de ce navire est le silence de fonctionnement.

Ce navire, dont la construction a été subventionnée par la CEE, sera engagé pour une partie de son temps dans des programmes menés en collaboration avec des scientifiques des autres pays méditerranéens de l'Union Européenne.

D'autre part le remplaçant de l'actuel THALASSA est maintenant en construction. Long de 72 m, polyvalent, ce chalutier pêche arrière de recherche halieutique sera aussi un navire océanographique. Son équipement, en particulier acoustique, sera très complet et comportera les matériels récemment développés en France (sondeurs scientifiques OSSIAN, comportant le système d'écho-intégration MOVIES B, système acoustique de positionnement de chalut PACHA).

## 2.2 - Machine à trier le poisson pélagique

Une maquette de la machine de tri par analyse d'image a été essayée à terre; le système mis au point pour séparer les poissons et les présenter l'un après l'autre correctement alignés sous la caméra fonctionne de façon satisfaisante. Un prototype va être construit et essayé à la mer sur un chalutier du port de Sète pratiquant la pêche à l'anchois (la cadence de tri est de 3 poissons/seconde, la machine opérationnelle comportera 10 lignes en parallèle).

Un appareil reprenant la partie ''analyse d'image'' de la machine à trier a été construit pour assurer la mensuration automatique des poissons. Essayé à la mer sur la THALASSA, il a donné toute satisfaction (poissons présentés à la main sur le tapis d'alimentation, cadence environ 1 à 2 poissons/seconde, acquisition automatique de la mesure sur ordinateur, précision meilleure que le demi centimètre). Cet appareil sera commercialisé par la Société MICREL (Hennebont, France).

# III - ACOUSTIQUE SOUS-MARINE APPLIQUEE A LA PECHE

Contrairement aux travaux décrits précédemment, menés exclusivement par l'IFREMER en technologie des engins de capture, et menés à l'IFREMER avec le concours d'autres scientifiques français en ce qui concerne le renouvellement de la flotte de recherche, les travaux en acoustique sous-marine appliquée à la pêche sont menés pour partie par l'IFREMER et pour partie par l'ORSTOM, les deux organismes restant en contact étroit en particulier en ce qui concerne les aspects méthodologiques.

## 3.1 - Travaux menés à l'IFREMER

### 3.1.1 - Echo-intégration et classification des bancs

Le travail de classification des bancs à partir des paramètres géométriques et énergétiques des bancs déterminés grâce au logiciel MOVIES B se poursuit dans le cadre du projet BIOMASS (programme FAR). Les descripteurs classiques se révélant insuffisants pour assurer l'identification de bancs, une analyse spectrale de l'amplitude des échos dans un banc a été entamée.

Par ailleurs nos partenaires dans le projet BIOMASS qui travaillent sur l'identification des échos obtenus en sondage large bande (Institut de chimie et de physique industrielle de Lyon, France; Marine Laboratory d'Aberdeen, Scotland) sont arrivés à des résultats prometteurs (détermination de la

signature acoustique de groupes de poissons, reconnaissance de la signature spectrale entre gadidés, chinchards et maqueraux, sur des poissons observés en cage).

### 3.1.2 - Essais du sondeur large bande

Pour pouvoir réaliser des essais du transducteur large bande à la mer sans être gêné par les bruits du navire, nous avons réalisé un corps remorqué support de transducteur dont les performances hydrodynamiques sont très satisfaisantes. L'engin est parfaitement stable en remorquage entre 4 et 11 noeuds.

### 3.1.3 - Traitement des données sonar

La possibilité d'un traitement numérique en temps réel des images d'un sonar de pêche multifaisceau a été prouvée (trajectographie de bancs); ce travail devrait se poursuivre en exploitant mieux les possibilités de reconnaissance automatisée des détections de bancs de poissons.

### 3.1.4 - Evolution des sondeurs OSSIAN

Un accord avec la Société MICREL a permis d'intégrer au sondeur OSSIAN (dans sa version scientifique) les modules d'échointégration par tranches d'eau et par bancs de poissons contenus dans le logiciel IFREMER ''MOVIES B'', et de reconnaissance automatisée de la nature du fond.

D'autre part les travaux de mise au point du transducteur du sondeur OSSIAN 2000 se poursuivent pour obtenir un sondeur grand fond à haute définition. Les premiers essais d'une maquette du sondeur seront faits en Méditerranée, à bord du N/O EUROPE dès le début de 1994.

## 3.2 - Travaux menés par l'ORSTOM

Suite à la mise en évidence par acoustique de structures biologiques liées à la présence de thons dans une zone de l'Atlantique Equatorial pendant une partie de l'année, et à leur identification comme poissons méso-pélagiques, des études en particulier sur la croissance de cette espèce sont en cours, et des campagnes complémentaires, à des saisons non encore explorées, sont en cours ou prévues (E. MARCHAL, J. PANFILI).

Le réseau Caraïbes poursuit ses travaux, entre autres de détections sur les petits fonds. Les participants se sont réunis en février 94 à La Havane; réunion qui se prolongeait

par un Congrès des Sciences de la Mer (F. GERLOTTO).

Au Sénégal, outre les travaux en petits fonds qui vont être renforcés par l'affectation d'un chercheur de l'INRA, ont commencé des études sur le mode de structuration de la population, et ses conséquences sur l'évaluation, par l'affectation d'un géostatisticien de l'ORSTOM (P. PETITGAS, J.J. LEVENEZ, J. GUILLARD). Le développement de Dakar comme site de méthodologie acoustique est en projet, afin d 'approfondir nos recherches sur les TS in situ et l'apport des systèmes large bande dans la variabilité des mesures et la caractérisation de cibles (B. SAMB, A. LEBOURGES).

Le groupe de travail francophone sur l'''Occupation de l'espace par les organismes aquatiques'', s'est tenu pour la troisième fois en mai 93 à Evian; il se réunira de nouveau à Montpellier à la faveur du FAST, en avril 94.

En Indonésie, l'étude du comportement des poissons au voisinage des dipositifs de concentration de poissons se poursuit dans la Mer de Java (D. PETIT).

Pendant l'été 93 a eu lieu une première campagne en Polynésie visant à étudier l'efficacité des dispositifs de concentration de thons. Les mesures ont été faites avec un dual-beam BIOSONICS à 120 KHz et un intégrateur INES-MOVIES. Le comportement des thons a été suivi par marquage acoustique (E. JOSSE).

Le programme AIR mené en collaboration avec l'Instituto de Ciencias del Mar (Barcelone, Espagne) et l'Instituto Ricerca Pesca Maritima (Ancona, Italie), se poursuit, avec non seulement l'échointégration mais aussi l'emploi d'un sonar haute fréquence pour l'étude de la structure des bancs (P. FREON, F. GERLOTTO).

Une collaboration avec le laboratoire d'acoustique des pêches du VNIRO (Moscou) débute, afin de mettre au point un prototype de sonar paramétrique pour les travaux en petits fonds et large bande (A. LEBOURGES).

# GERMANY

(E. Dahm)

## A) INSTITUTE FOR FISHING GEAR TECHNOLOGY, HAMBURG

### Investigations on stock assessment trawls

Investigations on losses beneath the groundrope of fishes concentrated between the wings of stock assessment bottom trawls were continued with the GOV standard bottom trawl. In its ICES approved mode of rigging this trawl has a roller gear of rubber discs of equal size covering tightly a steel wire. Thus, the footgear leaves no escape gaps for the herded fishes and ought to show a complete catching efficiency for these.

The experiments carried out using the method of bagnets as developed by ENGAS and GODE proved that this assumption is not true. Haddock is an exemption by a low overall escape rate of 2.9%, but other roundfish show distinct losses (whiting 16.6%, grey gurnard 39.8%, poor cod 38%). Dragonet is actually not affected by this trawl because it escapes to 97% Similar high escape rates were found with most flatfish (long rough dab 87.5%, dab 59.7%, plaice 84.2%).

Preliminary experiments with a further German standard bottom trawl, the 140-feet-net, equipped with a 21-inch-roller gear are even more striking. Whereas at a given fishing place at least 75% of the available whiting arrived in the codend of the GOV-trawl, the 140-feet-trawl caught only 13% of the fish in front of the trawl. In contrary to prior Norwegian results use of a rockhopper gear of equal height with a distance of 10 cm brought no significant change in the escape rates.

A few first tests showed a possible remedy against these losses.
By covering the roller gear in the range of the bosom by a catch improving apron of small meshed netting the losses of e.g. dab could be reduced from 65.6% to 37.6%, of plaice from 81.2% to 67.4%, of whiting from 24.6 to 8.8%. A further elaboration of this technique is intended.

**Development of hydroacoustical methods for stock assessment**

- The use of a towed body on FRV "Solea" is severely hampered by unwanted reflections at the water surface when working in fish aggregations close to the surface. Careful acoustic insulation improved step by step during measurements at sea brought relief.

- A new computer program for recording and evaluation of hydro-acoustical data was developed and successfully tested.

**Gear research on pelagic trawls**

Calibration catches with a trawl during hydroacoustic stock assessments are severely biased because of the ship's wake if the water depth is rather shallow. In collaboration with the University of Rostock a method was tested successfully to tow the net at one side of the ship thus taking it out of the disturbed zone.

**Sorting grid investigations**

In the frame of an EEC-Project sorting grids installed in trawls for the catch of pelagic species were tested and underwater video tapes taken. They prove clearly that the passage of small fish through these grids is much faster than through diamond codend meshes and thus causes less damage. The trials shall be continued with the aim to find appropriate grid bar distances to reduce as well discards as loss of marketable fish.

Similar sorting grid trials were carried out with two types of bottom trawls (GOV, 200-feet-trawl).

**Selectivity of sievenets in the shrimp trawl fishery**

Bigmeshed funnels whose end leads to a hole in the bottom panel help to reduce the unwanted fish bycatch in brown shrimp beam trawls whereas the shrimp catch is hardly affected. Though voluntary, the use of such auxiliary equipment is widespread in the German shrimp fishery. Trials undertaken in 1993 served the purpose to optimize the mesh size of these funnels. A comparison between 60 and 44 mm mesh size showed the smaller to be 80% effective in sieving out of the flatfishes. However, an accompanying loss of 40% of marketable shrimp had to be stated. The bigger mesh caused only minor

losses of sellable shrimps but was the reason of an important discard of small flatfish.

**Fishing effort**

A number of suggestions to charge fishing time restrictions on the total fishing fleet capacity has been collected by the EEC. Germany participated at a Working Group for the evaluation of these proposals.

**Unwanted bycatches in the setnet fishery**

The unwanted bycatch of wandering seabirds, mostly different species of ducks, in marine setnets recently caused much concern among environmentalists and the fishery administration in Germany. Available data are scarce and unreliable. A new project intends to assess the actual danger of setnets to seabirds by collecting more data and to discover strategies for the minimization of the problem. According to first results time of fishing and construction of the gear offer good aspects for a reduction of the bycatch.

