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International Council for the
Exploration of the Sea

C.M. 1979/B:4
Fishing Technology
Committee

REPORT OF THE WORKING GROUP ON REACTIONS OF FISH TO FISHING OPERATIONS

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Chairman: Dr C S Wardle

1. Meeting Place: Chalmers University of Technology Horsalsvagen 1, Goteborg, Sweden

2. Date: Wednesday 9th and Thursday 10th May, 1979

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4 General Aims of the Working Group

The aims of the Working Group have not changed since its first meeting at Nantes in 1973. They are: to discuss current practical problems in fishing operations particularly those that might involve aspects of fish behaviour, to keep in touch with techniques and facilities used to observe the reaction

of fish to fishing operations, to maintain an up-to-date knowledge of relevant studies of fish physiology, and behaviour including hearing and vision studies, to discuss interpretation of fish behaviour in relation to fishing operations, and to identify and encourage co-operative experimental work where this seems worthwhile.

5 Summary of Past Meetings

The first meeting, in Nantes in 1973, considered and defined these aims. The second meeting, in Aberdeen in 1974, gave special attention to the swimming performance of fish and generated a special ad hoc meeting at Texel which published a 76 page report on design and practical operation of research aquarium systems (Gear and Behaviour Committee, C.M. 1975/B:3). The third meeting in Ostend in 1975 concentrated on the effect of electric fields on fish (C.M. 1975/B:19 and B:20). The fourth meeting in Hull in 1976 as well as producing a general report (C.M. 1976/B:2), held a joint session with the engineering working group and produced a special joint session report on the methods for observing gear and reaction of fish to gear (C.M. 1976/B:3).

At Hamburg in 1977 (C.M. 1977/B:4) the special subject discussed was methods of attracting fish. At Bergen Council Resolutions (C. Res. 1975/4:11 and C. Res. 1976/5:4) relating to acoustic methods for pelagic and demersal stock assessment were considered and the effect of fish behaviour patterns on the echo target strength was examined at length as the special subject recommended by the Council Resolution 1977 2:12 (b).

At Bergen the Working Group recommended that "schooling behaviour in relation to the catching process" should be discussed at Goteborg and Council Resolution (C. Res. 1978/2:206) confirmed that the subjects included in the general aims of the Working Group should continue to be updated.

6 Agenda

1 Progress Reports and Programmes outlining research projects continuing in each country.

2 General contribution on subjects to be considered by this Working Group.

3 Special subjects discussed - a) Reaction of fish to rope trawls
b) The schooling behaviour of fish in relation to the catching process.

7 Progress Reports and Programmes

Belgium Although there are many practical fishing studies including application of electric fishing continuing in Belgium no particular work on fish reactions is in progress.

Canada a) A study has been made in Newfoundland of the reaction of crabs to traps. The side-entrance traps were found to be better than top-entrance traps, and those with 3 entrances were better than those

with 2. Centre-placement of the bait in the trap was found to be optional, and was more critical in top-entrance traps than in side-entrance traps. The entrances are best above the bottom of the trap to avoid conflict between late arrivals and crabs already in the trap. Trap saturation starts to reduce catch rate within 2 hours. It was estimated that 80% of the potential catch is missed during the normal 48-hour soak.

b) In bio-mass estimates of red-fish by trawling, the duirnal variability of results was found to be less than variability caused by contagious distribution.

c) Mid-water trawls for shrimp have been found to avoid juvenile red-fish catch. Separator shrimp trawls are having only mixed success, and it is proposed to study the vertical distribution of shrimp in more detail as a basis for better design of gear and fishing strategy. Variable depth sonar is being developed for better shrimp detection.

d) The tri-lab acoustical program for fishery resource inventory techniques is converting to micro-processor hardware and data logging for more sophisticated data and analysis subsequently ashore. Maritimes Region is more interested in counting techniques (ground fish) where as Newfoundland is more interested in integrating (capelin) and is developing its own hardware capability, so there may be more separation of the programs in the future. Target strength measurements continue at St Andrews - cod and herring already, other species to follow.

e) Development of BRUTIV is coming along, there have been some successful trial observations. It is to be used for evaluating accustic surveys and for observing fish reactions ahead of a trawl.

f) Acoustic techniques are starting to be used to study fish communities and their reactions to pollutants in the Great Lakes.