**Development of a method to measure actual horse power of a fishing ship when towing**

The prototype of a new torque measuring instrument invented by the Technical University of Aachen was successfully tested at sea. It is based on two magnetic stripes glued onto the ship's propeller shaft and their changing orientation under load. Installation is so simple that it may be carried out by laymen and errors resulting from minor mistakes during installation are automatically corrected. An EEC-project proposal to complete the method to industrial production maturity was delivered.

**Underwater photogrammetry and digital image processing**

Underwater video pictures taken during a cruise of FRV "Solea" allowed to calculate movement traces of fish, algae and sand clouds inside a codend by subtraction operations frame by frame.
The determination of shape and opening angles of codend meshes together with hydromechanical basic equations gave a picture of current distribution inside and around a codend.

Further work dealt with the threedimensional measurement of otter board traces and benthic organisms.

**Collaboration in planning and first sea trials of the new "Walther Herwig III"**

The final phase of construction and fitting out with scientific equipment of the new FRV "Walther Herwig III" stressed the manpower of the Institute of Fishing Gear Technology as well as several trial cruises at sea.

The new vessel is built according to state of the art with lower manpower requirements than the predecessor, excellent manoeuvrability, modern deck machinery and advanced navigational and scientific instrumentation.

Underwater noise measurements of the new ship carried out by a special branch of the German navy proved excellent noise reduction under fishing conditions.

**B) UNIVERSITY OF ROSTOCK**

Activities of the Institute for Naval Architecture and Maritime Technique included in the field of fishing gear research:

- Theoretical and experimental investigations on the moving behaviour of rope systems under bottom contact conditions,
- Organization of an international workshop on the subject: "Modern engineering methods in fishing gear research",
- Further development of the theoretical basis for the calculation of dynamically loaded rope systems,
- Further development of software solutions for the design and construction of bottom trawls,
- Development of design calculation procedures for two-boat-trawls,
- Construction of a floating poundnet for the catch of living cyprinids designed for the "Kleines Oderhaff" area of operation,
- Development of algorithms for the calculation of operational procedures during the use of danish seines.

# ICELAND

(P. Reynisson and G. Thorsteinsson)

## Acoustics

The yearly investigations of the Icelandic capelin were undertaken in autumn and winter.
In January the spawning was surveyed east and northeast of Iceland. In August the juvenile stock in the Iceland-Greenland-Jan Mayen area was surveyed as a part of our traditional 0-group survey. In october a two-ship survey of the adult and juvenile components was carried out in the same area.

An acoustic survey on the Icelandic summer spawning herring was carried out in November and December 1992. An effort was made to cover both the juvenile and adult components of the stock.

In September 1993 a short survey of the oceanic-type redfish (Sebastes mentella) in the Irminger Sea was carried out in order to investigate the feasibility of that of the year for acoustic assessment of this stock. Acoustic survey were carried out in June-July 1991 and 1992 for the same purpose. The results are promising for both these periods, although the conditions in the summertime seem to be more favourable; An international acoustic survey is planned in June-July 1994, with the participation of Iceland, Norway and Russia.

## Gear and selectivity

Experiments with 135 mm netting in the overhang of a Nephrops trawl, otherwise made of 80 mm meshsize, resulted in significant reduction of undersized haddock. Commercial Nephrops trawlers use 135 mm square mesh windows in the upper belly in addition to the large meshsize in the overhand reducing the undersized haddock bycatch by more than 50%

Experiments with square mesh windows in bottom trawls indicated that the bycatch rates of small haddock can be reduced greatly and the catches of small cod to some extent.
The results are much depending on depth, fishing grounds and other factors. The influence of the daytime and yeartime has not been investigated yet.

Iceland has participated in a Scandinavian project on the selectivity of shrimp trawls. A TV-film has been made on the

problems of the shrimp fisheries in the North-Atlantic in cooperation with a filming company.

Private companies have developed two kind of dredges for catching sea urchin (Strongylocentrotus droebachiensis). Both designs were successful and are widely used in commercial fishing. Underwater TV observations showed the catchabilities of both versions to be good and the influence on bottom organisms to be rather low.

An experimental fishing for the common whelk (Buccinum undatum) was started with different kinds of traps.

# IRELAND

(N. Pfeiffer, P. Hillis and R. McCormick)

## Deepwater trawling

A series of deepwater (800-1300M) fishing trials were undertaken by BIM. Data on temperature at fishing depth and gear performance were recorded using Scanmar equipment. This project was funded by the EU's DG XIV under an Exploratory Fishing Programme.

## Conservation/selectivity trials

The series of square mesh experiments begun in 1990 were continued in 1993. A set of fishing trials to further evaluate using square mesh in prawn trawls was carried out by the Fisheries Research Centre (FRC) using twin rigged trawls. Catches of immature whiting were found to be significantly lower in a prawn trawl fitted with square mesh when fished against a standard prawn trawl. The method of using twin rigged trawls for catch comparison studies proved to be effective.

BIM carried out work on three more projects dealing with square mesh. The first of these were carried out onboard a seine netter. The results were not as positive as previous trawl square mesh trials, although observations revealed that the problem of discarding is not as acute on seine netting vessels.

Promising results were obtained from a second set of trials where the concept of placing selectivity panels in the bellies of trawls was tested for effectiveness in releasing immature flatfish and monkfish. Further trials are planned for 1994.

Square mesh trials were also carried out in the hake fishery off the Southwest coast. These were severely hampered by weather conditions, but are set to be continued during 1994.

An investigation into the use of fixed nets for catching demersal whitefish species was begun in 1993 by FRC. A set of selectivity trials were carried out using a chartered commercial vessel to fish for whitefish species off the Southwest coast. A variety of different mesh sizes and twine diameters were deployed simultaneously and the data is presently being analysed.

# THE NETHERLANDS

(B. van Marlen)

**Project "FAR" EC TE-1-154 "Fishing gear model and full-scale relationship ".**

Full-scale measurements on net MAR-143 have been carried out in March-April 1993 on RV "Tridens". Research workers from RIVO (NL), DIFTA (DK) and SOAFD's Marine Laboratory (UK) collaborated. An extended set of equipment was, used, such as, acoustic depth and spread meters, tension meters, door angle meters etc. RlVO's ROV was used to observe instrumentation *in situ* and measure cross sectional net shapes using an ROV mounted SONAR. Duplicate hauls were made to ensure a vast set of data for each rigging. Additional model tests were carried out in the flume tank of DIFTA to extend the model data to larger w/e heights. Preliminary data analysis was done in each laboratory and a complete data bank set up at SOAFD. During the last project meeting all data was checked and corrected and geometry and resistance calculations done using analysis programmes. Regressions were made for the w/e height and the reciprocal value of the drag coefficient for comparable combinations of models scales at a range of net spreads. Plotting the length scale ratio and the velocity scale ratio resulted in an empirical relationship deviating from Froude scaling. Instead of 0.5 as in Froude, the factor 0.6 was found. It is not known whether this relationship also holds for other net designs, and it is suggested to repeat this exercise with a totally different design of trawl.

**Project "FAR" EC TE-3-613 "Improved species and size selectivity of mid water trawls (SELMITRA)".**

A cooperative research cruise was carried out on RV "Solea". Several grid arrangements were observed with RCTV at sea in waters around the Orkneys. The cover used to sample fish escaping through the grids had a clear effect on their behaviour when the front edge is sloping upwards. A new design was made and tried out. Interesting shots of a school of herring escaping through the front opening were made. Tank experiments on live fish (mackerel, horse mackerel and herring) have been continued in the facilities of SOAFD's Marine Laboratory. The swimming performance of these three species did not is quite similar and separation due to differences in maximum sustainable speed can not be expected. In addition all three species did not show remarkable differences in reactions towards barriers placed in the tank. A distinct difference is

that herring is more sensitive to sound stimuli, but it is not known whether this can be used. The fish learn quickly to ignore such stimuli. Comparative fishing has been done in November 1993 on a large midwater trawl onboard RV "Tridens" in Irish waters. Five grid arrangements were tested. A cover was placed over the grids to appraise escapement. The sorting efficiency was limited, but slight improvements were found when the grids were placed at an angle and a guiding panel was inserted. The best success was found on herring. It will be difficult to achieve a total species selection, but it is conceivable that small fish, particularly herring can be sorted out. Research will be continued in 1994 and 1995.

**Project EC AIR2-CT93-1015 "Optimisation of a species selective beam trawl (SOBETRA)"**

This project started in 1993 as follow-up of "FAR" TE-2-554 on improving round fish selectivity in beam trawling. Participants are again RVZ at Ostend, B, SEAFISH at Hull UK, and RIVO at IJmuiden NL. The objective is to optimise the technical gear modifications found earlier and to gather more scientific data for several sub-fleets in this fishery. A first meeting was held in Ostend in October 1993 to plan the activities for 1993. Model tests were done in February in the flume tank of SEAFISH. The beam trawl designs were modified and improved. Direct observation at sea will be done in the spring of 1994.

**Research into the effect of shortening beam length from 14m to 12m.**

In October-November 1993 comparative fishing trials were carried out on two commercial beam trawlers UK-104 and UK-156. The aim was to quantify differences in catches and earnings between a vessel rigged with 14m beams and a vessel rigged with 12m beams. The effect of the legislation enforced in 1987 to limit the length of a beam to the maximum length to 12m on the fleet has been discussed on an international level. A second objective of the study was to estimate the overall effect on the fleet. Gears were set at 14m and fished for two weeks on one of the boats to make sure they were performing as intended. The actual trials took for weeks, after the first two the nets were interchanged between the vessels. Catches were recorded and samples taken of which a length-frequency distribution was determined. The measured catch quantities compared well with the data given by the auction. All catches and earnings were multiplied to a standard fishing time of 100 hours to enable comparison. The 14m gears caught between 10% and 20% more flatfish (mainly sole and plaice) with earnings between 5% and 15% higher. During the second two weeks the sole catches of one of the vessels fell short. A solid explanation could not be found.

# NORWAY

(A. Bjordal)

## FISH BEHAVIOUR AND REACTION TO FISHING GEAR

Analyses of catch data from commercial vessels operating within areas where seismic exploration with airguns was conducted, showed catch reductions of 55 to 80% of cod on longlines set close to the seismic survey tracks. Also a 80% reduction in the bycatch of cod in shrimp trawl fisheries was found. The effect of airgun noise on saithe catches was less consistent.

Fishing experiments for cod and haddock were performed simultaneously within the same area with commercial bottom trawl and longline during two periods with different stock levels. The haddock:cod ratio was higher in longline than in trawl. The selectivity of longline was affected by fish density, size, and species composition of the area fished.

The food searching behaviour of Norway lobster responding to baited pots has been studied by an acoustic telemetry positioning system and fishing experiments.

Behaviour of acoustically tagged cod was studied both undisturbed and stimulated by vessel noise during trawling.

Studies on catchability of wrasse by different gears showed that good catches are obtained when the temperature exceeds 9-10°C.

## SELECTIVE FISHING AND SURVIVAL AFTER ESCAPEMENT

Development of grids for size selection of shrimp and Norway lobster was continued in cooperation with other Nordic countries. Grid designs for combined fish escapement and size selection of shrimp were developed and tested. The Nordic project also included experiments with 45 mm and 55 mm codend mesh size, both diamond and square mesh shapes. Grids made from fibreglass material were tested in shrimp trawls.

Size selection experiments with 9 and 10 mm (grid opening) IMP planegrates in the upper codend panel of coastal shrimp trawls have shown promising results. The work will continue with further full scale experiments this spring.

Two cruises were conducted to evaluate the selection performance of grids (Sort-X) with 50 and 55 mm bar spacing. Data were obtained for species like cod, haddock, redfish and Greenland halibut. The results were comparable to those previously obtained during the period 1990-92. Experiments with 50 mm grids and 100 mm codend mesh size were conducted in the fishery for saithe in the Barents Sea. This arrangement gave acceptable selection characteristics.

Experiments with a horizontal panel in the aft belly of a fish trawl were conducted on fishing grounds off Northern Norway. 70% of the haddock were caught in the upper level as 70% of the cod were caught in the bottom level, indicating differences in behaviour between cod and haddock. Most of the saithe (90%) were caught in the upper level, but the catch rates for this species were low.

Sorting grids have been tested in purse seining and pelagic trawling for mackerel and in net pens and purse seines with saithe. The 10 m2 sorting grid used in the mackerel purse seine functioned well, and sharp selection curves have been established. The survival of the escaping fish is now being investigated. In net pens with saithe, sharp selection has been obtained using both nylon and aluminium grids. Flexible nylon grids that can be hauled through a power block have been tested.

Danish seine experiments with square mesh codend showed that plaice can be selectively caught in areas with high abundance of cod and haddock.

Experiments to study survival of 0- and 1-group gadoids were carried out. The 1993 field season was mainly used for methodology developments, but preliminary observations indicated a high survival rate for 1-year old cod and haddock after escapement from trawls.

Observation during drift-line fishing for haddock indicated a significant mortality of undersized haddock which are knocked of the hooks during hauling.

## IMPROVEMENT OF FISHING GEAR AND METHODS

Work to develop techniques to reduce mortality of cod caught with seine net for live storage in net pens has been continued. An improved net pen for towing and storage of mackerel and saithe was designed and tested. A new, collapsible fish trap design with double funnels and compartments above each other gave good catch rates. Other gave good catch rates for cod. Trial fishing with different pot designs for Spider crab *(Lithodes maja)* and King crab *(Paralithodes camtschatica)* were

conducted.

Fishing experiments with an alternative longline bait based on minced mackerel in nylon bags showed promising catch results for haddock and torsk.

A new pelagic trawl for sampling of 0-group fish has been developed and tested with good results. The mouth area of the trawl is approximately 10x10 m. The demersal sampling trawl used in the Barents Sea (Campelen 1800) has been further tested when strapping the warps in front of the trawl doors to obtain fixed door spread. Studies of the geometry of the demersal sampling trawl when factors like towing speed, fishing depth, warp length, and bottom conditions were varied, continued in 1993.

Direct observations and bag experiments indicated that escapement of cod under the ground gear of a bottom trawl is significantly higher with low fish abundance in front of the ground gear than with high abundance.

The influence of vessel motions on efficiency and energy costs in trawling has been analysed by theoretical calculations and studied by model tests in a towing tank. Vessel motion in a seaway will cause large dynamic variations in the warp line tension, resulting in reduced door spread and vertical bouncing of the trawl doors off the bottom, as well as increased mean warp tension, increased energy consumption, and decreased catching efficiency. Preliminary analysis of the model test results seems roughly to confirm the results of the calculations.

Technological development possibilities that may expand the use of longlining has been identified.

## FISHING VESSEL TECHNOLOGY

Investigations into resistance and seakeeping properties of catamaran fishing vessels have continued. Model tests concerning the feasibility of catamarans for trawling have been carried out.

Technology for handling and keeping fish alive after capture has been further developed and tested.

## FISHERIES ACOUSTICS

### Surveys

The acoustic systems EK-500 and BI-500 have been used on six research vessels for about 1500 vessel survey days in 1993.

### Development projects/activities

### Sonar project

The sonar Simrad SA-950 was installed on "G.O. Sars", July 1992, and has been tested on several surveys. Interface towards a HP-720 for downloading graphical information, and some software for this have been developed. The same sonar is now mounted on the new research vessel "Dr. Fridtjof Nansen". The sonars will be used in a project aimed at biomass estimation of fish schools, and to study their behaviour and migration pattern.

### Deep towed body project, phase 1 and 2

Further development on the deep towed body concept continued in 1993, but was delayed by financial reasons. Most of the work in connection with bringing parts of the EK-500 into a pressure resistant nose of the body is finished, as well as the communication part to the vessel over an optical/electrical cable. The main sea test of the full system will be made in April/May 1994.

### BEI/BI-500, The Bergen Echo Integrator

The mapping/charting module for BI-500 is now being tested. A system for manual data input have been implemented, as well as a system for scrutinising multiple frequencies. The last year have also been used to ensure a high stability on the system, needed for the extensive survey work conducted by IMR. About 650 GB of scrutinised raw data was stored from the system in 1993.

### Seismics and fish

Several projects concerning seismic activity and fish were run in 1992, and have been reported in 1993. These are:

- Two projects to determine the effect of air gun sounds on

eggs and larvae, one experimental and one combined field and modelling project.

- One project to determine the effect of seismic investigations with air guns on catch rates success and fishing availability.

- One project to determine harmful effects on fish from explosives.

### *In situ* TS measurements

Measurements of target strength of herring have been conducted in 1993, with the goal to measure the average target strength inside the dense layers in the herring hibernating areas, where also the spawning stock survey is conducted. The measurements were made from a rig, holding split beam transducers, scanning sonar, and stereo single frame camera. Supporting data from net penned herring and purse seining/acoustic comparison are also collected in 1993. The project is also aimed at establishing routine procedures for in situ TS measurements in general.

### Survey design

Detailed mapping of the herring distribution during its hibernation phase in Ofotfjorden was repeated in 1993, using two research vessels. Geostatistics are used to compute stock coverage confidence intervals. Multiple frequencies, 18, 38, 120 and 200 kHz, have been analysed for the same surveys.

### Protruding transducers

Three of our research vessels have been equipped with instrument keels (centre board), protruding to any length, 2.5 to 4.0 m below the vessel hull, in order to improve the acoustic data in bad weather. Two to four transducers have been mounted in the keels, and systematic trials have been made, both with respect to vessel stability and transducer aeration.

# RUSSIA

(V. Shleinik)

**PINRO, MURMANSK**

Experimental investigations on selectivity of bottom trawls rigged with the "SORT-X" when conducting fishery for cod were carried out during 1993. Optimal conditions of this system application were determined for trawlers of two types.
Operations were conducted by trawlers with the main engine power 735 and 1760 Kw. Mesh size in the codend were 110-140 mm.

Comparative trials of catchability of bottom trawl "Alfredo-3" and Russian 45,3/47-meter trawl were carried out.
The following data were obtained:

- practical recommendations on installation and servicing of "SORT-X" on trawlers of two types during fishery for Arcto-Norwegian cod;

- data on efficiency of the "SORT-X" system using codends with 110-140 mm mesh size during fishery for Arcto-Norwegian cod;

- comparative data on catchability of bottom trawl "Alfredo-3" and Russian 45,3/47-meter trawl.

# SPAIN

(F.J. Pereiro)

## SELECTIVITY

The selectivity of the main species in trawl codends present in the Gulf of Cadiz was measured using the cover technique. For each specie and experiment two different logistic models were performed. The main features for these trials are summarised in the next table:

| Experiement | ARSA 1092 | ARSAO 0393 | ARSA 1093 | Com.fleet |
|---|---|---|---|---|
| R/V | F.P.Navarro | Cornide de Saovedra | Cornide de Seavedra | Segundo Molinero** |
| Date | 8/10/92-22/10/92 | 15/3/93-25-/393 | 17/10/93-25/10/93 | Two days/quarter |
| Depths | 15-200 m | 15-600 m | 15-600 m | 15-600 m |
| No. hauls | 21 | 34 | 29 | - |
| Cover mesh | 20 mm | 20 mm | 20 mm | 20 mm |
| Codend mesh* | 50 (52,74±1.8) mm | 45 (42.77±1.8) mm | 60 (30.2±1.99) mm | 40 |
| Species | *Citharus linguatula*<br>*Merluccius merluccius*<br>*Mullus spp*<br>*Diplodus annularis*<br>*Pagellus acarne*<br>*Parapenaeus longirostris* | *Micromesistius poutassou*<br>*Merluccius merluccius*<br>*Diplodus bollotti*<br>*Pagellus bollotti*<br>*Parapenaeus longirostris*<br>*Nephrops norvegicus* | *Dicologoglossa cuneata*<br>*Citharus linguatula*<br>*Merluccius merluccius*<br>*Micromesistius poutassou*<br>*Pagellus acarne*<br>*Mollus surmuletus*<br>*Parapenaeus longirostris*<br>*Nephrops norvegicus*<br>*Loligo vulgaris*<br>*Sepia officinalis* | *Merluccius merluccius*<br>*Parapenaeus longirostris* |

*theoretic mesh (real mesh)
**commercial trawler from Isla Cristina (Huelva)

Contact person : Ignacio Sobrino. IEO Càdiz. P.O. Box 2609. 11080 Càdiz. Fax no.: 34 56 263556.

**FISHERIES ACOUSTICS**

During 1993 different acoustics activities were carried out, all of them using an EK-500 echosounder.

## 1.- Development of acoustics techniques

A new research program, *DETAC,* for develop acoustics techniques started the last year. The main objectives are to develop and to check a new tool for control/capture data from EK-500 echosounder, studies about fish behaviour and TS measurements and survey planning studies. Two surveys were performed in Mallorca island on board of R/V "Odon de Buen" in February and June.

During these surveys the control/capture program "Bravo" was checked; this program briefly consists in a qbasic program that controls the main settings of EK-500 (scales, printers, GPS output, etc.) and captures the integration table telegram each mile via RS-232 serial port.

The survey track consisted in a parallel grid design with 2.5 nm between transepts. For pelagic fish present in the studied area, there were not significant differences among CV's considering all the transepts, removing one (5 nm between transepts) or two (7.5 nm between transects).

Contact persons: Joan Miquel, Magdalena Iglesias. IEO - Palma de Mallorca.

## 2.- Acoustics survey for assessment

### 2.1.- Atlantic and cantabrian waters

Two surveys were carried out, *Pelacus 0493* during April and *Ecocadiz 0693* in June.

The main goal for *Pelacus 0493* was the abundance estimation of sardine and blue whiting present in cantabrian and galician waters, but it was not possible to do in situ TS measurements for both species. Contact person: Pablo Carrera. IEO - A Coruña

*Ecocadiz 0693* was the first acoustic survey for the assessment of pelagic fish done during spring in the Gulf of Cadiz. A total of 517 nm were surveyed covering an area of 2 865 square nm; small boar fish ( *Capros aper* ) was the most abundance specie found, with 217 579 mt, corresponding to 20 784 millions fish. This specie, with small trumpet fish (

*Macrorhanphosus scolopax* ), which were distributed within 500 to 100 m isobath, have restricted the distribution area of sardine and anchovy to shallower waters (less than 100 m). For sardine and anchovy, the total biomass assessed were 90 974 and 6 569 mt respectively corresponding to 2 485 and 462 millions fish.

Contact person: Milagros Millan. IEO - Cadiz.

2.2.-Mediterranean sea

*Ecomed 93* was the forth fall survey carried out in the Spanish Mediterranean Sea. These survey usually covered the area between the Gulf of Lion to Punta Europa, Gibraltar. Unfortunately in 1993 a failure in our EK-500 echosounder, reduced the prospection area to Cataluña and Alboran Sea (Malaga to Punta Europa). In 1992, an important population of boar fish ( *C.apros aper* ) had been found in Alboran Sea (as in the Gulf of Cadiz in 1993), but during *Ecomed 93* this population was disappeared. Fishermen from both Gulf of Cadiz and Alboran Sea (also from Portugal) have reported about the presence of important amounts of boar fish or trumpet fish for periods more or less shorts that cause great problems to the normal fishing activity.

Contact person: Rogelio Abad.-IEO - Malaga

# SWEDEN

(Roger Karlsson and Bertil Johansson)

## General

Below some of the work done in Fishing Technology during 1993 is described. Apart from this there are a number of projects going on regarding trawl design and selectivity. One of these, "Selectivity experiments with cod trawl in the Baltic" is reported separately.

Where reports are available, they are mainly in Swedish.

## Improved safety and work environment for fishermen

### Safety and work environment courses

During 1993 courses were started for fishermen. The courses, as mentioned last year, in one block cover theory and practice of survival matters like hypothermia, life rafts and fire fighting equipment and in another block theory and practical advice on work environment factors like ergonomics, noise, vibrations, accident risks, eating habits and psychological factors. As a complement to the courses safety engineers visit fishing vessels to check, and give advice, on safety and work environment factors on board. Funds have also been made available to give fishermen free consultative help in connection with construction and rebuilding of fishing vessels.

### Rehabilitation of fishermen

Recently a new project started aimed at rehabilitation of fishermen with physical and other problems. The idea is to find fishermen and give help at an early stage to make it possible for them to continue with professional fishing.

### Safer trawl handling systems

More than half of the serious accidents in the Swedish fisheries occur during hauling or setting of the trawl. In a project ideas to reduce the accident risk in these operations are tested. These include things like fixing devices for otter

boards and emergency stops for the trawl drum.

Active noise reduction on fishing vessels

Fishing vessels in general have high noise levels. In a new project active noise control, i.e. a system with loudspeakers transmitting sound with a phase lag resulting in a reduced sound level, will be developed and tested. This could be a cheap system to reduce the noise in specific areas of the vessel.

**Freon minimised R.S.W. plant in Fishing Vessel.**

In an ongoing project, the aim is to reduce the amount of Freon as much as possible in the refrigeration system of fishing vessels. The present systems use large amounts of Freon gas, which is to be avoided fro environmental reasons. The risk of leakage is also high due to corrosion of the refrigeration tubes.

International resolutions have been made in the so called Montreal Protocol, that the use of Freon gas shall be reduced.

Pro Ref AB, a Göteborg based company, have the following goals with their new development in this field:

1. Reduced amount of Freon gas in the plant (about 90% reduction).

2. Reduced leakage risk by separating Freon gas and salt water.

3. The new design should be easy to convert to new refrigeration media.

4. The plant should through it's design be simple to split to separate parts, thereby giving better reliability.

5. Marginal raise in costs compared to traditional plants

A prototype unit has, so far, fulfilled the goals.

# UNITED KINGDOM

ENGLAND, Fisheries Laboratory, Lowestoft

(G.P. Arnold)

**Electronic tag development:** The first batch of data storage tags was released on 50 large maturing female plaice in the Southern Bight of the North Sea on 15 December 1993 at the start of the autumn spawning migration. The first fish to be recaptured was caught by a French fishing boat on 17 January 1994 and returned with its tag to the IFREMER station at Port-en-Bessin on the Normandy coast. The 53 cm long fish, which had travelled approximately 290 km from the release position, had nearly finished spawning when it was caught on the plaice spawning ground in the eastern English Channel. The 33 day pressure and temperature record showed that the fish had migrated south by selective tidal stream transport and had moved into warm water (> 9°C). Subsequently the behaviour of the fish changed and it made diel vertical movements, moving off the bottom at sunset and spending each night in midwater. The ground track of the fish was reconstructed from its vertical movements, using the real-time version of the laboratory's tidal stream simulation model.

Reasonable agreement between the actual and the simulated end point of the track was obtained by assuming that the fish swam downtide at a speed of 1 body length per second.

Two more tags were recovered after 45 and 50 days at liberty. The third fish had migrated north by tidal stream transport and was recaptured inshore near Hartlepool. Its track, which was similar to that of the first fish, also showed periods of diel vertical movement but the fish spent shorter periods in midwater. It is hypothesised that these diel vertical movements are associated with spawning and that intervening periods when the fish remained on the bottom for one or more days may be associated with ovulation.

**Shrimp fishery by-catch reduction:** Comparative fishing trials have been carried out in the Wash and Humber estuary to assess ways of reducing the by-catch and discard rate of juvenile fish in the shrimp fishery. A standard shrimp trawl with a 22 mm codend was fished alongside a similar net modified in three separate ways to include a large mesh (50 mm) liner, a modified groundrope or a Larsen grid (13 mm bar spacing). All three modifications reduced the fish by-catch without significantly affecting the shrimp catch but the Larsen grid was the most effective. Under commercial conditions this device achieved by-catch reductions of 46 and 64% for plaice and sole and 76% for whiting. A loss of 7% of commercial-sized shrimp was offset by improved quality of catch and reduced sorting time. Future work is planned to look at seasonal variation in fish by-catches and ways of reducing discarding and mortality of undersize shrimp. The work is being carried by Humberside University on contract to MAFF.

SCOTLAND, Marine Laboratory, Aberdeen

(P. Stewart)

## Selectivity

The selectivity of cod, haddock and whiting in pair seine cod-ends was measured using the hooped cover technique. Four cod-end mesh sizes of 90, 100, 110 and 120 mm and two sizes of circumference ( 100 and 120 total meshes round) were tested during 33 valid hauls. The data will be used to construct a selectivity model taking account of between-haul variability. Initial inspection suggests that the selectivity of pair seines is not greatly different from that of pair trawls made of similar twine.

The selectivity of 70 and 80 mm mesh prawn trawl cod-ends was investigated using the twin trawl system. The data will be assessed taking into account between-haul variance.

The effect of twine thickness on selectivity for haddock was measured for 100 mm mesh cod-ends made of thin (double 3.5 mm) and thick (double 6 mm) braided polyethylene. A significant difference of 1.3 cm was found in L50 showing that thick twine reduces selectivity. In the same trials fish sampling procedures were investigated. The length frequency distribution of every basket was determined so that the variance due to different effects could be assessed.

Promising results were obtained in separating cod and marketable flatfish, haddock and whiting into a lower cod-end by using an inclined grid through which the juveniles could escape. Another grid design in a prawn trawl demonstrated the possibility of improving the escape of small prawns *(Nephrops)*.

Differential equations which govern cod-end geometry have been derived at the Marine Laboratory. They are expressed in terms of the cod-end design parameters (mesh size, number of meshes around, etc), the resistance of meshes to opening and a general loading function. Work has been continuing in their development, particularly with regard to their numerical solutions.

Theoretical work investigating the resistance of meshes to opening has been carried out and has provided a framework on which to base experimental trials. The aim is to be able to describe the lateral force required to open a mesh in terms of the bending stiffness of the twine that makes up the net and the longitudinal force pulling on the mesh.

**Modelling**

The EC project to study the relationships between model and full scale nets has been completed. An empirical rule has been established that the velocity for models in flume tanks should be scaled by the overall linear scale to the power of 0.6. This compares with the traditional Froude law having a power of 0.5. There is no evidence to determine whether this empirical rule will apply to other designs of net apart from this particular large mesh pelagic rope trawl tested in sizes from full-scale down to a scale of 1:40.

**Fishing Effort**

Cod-end catch data were collected from single and twin Nephrops trawls on commercial grounds using a 550 hp commercial fishing vessel. The single net was a standard dual purpose fish/prawn trawl suited to the size of vessel. The two commercial twin rig nets were of a size usually fished by the vessel on the same grounds. Gear performance, swept area, fuel consumption and catch data will be compared in order to assess the difference in fishing power of single and twin trawls.

An EC project to compare the fishing effort exerted by most types of towed demersal gears in the Central and Southern North Sea continued. A survey of fishing gears was carried out. Fleets were identified and catch statistics for each fleet obtained from the national data banks. Gear performance trials on representative vessels from each fleet were started.

**Fish Survival and Damage**

A joint SOAFD/DIFTA EC project continued to study the survival of, and damage to haddock and whiting as a result of escape from 70, 90, 100 and 110 mm diamond mesh cod-ends towed at 1.5 m/s by a 550 hp vessel. Triplicated experiments monitored the survival of 15-38 cm haddock and 17-35 cm whiting. The respective survival rates for the haddock and whiting were 48-67% and 52-60% for the 70 mm cod-end, 79-82% and 73-78% (90 mm cod-end), 73-83% and 67-77% (100 mm cod-end) and 85-89% and 83-86% (110 mm cod-end). These percentages relate only to the numbers of fish escaping from a particular cod-end regardless of fish length. Further analysis suggests that survival may be a more complex function of length but that there is no clear dependence on mesh sizes in the range from 70 to 110 mm. Fish scale damage was assessed using a new image analysing technique and the relation between damage, survival and selectivity (which was also measured) will be studied.

**Behaviour**

As part of a continuing effort to investigate how cod-ends might be made more selective tank experiments similar to those reported last year for mackerel were carried out with horse mackerel, herring, saithe and haddock. These experiments investigated the mechanisms whereby fish can be encouraged to

swim through the meshes of a confining funnel modifying the natural behaviour which is to keep clear of them. The most effective cause for fish choosing to pass through the funnel meshes is a complete blockage of the funnel and this is similar to the case at the rear of the conventional cod-end. In all the tank experiments, an effective illusion has been found to be a tunnel made from black canvas or black meshes. Despite the clear passage along the centre of the dark tunnel fish in experiments elected to pass laterally around the outside of the dark tunnel even if this means passing through meshes. This arrangement has now been tried during a variety of research cruises and has continued to convince observers that it is causing large numbers of fish that normally ignore meshes or grids to pass out ahead of the black tunnel. These finding have pointed to other problems which still need further investigation. These are that positions in extensions ahead of the cod-end involve fast water flow on either side of the mesh, the fish are already physically exhausted, that cold seasonally slows down the swimming ability, that smaller fish have less ability than larger fish, that low light levels reduce the stimulus and glow materials may be needed below certain low light levels. These experiments are continuing.

**Acoustics**

Surveys of herring were carried out 1) in the ICES area VIa North and 2) in the Orkney, Shetland and Buchan areas, in July 1993. These surveys were in conjunction with the Norwegian, Danish and Dutch fisheries research laboratories. Survey data were collected using the Simrad EK500 and recorded on a Sun computer using the BI500 software at frequencies of 38, 120 and 200 kHz. Data on temperature, salinity and seabed type (ROXANNE) are collected during the survey. The relationships between stock depth, temperature, salinity, and seabed are being investigated from this data. Some significant correlations have been found between depth and temperature.

Work on wide-band acoustics has been continued with the development of an improved transducer, and the new computer controlled receiver and transmitter. Initial trials on wide-band beams from a flat transducer have been completed. Studies on reflectivity continue with measurements on cod, saithe, haddock, horse mackerel and mackerel. The data are being analysed for recognition rates using neural net and discriminant analy-

sis. This work is supported under the EC FAR programme and is being carried out in cooperation with ICPI Lyon, IFREMER Brest and IMB Crete.

Work on survey design methods has continued. The series of simulations to investigate the precision of estimates with different survey methods has been developed to include consideration of variance as well as abundance. The results are encouraging and indicate that systematic designs have distinct advantages in survey precision. Use of geostatistical estimators for variance allows examination of survey strategies. Automatic fitting procedures for variograms have been used to obtain better understanding of the precision of the variance estimates. The conclusions of this work are that the best abundance estimates are obtained with systematic surveys and variance can be calculated using geostatistics. The best variance estimates can be obtained using a transect design of two transects per strata. The final choice of strategy depends on the relative importance given to these two parameters. A project funded by the EC to examine the usefulness of geostatistics will start in May and is in cooperation with IMR Bergen and Ecole de Mines Fontainebleau.

# U.S.A.

(J. Traynor)

Fisheries Acoustics Science and Technology Issues

**Alaska Fisheries Science Center**

Alaska Fisheries Science Center (AFSC) in Seattle has continued research on pollock (Theragra chalcogramma) and whiting (Merluccius productus) in the Northeast Pacific Ocean. During 1988 and 1989 and again in 1991-1994, acoustic surveys of the spawning population of pollock have been carried out in January-March in the deep water portion (>1000 m) of the Bering Sea, and, in 1989, 1991-1994 including shelf waters of the eastern Bering Sea. In 1993, in a multi-national effort, the survey area was expanded to include the western Bering Sea and the Aleutian Basin. Annual surveys of the Gulf of Alaska spawning stock in the Gulf of Alaska have continued through 1993. Target strength studies of fish using the split beam technique continue and standard sphere calibration is the primary calibration technique. Cooperative surveys of pollock in the Bering Sea with the Japanese Fisheries Agency have continued. (Contact persons: Jim Traynor, Neal Williamson)

**Southeast Fisheries Center**

The Southeast Fisheries Center continued assessment and experimental work using a 38 and 120 kHz dual beam system. Activity in 1993 included: 1) a survey of reef fish and 2) a fall fisheries acoustic/trawl survey for small pelagics in the western and north-central Gulf of Mexico. Additionally, a pilot survey to estimate the abundance of spawning Atlantic menhaden was conducted off the southeastern coast of the United States in conjunction with an egg/larval survey in December 1993. The data from the menhaden cruise are not yet analyzed. (Contact person: Chris Gledhill)

The Ocean Acoustics Branch of the Naval Research Laboratory is investigating ways to improve Navy predictions of scattering from dispersed and aggregated fish. A major emphasis is

at swimbladder resonance, frequencies of 0.5 to 10 kHz. Routine measurements are made using a near-surface explosive sound source and a downwardly directional receiver. Ongoing studies are:
1) A model aimed at using satellite remote sensing and historical data bases of fisheries information to predict the distribution and level of low frequency scattering from whiting, rockfish, and near surface pelagic species on the US west coast. The effort includes developing theoretical acoustic models of low frequency resonance scattering from fish schools. Tests are planned for summer 1995 in conjunction with the Alaska Fisheries Science Center.
2) A sea surface scattering study in the Gulf of Alaska in March 1992 using a horizontal line array also detected near surface salmon. Measurements gave their swimbladder resonance spectra and spatial distribution pattern over several square km's of ocean surface. Analyses are underway.
3) An acoustic survey of mesopelagic fish in the Arabian Sea is planned for spring 1994. (Contact persons: Redwood Nero, Richard Love)

**Tracor Applied Sciences and University of Southern California**
In December 1993, the BITS mooring, which uses high frequency acoustical sensors to measure zooplankton biomass, was retrieved from the shelf slope break south of Los Angeles, CA, where it has been operating since April 1993. This mooring uses VHF telemetry to report volume scattering strength measurements from seven discrete depths to a shore based computer, from which the data are accessed by several cooperating investigators at Tracor Applied Sciences (Holliday & Greenlaw) and the University of Southern California (Pieper & Dawson). Temperature and light measurements are reported on half hour intervals at each depth instrumented with acoustical sensors. Data from several weather sensors are also included from instruments located on the surface mooring. We were unable to detect any substantial impact on the acoustical data from the moderate fouling incurred during the deployment. It is anticipated that the BITS mooring will be deployed again in the same location in the late winter or early spring of 1994.

Funding has been approved for a second BITS mooring to be used during the GLOBEC field program on Georges Bank. The initial deployment now scheduled for mid - 1995. This system will

include sensors for up to six or more discrete depths, each operating at as many as eight frequencies.

Plans are advancing rapidly for deployment of two eight frequency zooplankton sensors on a JGOFS mooring in the northern Indian Ocean. These sensors will be used to examine temporal variability in zooplankton biomass and size structure as modulated by monsoon related physical forcing. Initial deployment of these sensors is planned for October 1995. Two six month, back to back deployments are anticipated to achieve a full annual cycle. Research is also in progress at Tracor to develop and build a four frequency acoustical zooplankton sensor for use on a Seasoar to yo platform to be used during JGOFS cruises in the Indian Ocean. The most challenging part of this work is the design of transducers in the multiple megahertz operating range which will survey numerous pressure cycles to depths of 300 - 500 m or deeper, while maintaining their calibrations.

**Southwest Fisheries Science Center**

Acoustic technology is used in a study of predator/prey interactions in the Antarctic marine ecosystem. The predators are chinstrap penguins and southern fur seals breeding in the vicinity of Elephant Island, off the northern tip of the Antarctic Peninsula; their principal prey is Antarctic krill (Euphausia superba). Aspects of the foraging ecology and reproductive success of seals and penguins are studied at selected breeding sites. Complementary shipboard observations are used to describe within and between season variations in the distributions of krill, zooplankton, phytoplankton, and water types. During the 1993 field season, a Simrad EK500 echo sounder was used by the Antarctic Ecosystem Research Group at NMFS's Southwest Fisheries Science Center to map the distribution of krill and to estimate its abundance. A 120kHz split-beam transducer and a 200kHz single-beam transducer were deployed on a dead-weight towed body from the R/V Surveyor. The acoustic system was also used to collect target strength measurements on both individual and aggregated krill, as well as to direct simultaneous high-resolution net sampling. Following the field work, a series of calibration experiments were conducted using the anechoic tanks at the Acoustics Laboratory, Naval Post-Graduate School in Monterey, California. In support of

another field project that addressed winter foraging strategies of sea birds in the vicinity of South Georgia, a Simrad EK500 echo sounder was used, with 38, 120, and 200 kHz transducers mounted in the hull of the R/V N.B. Palmer, to map the distribution of prey. In early 1994, acoustic surveys for krill were again conducted in the vicinity of Elephant Island using 120kHz and 200kHz transducers mounted in the hull of the R/V Surveyor and a side-looking 120kHz transducer mounted in a towed body. Additional experiments addressed fine-scale structure of backscattering across an oceanographic front, horizontal and vertical movements of krill aggregations, and acoustic classification of zooplankton taxa. (Contact persons: Roger P. Hewitt, David A. Demer)

**Cornell University**

Overall research interests are centered on the application of acoustic techniques to fundamental problems in biological oceanography. In applying these techniques, an emphasis is placed on improving oceanographic instrumentation as well as the information technology necessary for managing, analyzing, visualizing, and disseminating primary data and higher order data products. Recent research projects have included studies of trophic interactions involving krill in the Gulf of Maine and Southern Ocean, as well as studies of physical-biological interactions associated with abrupt topography in the oceanic Pacific. (Contact person: Chuck Greene)

**Atlantic Oceanographic and Meteorological Laboratory**

A series of field tests of a modular high-frequency "Searchlight SONAR" were made in the Northern Gulf of Mexico and off the Florida Keys. Acoustic backscatter returns were closely correlated with zooplankton abundance measured by the in-situ camera system. The final design has incorporated two sets of three independent frequencies each. When software refinements are complete it will generate realtime size-frequency distributions of plankton populations. The system can be mounted on a MOCNESS or other traditional sampler to yield directly comparable data. Gulf of Mexico data generated by the system were used in a paper presented at the Estuarine Research Foundation meeting last Fall.

The sonar was also deployed as part of an integrated biophysical sampler towed at 8kts for a two day survey off the Florida Keys. It yielded realtime maps of all sensor information CTD, flourometer, transmissometer, and acoustic backscatter at six frequencies ranging from 256KHz to 3.0MHz. Surprisingly an extended body of low salinity water was found whose biological and physical characteristics confirmed that the source was the Mississippi River. The data are the basis of a paper about to be submitted to Science describing the observations and relating them to an unusual wind regime in the Northern Gulf, an extreme northern position of the Loop Current and unusually high summer discharge from the Mississippi in the wake of the widely-reported late spring flooding in the midwest. Later in the year it was used to sample larval fish predators and prey in the South Atlantic Bight as part of SABRE.

**South Carolina Marine Resources Research Institute**

A Tracor Acoustic Profiling System (TAPS) within a local estuarine inlet provided high resolution, size specific information on plankton distribution in real time. The four frequency system is used to integrate plankton and physical data over long time periods to investigate ingress of larval shrimp and blue crab megalope. The TAPS unit is being deployed in collaboration with V. Holliday and C. Greenlaw of Tracor Sciences and Systems.

An old military side scan sonar system (1.5 MHz), with resolution of several centimeters, is being renovated by Deep Sea Systems International Inc. and may be demonstrated in fisheries assessment applications during 1994. Meanwhile, offshore groundfish population assessment continues to be based on traps with attached still cameras, while developing an independent/ inexpensive video "point count" system.

Scientists at the Woods Hole Oceanographic Laboratory have been working on the frequency dependence of acoustic backscattering from zooplankton and micronekton and the development of appropriate scattering models. Laboratory measurements have been made of a decapod shrimp species, a copepod species and various machined objects using a laboratory sonar (50 kHz to 5 MHz) under development by Tim Stanton. The data are used to develop and test scattering models of finite length elongated bodies with realistic boundary conditions.

The results show that the target strength of elongated zooplankton can be predicted very well using a bent cylinder model. Later this year, they plan to use the equipment to make measurements at sea of freshly captured specimens. Work continues on obtaining acoustic measurements with BIOSPAR (Bioacoustic Sensing Platform and Relay) and other high resolution sensors for use on towed systems such as MOCNESS. (Contact persons: Peter Wiebe and Tim Stanton).

Fishing Technology and Fish Behavior Issues.

## WEST COAST AND ALASKA FISHERIES GEAR RESEARCH

### Agencies

National Marine Fisheries Service, AFSC, RACE Div. (**NMFS**)
contact: Craig Rose (206) 526-4128
Fisheries Industrial Technology Center, University of Alaska (**FITC**) contact: Chris Bublitz (907) 486-1516
Fisheries Research Institute, University of Washington (**FRI**)
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Alaska Fisheries Development Foundation, (**AFDF**)
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### Pollock Codend Mesh Study 1 (**FITC**)

Approximately 2.5 billion pounds of Alaska Pollock (Theragara chalcogramma) are harvested annually from the Bering Sea and Gulf of Alaska. This fishery is a single species directed trawl fishery with less than 5% by-catch of other species; however, the catch and discard of undersized pollock is causing considerable concern. To address this problem, the FITC initiated a study, funded by the Staltonstall-Kennedy Foundation, to determine the optimum square mesh size for the Alaska pollock fishery.

Mesh size was predicted using a model from morphometric measurements of 1024 pollock. Based on this model, a general formula was derived to determine optimum bar length which

would eliminate fish less than 40 cm total length. A square mesh codend was then constructed from 800 ply UC twine and fished from a commercial fishing vessel during commercial fishing operations. A random block design was used to change between a standard pollock codend and the test codend.

Results showed that the optimized square mesh codend reduced the catch of pollock less than 40 cm total length by 73%. This technique provides a method by which management agencies can develop mesh size regulations based on target size of fish.

Pollock Codend Mesh Study 2 (**AFDF, FITC, FRI**)

The first stages of a study to measure the escapement of non-commercial sized pollock from size different codends was completed in October, 1993. Using the alternate haul design, codends of different mesh type (square vs. diamond) and mesh sizes were used. Also employed was a diamond mesh codend with a top panel of square mesh. The codends were detachable and randomly rotated among four catcher vessels of varying horse-power, who delivered their catch to a mothership. Catches of six treatment codends were directly compared to catches made with a double layer, small diamond mesh codend.

Due to an unusually small percentage of undersized fish in the Bering Sea during the field season, testing of the smaller square and diamond mesh codends has been postponed until 1994. Fish size selection curves were developed for all codends; however, only the larger diamond and square mesh codends had adequate sample sizes and L25-L75 estimates within the size range of pollock available to the trawl.

Work with the remaining codends will take place in July of 1994. The work will be followed up with an analysis of survival of pollock escaping from codends. This study is funded by the Staltonstall-Kennedy Foundation.

Halibut Bycatch Reduction in Pacific Cod Trawls (**AFDF,FITC, NMFS**)

A Pacific cod bottom trawl, designed by Gourock Trawls was modified in two ways to reduce the bycatch of halibut in the cod fishery. A "Centipede" fishing line is fished above the footrope using a series of 1 m dropper chains and a horizontal separator panel is situated 1/3 back in the lower belly of the net. Remaining open approximately 3 feet vertically, the separator panel provides a secondary escape hatch for flat-fish.

Field testing during the commercial cod season in the Gulf of Alaska with the separator panel alone was completed in March, 1994. This will be followed by tests of the Centipede footrope and other modifications of the footrope/roller gear using an underwater camera. This study is funded by the Staltonstall-Kennedy Foundation.

Post-release survival and stress of trawl-caught Pacific halibut (Hippoglossus stenolepis) (**FRI**)

Field studies have been conducted in the Gulf of Alaska to develop and implement a sea-bed cage methodology for estimating survival of trawl-caught and discarded Pacific halibut. Field work was conducted during 1992 and 1993; an additional field season is planned for 1994. Trawl caught halibut were placed into cages that were returned to the sea-bed for a period of one to seven days. We found three to five days soaking duration sufficient for detecting all trawl-induced mortality; 1 day was insufficient and 7 days soaking duration produced confinement-mortality. Survival decreased dramatically as deck exposure increased from 13 to 23 minutes. In addition, we tested effects of towing duration, and found significantly higher mortality for longer tows (0.5 vs 2.0 hour tows).

Controls were implemented into the 1993 design. Hook and line caught halibut were placed into sea-bed cages and retrieved after 1, 3, 5, and 7 days. No significant difference in survival was detected between 3 and 5 day soaking durations, but a significant reduction in survival was observed following

seven days in sea-bed cages. Hook and line controls thus indicate that seven days of cage confinement may impact survival. Some cages also were converted to fish traps (i.e., control group). We experienced problems with trap methodology until the end of the field season, when 100% survival was attained for 3 and 5 day soaking durations (sample sizes were small).

A study of the relationship between physiological blood stress parameters and survival was conducted concurrently with the sea-bed cage study. A number of different stress indicators have been analyzed. Results show that stress parameters are fairly accurate indicators of the fate of individual halibut. Stress results also validate controls used in the cage study; control fish typically exhibited lower indicator values than trawl caught specimens, and fish caught in traps had lower values than those caught by hook and line. Recovery of discarded halibut was monitored by sampling fish immediately after being caught and then again after 1, 3, 5, and 7 days in sea-bed cages. Most stress parameters measured returned to normal levels one to three days following capture. Trawl simulation studies also were conducted in the laboratory, where stress indicator values were similar to those observed in the field.

Herding in Survey Trawls (**NMFS**)

The effects of sweep herding on trawl survey catch rates was examined by comparison trawling with different sweep lengths. Catch rates were compared from an 83/112 Eastern survey trawl fished with 15, 30 and 45 fm sweeps in an alternate tow design. These data were fit to a regression model to estimate the proportion of fish herded into the trawl path. Initial results indicate that the 65% of arrowtooth flounder (Atheresthes stomias) in the path of the bridles were herded into the trawl path. No significant variation between size groups has been detected.

## Effects of Survey Trawl Shape on Catchability (**NMFS**)

To examine the effects of trawl shape variation on survey trawl catch rates, comparison towing was conducted between the Nor'Eastern trawl fished in wide and narrow configurations. The narrow configuration was achieved by placing a 16 m restrictor (constrictor) line between the towing warps 100m ahead of the doors. Eighteen pairs of alternate tows with and without the restrictor gave mean trawl widths of 13.3 and 15.6 m. Comparisons of catch per area swept (wing measurement) detected a significantly higher catch rate (+ 10%) for two flatfish species in the narrow configuration. This difference in efficiency compensated for the width differences so that unadjusted catch rates were not significantly different. Comparisons between size groups detected no trend in the catch rate difference by size. Pollock catch rates were much higher (+ 43%) in the narrow configuration, possibly due to increased trawl height or more fish descending out of the water column due to the restrictor. Acoustic observations of midwater schools from a small boat maneuvering around the towing vessel indicated diving behavior on some tows.

## *In-Situ* Research on Fish Behavior in Trawls (**NMFS**)

Underwater video cameras and sonar have been used to observe fish interacting with trawl gear. The purpose of this ongoing work is to detect differential behaviours for use in the reduction of bycatch. Observations in 1993 included pollock, cod, halibut and rock sole in the intermediate and codend of the trawl. Cod and halibut remained in the middle of the mouth, intermediate, more frequently encountering the side panels, while rock sole remained near the bottom panel. Holes in the side panels were found to release both cod and halibut. When codends were brought to the surface and towed at very slow speeds, cod swam downwards to compensate for their positive buoyancy and crowded against the bottom panel while flatfish swam throughout the codend. None of the species were observed to swim forward out of the codend in any significant numbers. In the mouth of the net, flatfish and individual cod swam in front of the groundgear for a length of time related to their swimming endurance, while cod in schools were observed to move back with much less hesitation.

## EAST COAST GEAR RESEARCH

Massachusetts Division of Marine Fisheries
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**Assessment of Juvenile Bycatch and Codend Escapee Survivability in the Northeast Fishing Industry -- Second Year's Study**

Juvenile groundfish discard and its potential low survival are major issues in the management of the multispecies groundfishery off the coast of New England. Four cruises were completed to assess the survival of the deck discard of Atlantic cod (Gadus morhua), American plaice (Hippoglossoides platessoides) and yellowtail flounder (Pleuronectes ferrugineus). Survival rates were determined by placing the "discarded" fish in large cages and returning them to the tow depth for a period of about 24 hours. A spring cruise in April 1992 resulted in overall survival rates of 51% for cod (N=99), 66% for plaice (N=114), and 77% for yellowtail flounder (N=144). Two summer cruises conducted in June 1991 and May-June 1992 produced combined total survival rates of 9% for cod (N=244), 40% for plaice (N=182) and 66% for yellowtail flounder (N=36). One winter sampling cruise was conducted in January-February 1993; cod survival was 36% (N=47); plaice, 0% (N=37); and yellowtail flounder, 50% (N=15). Primary factors that were determined to influence survival of cod were air temperature, decktime, fish length, tow duration and low weight. Air temperature, deck time, fish length and tow duration were most critical to plaice survival. Tow duration and deck time affect the survival of yellowtail flounder. Cod, yellowtail and plaice blood samples were taken from a subset of the landed fish and analyzed for hematocrit, protein, lactate, chloride, glucose, sodium, potassium, total osmolality and cortisol. With the exception of glucose, all measured parameters for cod bycatch were generally elevated above control values, even in those fish sampled within 3 minutes of landing on deck. Yellowtail, in contrast, generally exhibited elevations in all parameters except for cortisol. No control American plaice data were available for comparison. Lactate was the only blood parameter that continued to rise in all three species as time on deck was extended. Cod also exhibited increases in protein, hematocrit, K, and cortisol. Total osmolality increased as

time on deck elapsed for both yellowtail and plaice (as well as chloride in yellowtail; glucose, K, and hematocrit in plaice). These data demonstrate that cod and yellowtail had been considerably stressed prior to landing. Although fish were subjected to highly stressful conditions on deck, this additional stress was less than that the fish experienced prior to being landed. Atlantic cod bycatch, caged bycatch and codend escapees all exhibited perturbations of osmotic balance and elevations in several of the other nonosmotically-linked blood parameters. In general, codend escapees were less stressed than the caged bycatch, which in turn were less stressed than the deck-processed bycatch.

**Whiting Selectivity**

The whiting investigation included two separate cruises. The first was aboard the NOAA SHIP **R/V DELAWARE** in July 1992. This cruise was to the vicinity of Cultivator Shoal, near George's Bank. The purpose of the cruise was to conduct catch selectivity investigations of four codends of different mesh sizes and configurations in the whiting fishery. This cruise included personnel and equipment from URI.

The cruise was completed as scheduled. Thirty-one tows were made in depths ranging between 50-95m with the trawl net aboard, a Yankee 36. The net was modified by attaching different codends to it and fishing while the attached codend was surrounded by a codend cover. Two codends were diamond mesh and one codend square mesh; they measured 70mm(2.75in), 108mm(4.25in), 4.25in respectively.

Codends were measured with she MDMF Marfish Gauge.

Twenty-six of the 31 tows were one hour in duration. The remainder were either 30 min. or 45 min., and were either initial exploratory tows or tows that were shortened because of large dogfish catches.

The codend and codend cover catch was processed separately. The total catch was counted and weighed. The whiting and hake catch were measured for length frequency. A total of 3714 whiting and 3061 hake (both red and white mixed) were caught

and sampled from all three codends and the codend cover. Other species such as sea herring, mackerel, and butterfish, were weighed and sometimes measured, if the catch was significant.

Very low light camera systems were mounted on the net during the daylight tours by personnel from URI. A total of 25 deployments were made with the camera systems. The cameras were usually both mounted on the net simultaneously in locations that were usually in close proximity to each other. Camera location combinations included: 1)headrope and wing; 2) rear of belly and codend; and 3) codend and codend cover. Good footage of the gear and the behavior of some of the caught species was obtained.

The second cruise also involved URI. A graduate student, using previously acquired program data, fashioned a net designed for catch reduction of groundfish - especially flatfish - in the small mesh whiting fishery. Our initial work produced results that were very encouraging in separating out this bycatch than has plagued the whiting fishery. The Division is planning to require a net with species separation capabilities based on this research in the commercial inshore whiting fishery in the near future, after a commercial version of the net is perfected during further joint testing by URI and MDMF. The fall testing of a commercial grade separator trawl provided some progress in design, but a spring cruise is needed to further refine it.

The second cruise also allowed us to acquire more data on selectivity. This data and previously acquired data on selectivity are presented below (Table 1 and Figures 1-4).

Table 1. 1992 Whiting Selectivity Summary Statistics

| CODEND (in/cm) | NUMBER OF TOWS(FISH) | $L_{50}$ (CM) | SELECTION RANGE (cm) $L_{25}$-$L_{75}$ | SELECTION FACTOR |
|---|---|---|---|---|
| 2.72/6.9D chaffing gear | 4(2029) | 23.1 | 13-29 | 3.3 |
| 2.72/6.9D no chafing gear | 6(6154) | 30.0 | 25-35 | 4.3 |
| 3.5/8.9D | 3(1734) | 33.0 | 29-37 | 3.7 |
| 3.5/8.9D | 4(737) | 34.8 | 30-40 | 3.9 |

One interesting part of the investigation was some comparisons with codends with and without chafing gear. When conducting sea trials for codend selectivity it is important to try to simulate commercial practices as closely as possible. Standard fishing practice includes the use of chafing gear, mats of frayed twine or webbing, whose purpose is to cushion the codend and prevent the codend from being abraded. In an experiment conducted in November 1992, selectivity trials were conducted with and without the chafing gear. In those tows made without the chafing gear, there was improved escapement over tows made with the gear (Figure 5). This is probably due to the chafing gear covering the meshes of the codend, thus preventing escapement through these meshes. There may also be behavioral differences in the response of fish to the visual stimuli presented when the chafing gear is present or absent. The difference in escapement may also be a function of bottom type and net configuration. For instance in a net without chafing gear, being towed on soft bottom, the fish may respond to the sand cloud beneath the codend as if in were a solid barrier. While towing an hard bottom this sand cloud would not be present and escapement would he expected to improve. Thus it would be expected to find varying results in escapement through codends without chafing gear. However, if chafing gear is present there is no chance for fish to escape through the bottom of the codend.

**Twisted Mesh in the Codend**

Certain commercial fishermen continue to find methods to counter conservation efforts to reduce bycatch, especially if the regulation may effect the efficiency of landing legal size groundfish. One common technique is to reduce effective mesh size. Dragger fishermen know that legal-size groundfish escape from 5.5 inch mesh, so efforts are made to decrease the escapement of fish through the codend.

We became aware of a method to greatly reduce the effective codend mesh size early this spring. A codend top-panel was available that was made with knots that twisted the twine. (The top-panel of the codend is the main area of that section of the trawl that allows fish to escape; the bottom panel of the codend is covered with chafing gear which essentially prohibits fish from escaping.) The result was a codend that measured a stretch mesh of six inches, but when properly rigged and towed had an effective mesh size of about three inches.

We acquired an example of this netting and constructed a codend using it. A video was produced to provide fishery managers and law enforcement personnel a graphic means to readily identify this mesh. The video described the construction of this twisted mesh panel, how it differed from the usual codend construction, and showed how it behaved underwater when towed. This video was shown to the New England Fishery Management Council, and copies of it were forwarded to the Mid-Atlantic Council, the U.S. Coast Guard and fishery researchers and managers located in New England, along the Gulf and Pacific coasts and Canada. A copy was also sent to the Scotland's Department of Fisheries and Agriculture, in response to their request.

SUMMARY OF ONGOING RESEARCH AT
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# LOBSTERS AND TRAPS: SUBSIDIZED HOUSING OR THE LAST MEAL

K.M. Castro

Lobstermen in the Northeast USA have long speculated that juvenile Homarus americanus utilize their traps as a source of food and shelter as they freely enter and exit traps. The concept of man-made objects enhancing habitat value is not a new one; increased habitat utilization may be evidenced by the presence of significant densities of the target species in response to increased prey, shelter or other factors. This study is addressing two specific questions: (1) What is the frequency of sub-legal lobster revisits And what activity is observed inside the traps? and (2) Does the presence of a baited trap increase the density of lobsters in a given area?

These experiments are being conducted using a mix of tag-recapture, LCROV observations with a low-light camera and red lights and quadrats using SCUBA diving and the Thompson adaptive cluster sampling method. Density changes are being tested with a Beyond-BACI design, with several control areas and one treatment area. Laboratory experiments are supplementing the field work in regards to the possible damaging effects of tagging. Data has been collected over two seasons (summer and fall 1993) and more sampling will be conducted during the winter and spring.

# THE EFFECTS OF MOBILE FISHING GEAR ON SEABED MOUNTED INSTRUMENTATION HOUSINGS

J.T. DeAlteris and J.A. DeAlteris

Scale model testing of the interaction of various mobile fishing gear types with seabed mounted instrumentation housings was conducted. The purpose of the testing was to find a housing design which would withstand repeated impacts with these fishing gear types. The fishing gear models used included a trawl net with a roller sweep, a trawl net with cookie sweep, a trawl net otter board door, a scallop dredge, and a hydraulic clam dredge. These tests were performed in the tow tank facility at the University of Rhode Island and were made in one-tenth scale.

The instrumentation housings were designed to hold hydrophones which will be used for underwater tracking as part of an acoustic tracking range for the U. S. Navy. The designs chosen to be tested were in the shape of truncated pyramids, with three different slopes to the pyramid sides while holding the pyramid pinnacle (and thus hydrophone height) above the seabed constant. The data collected included impact and pullover forces for each of the fishing gear types on each of the housing designs taken at three representative towing velocities and two different approach orientations. The lateral resistance to movement and settling observations for the three pyramid designs was also evaluated using scale models in a tank with a sand bed.

Based on these tests and site specific environmental considerations, various prototype housings will be tested in the field for their survival against interaction with commercial fishing gear.

# EFFECT OF SIZE SELECTION WITHIN AND BETWEEN FISHING GEAR TYPES ON THE YIELD AND SPAWNING STOCK BIOMASS PER RECRUIT AND CATCH PER UNIT EFFORT FOR A COHORT OF AN IDEALIZED GROUNDFISH

O.T. DeAlteris and R. Riedel

A discrete time model was developed to evaluate yield and spawning stock biomass per recruit and catch per unit effort for a cohort of an idealized groundfish. This fish is characterized as relatively long lived (M = 0.2), slow growing (K = 0.2) with maximum length and weight of 100 cm and 10 kg, respectively, and 50 percent maturity at an relatively early age of 3 years. The size selection characteristics of trawls and hooks were described with a logistic distribution function with a range of $L_{50}$,s and steepnesses; and the size selection characteristics of gillnets and traps were described with a normal distribution function with a range of $L_{opt}$'s and standard deviations.

Analysis of isopleth diagrams for yield and spawning stock biomass per 1000 recruits for both types of selection functions indicate that yield is maximized for both types of selection functions when harvesting is directed on a fish length slightly larger than that at which biomass for the cohort of the unfished population is maximized, and at fishing mortality levels of 2 and greater. Spawning stock biomass under these harvesting conditions is between 24 and 36 percent of the unfished condition. The steepness of the logistic distribution function as related differences in trawl codend mesh shape or hook style does not affect the cohort yield, but significantly affects the spawning stock biomass, at these levels of fishing mortality and $L_{50}$. The standard deviation of the normal distribution selection function as related to differences in gillnet and trap design also does not affect the cohort yield, but again significantly affects the spawning stock biomass at these levels of fishing mortality and $L_{opt}$. Thus, the sharper the selection process, the greater the spawning stock biomass available for production of future cohorts, when the harvesting is directed at fish lengths slightly larger than that at which the biomass for the cohort of the unfished population is maximized.

In contrast, catch per unit effort is maximized at fishing mortality values of approximately 0.5, when the age at entry

or length of susceptibility to fishing gear is set at the age or length of maximum biomass for the unfished cohort.

These conflicting results present a dilemma for the fishery resource manager: maximize cohort yield at fishing mortality values of 2 and greater, with a minimum 65 percent reduction in catch per unit effort, or maximize catch per unit effort with a 25 percent reduction in potential yield. However, with compromise, 85 percent of the maximum potential yield can he realized with only a 20 percent reduction of catch per unit effort at a fishing mortality level of 0.75.

Ongoing research is applying this generalized model to specific groundfish species in the Northwest Atlantic Ocean, and stochastic processes will be incorporated into the constant recruitment function.

## ASPECTS OF THE CATCHABILITY OF TEMPERATE WATER FISH TRAPS

H. Lavigne and J. DeAlteris

Fish traps have many conservation attributes not shared by other commercial fishing gear. While trap use in temperate waters has expanded during the last few decades, an imperfect knowledge of trap function exists. Also, very little is known concerning the behavior displayed by fish in relation to these traps. Both trap design and fish behavior directly affect fish catchability. This project will test various hypotheses concerning the effect of select trap design features and fish behavior on trap CPUE. Underwater video data will be collected and used to generate in-trap ethograms for select inshore species. An end product of this research will be new hypotheses regarding trap design improvements that, if tested, could lead to enhanced trap size and species selectivity, and CPUE.

# THE EFFECTS OF TRAWL SWEEP RIGGING ON FLATFISH BYCATCH REDUCTIONIN THE SMALL-MESH WHITING FISHERY OF NEW ENGLAND

D. Morse and J. DeAlteris

Sea trials to evaluate the effects of trawl sweep rigging on the retention of whiting, hake and flatfishes were performed in the small-mesh whiting fishery of New England. Experiments conducted during November and December, 1992 in Cape Cod Bay, Massachusetts, examined the selective effects of a raised fishing line, while trials in June and July of 1993 near Block island, Rhode island, evaluated designs combining an elevated fishing line with a discontinuous chain sweep. Sweep heights ranged from 0.45 m to 0.9 m in the bosom of the net, with breaks in the sweep ranging from 2.1 to 4.6 meters wide. Designs were evaluated through alternate tow catch comparisons, net geometry mensuration and videographic monitoring.

Wilcoxon Signed-Ranks tests detected no significant reductions in bycatch in the elevated fishing line experiments at the 95% confidence level, while dramatic reductions in bycatch occurred in the discontinuous sweep trials, though loss of target species generally accompanied bycatch loss. The final experimental type, a design with a sweep "window" 0.45 m high and 2.1 wide, reduced flatfish catch while retaining target species, but low sample size and scarce whiting detract from these findings. It is concluded than bottom disturbance by the sweep is the primary factor in flatfish escapement behavior in the net mouth, and can be used effectively for selectivity purposes. Further, future experiments should focus on: 1 - designs which feature 10.2 to 20.3 cm clearance between the hanging line and sweep, and a break in the sweeps chain of between 0.9 and 1.8 meters; and 2 - the possibility of designing ground gear with "windows" of no substrate disturbance.

## A STUDY OF THE SURVIVAL OF RELEASED SCUP (Stenoztomus chrysops), BLUEFISH (Pomatomus saltatrix), AND WINTER FLOUNDER (Pleuronecetes americanus) FROM RECREATIONAL ANGLING

E. Williams and 1. DeAlteris

In 1991 an estimated 7,691,000 fishing trips were made by marine recreational anglers in the North Atlantic. During these trips an estimated 2,254,000 scup, 1,851,000 bluefish, and 224,000 winter flounder were released by recreational anglers. Regulations have been created for these species with little knowledge of survival rates for fish caught and released. Management should take into account the mortality inflicted by the hooking, handling, and releasing process. Survival estimates from caught and released fish will aid fisheries managers in population modeling and in the analysis of potential yield-per-recruit. Preliminary results from an ongoing study at the University of Rhode Island indicate survival of fish released from recreational angling is almost entirely dependent on the location of the hooking wound. Scup which have been hooked in the jaw area and placed in a cage for 7 days have shown 100% survival, even after 4 minutes of handling. However, scup which have been hooked in the gills or esophageal region have only exhibited a 4% survival rate. Bluefish, thus far, have exhibited 100% survival regardless of hooking location.

Agency
State of Maine, Department of Marine Resources
Fisheries Technology 1993-94 Progress Summary

Daniel F. Schick
Marine Resources Scientist

Two areas of research are currently being pursued, both dealing with northern shrimp fishery gear. The first is a series of tests of a descending mesh panel mounted in the aft area of the belly of an otter trawl. The initial purpose of this panel was to knock down the amount of trash, primarily rockweed (Ascophyllum sp) and lobsters, that was caught by the gear. The fisherman had installed this panel of 4" mesh twine in frustration over the amount of time he spent picking clean

his shrimp catch. With the advent of the Nordmore grate, the fisherman advocated the use of this panel instead of the grate stating that the panel released finfish, if an escape hole was opened ahead of the lower edge of the panel. We made two trips with him, testing the gear in sequential pairs with a control net. The panel did indeed release finfish, but the size and number of fish retained substantially exceeded the size and numbers retained by the Nordmore grate. The permission was denied and the fisherman hopes to get us back out to try the panel with 3" mesh to improve the separation.

The second area of research centers around a modification to the Nordmore grate system. This is the addition of a second grate behind the first one with the second grate bar spacing being 7/16" instead of 1". The purpose of the Nordmore system is to allow fish to escape in front of the first grate and allow shrimp to pass through. The purpose of the second grate is to retain large shrimp and allow the small shrimp to pass through. The large shrimp would slide up the second grate and be retained in the cod end, which is attached to an opening at the top of the second grate. A small mesh panel on the cod end behind the second grate would prevent the small shrimp from reentering the net. This idea was proposed by two separate fishermen, who have encountered high catches of very small northern shrimp while using the Nordmore grate. There is a very strong year class of northern shrimp in some areas of the western Gulf of Maine that should be only partially recruited to the gear. It may be that there are so many of these shrimp relative to the larger, fully recruited shrimp that they represent a sizeable portion of the catch even though only partially recruited. There may also be a shift in the cod end selection curve for shrimp created by the placement of the Nordmore grate in the extension. Decreased water flow in the cod end and decreased mesh opening ahead of the ball in the cod end due to smaller total catches (few fish) may both contribute to this shift. One fisherman has already constructed his system and testing of the double grate device will begin this spring.

## GULF COAST GEAR RESEARCH

Agency
National Marine Fisheries Service
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In 1990, Congressional amendments to the Magnuson Fishery Conservation and Management Act required the Secretary of Commerce to establish a program to assess the impact on fishery resources of incidental harvest by the shrimp trawl fishery under the jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils. In response to this requirement, the National Marine Fisheries Service (NMFS) Southeast Region developed a research requirements document (NMFS, 1991), and a research plan was developed by the Gulf and South Atlantic Fisheries Development Foundation (GSAFDF, 1992), addressing the shrimp trawl bycatch problem. One of the objectives of the plan is to identify, develop, and evaluate gear (bycatch reduction devices, BRDS), non-gear and tactical fishing options for reducing bycatch.

The Harvesting Systems Division of the NMFS Southeast Fisheries Science Center's Mississippi Laboratories was tasked to investigate the potential for developing gear modification to mitigate the problem of shrimp trawl bycatch mortality. The objectives of the research are to: (1) evaluate existing bycatch reduction techniques, (2) collect data on the behavior of fish and shrimp when encountering shrimp trawls and, (3) develop and evaluate new bycatch reduction techniques.

Fifty-one bycatch reduction device conceptual designs have been evaluated by Harvesting Systems Division scientist scuba divers. These designs were developed by the commercial shrimping industry, the Harvesting Systems Division, and other researchers working cooperatively with commercial fishermen and net shops. New prototypes incorporate design features developed to stimulate fish escapement based on behavioral responses.

This status report presents data from scuba diver evaluations and bycatch reduction/shrimp retention test results for prototype bycatch reduction device (BRD) designs. It is intended to

document research results to date, and to stimulate new gear development.

Included in this report are descriptions, diagrammatic drawings, and diver evaluation comments for 39 bycatch reduction device designs. Fish bycatch reduction and shrimp retention data are presented for 30 prototype BRD designs. A discussion of fish and shrimp behavior in trawls and in response to bycatch reduction devices is also included.

Thirty design combinations have been tested on commercial fishing grounds. Of these, 12 have demonstrated overall fish bycatch reduction rates between 43% and 67% and 7 had shrimp retention rates between 90% and 100%. Prototype designs that show the best potential for achieving a 50% reduction in total fish bycatch with better than 90% shrimp retention are the large mesh funnel design, the extended funnel design, the HSB design, and the fisheye design.

Total fish reduction rates varied according to catch composition, and reduction rates for individual species varied among design. Croaker, spot, catfish, Atlantic bumper, longspine porgy, butterfish, trout, and whiting were the predominant fish species encountered during BRD evaluation testing.

The large mesh funnel design had 34% or greater reduction rates for predominant species and was the only design that significantly reduced longspine porgy. All of the predominant species were reduced by an least 36% by the extended funnel design except longspine porgy and croaker. Reduction rates greater than 45% were achieved with the HSB for all predominant species except trout. The fisheye designs, had good reduction rates for all of the predominant species except longspine porgy. the double fisheye design had a low reduction rate for trout.

Data collected on economically important species, including shrimp, showed the best shrimp retention rates were achieved with the extended funnel, the large mesh funnel, and the HSB designs. The best reduction rates for red snapper were achieved with the RWF fisheye, the double fisheye, the bottom position fisheye and the HSB design. Reduction rates for Spanish and king mackerel were best with the large mesh funnel, the extended funnel, and its fisheye designs.

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## Trouser Trawl Progress Report

Work to reduce bycatch of undersized finfish in the winter trawl fishery for the 1993-94 season began in January 1994. This work is funded by the U.S. Fish and Wildlife Service and the objective is to demonstrate if the bycatch of important finfish species can be reduced through changes in mesh sizes of fish trawl codends and extensions. Target finfish species are weakfish, black sea bass, and scup.

A trouser trawl, patterned after commercial flynets, is being used in the project. The trouser trawl splits into two separate extensions and codends after the last tapered body section. This allows for direct comparison between experimental and control nets. To date, five cruises have been completed aboard a chartered commercial vessel with eight sea days and 32 tows. All trips have been inshore and have targeted weakfish. Black sea bass/scup work is slated to begin the second week in March. The following extensions and codends have been tested against a 2-inch diamond control extension and codend.

4-inch square extension and 2-inch diamond codend
3.5-inch square extension and 2-inch diamond codend
3.5-inch square extension and 3.5-inch square codend

3-inch square extension and 3-inch square codend
3-inch diamond extension and 3.5-inch diamond codend

3-inch square codend
3-inch square extension and 3.5 inch diamond codend

We have seen a substantial reduction in the amount of fish caught in the experimental side compared to the control for each of the above sizes. There were some differences in the size of fish (i.e. small fish released) between experimental and control sides but not the differences we would like to see. So far, weakfish from 8-11 inches have dominated the catch. The extensions and codends we have tested have released almost everything under 12 inches. We will not be able to demonstrate size selectivity (i.e. release of small

fish) until larger fish are found in future cruises.

I believe the remaining nine days of testing need to be completed before any further discussion can be made concerning the results of this work. I am hopeful that this testing, along with the availability of larger fish, will result in mesh sizes that select for various sizes of weakfish.