Faroe — Using a 26 fathom mouth opening midwater net fish were observed diving 50 metres on sonar observing mouth and funnel area. No specialist programme is undertaken in fish reaction studies.

France — Experiments to evaluate the different Trolled lures used in the tuna fisheries has continued and the superiority of black lures not normally used by fishermen has been shown. In dull weather conditions 70% to 80% of the catch was taken on these lures. Red was good in bright weather.

A valuable study was made in selective fishing for Nephrops using a 4 panel trawl with separate lower and upper codends. The success in separating small fish from the shellfish depended on the design of a horizontal splitting panel. Contribution by J Prado (title - Experimentation d'un chalut selectif a langoustine).

A careful study has been made of the different behaviour of sprat,

anchovy and sardine in pelagic nets using evidence from echo sounder and catch. Contribution by N Diner and D Overault (title - Donnees preliminaires sur le compartement des petits pelagiques cotiers du Golfe de Gascogne vis-a-vis du chalut pelagique). The sprat was shown to be much easier to catch than anchovy which was also easier than sardine. This gave rise to important errors in the assessment of the abundance of each of those species.

Germany Federal Republic of — There is considerable interest in the reaction of fish particularly to the new rope trawls. Herding of red fish has been observed by use of echo sounder, whereas blue whiting showed no reactions to the rope trawls.

Iceland — It is hoped to continue observation of the selectivity of seine nets and of trawls designed to separate prawns and small fish. Selectivity of separator prawn trawls was reduced when large numbers of prawns were caught and clog the panels.

Netherlands — There are a number of university groups working on aspects of fish behaviour but none particularly dealing with fishing gear reactions. There is a great deal of interest in the reactions of fish to gear at the IJmuiden laboratory but, no specialists. Cooperative programmes with other institutes, including diving observations with Aberdeen Marine Laboratory, have helped to examine the behaviour of fish in gear.

Norway — A programme has been developed where members of the University, the Marine Institute and the Fishery Technology Institute co-operate on a number of projects.

In Bergen the aspects of behaviour of fish in long line fishing are a major part of their research effort. The investigations include aspects of bait, hook shape, construction of snoods and lines, fishing technique and seasonal variations.

A study investigating the effect of adding an artifical structure (eg an oil rig) to a marine area is being continued.

The behaviour of capelin and blue whiting in a mid-water trawl using acoustic techniques to look at herding and by observing meshing of fish etc is continuing.

Acoustic techniques continue to be used for a number of studies including the observation of the change in attitude and spatial distribution of fish when a vessel is approaching.

Other studies include: The use of sound signals to recall salmon to feeding points is being developed for fish farming purposes. Acoustic heart beat tag studies and behaviour of fish during trapping.

Poland No specialist work in the field of fish reaction but some important studies have been made of the use of nylon tape instead of twine to form the meshes in the codend and the effect of this on codend selectivity has been examined.

Sweden No specialists are examining fish behaviour aspects of gear. Some attempts are being made to develop direct diving observation techniques with the aim of filming fish reactions a diving vehicle designed to take diving observers alongside a fishing gear was shown to those attending the meeting.

United Kingdom Aberdeen Marine Laboratory is continuing a programme of research into long line fishing. Subjects included: laboratory experiments investigating the sensitivity of fish to chemical stimuli; field bait and hook tests by comparative commercial fishing and direct observation of fish reactions to bait. Artifical baits so far tried have been less effective than natural baits. Measurement of the sensitivity of vision and of directional hearing in fish is continuing. The natural movements of fish in Loch Torridon are being followed by applying acoustic tags in a sound range.

Aberdeen Marine Laboratory is continuing a programme of fish swimming performance studies and experiments where fish reaction behaviour to gear components is being recorded. MacLennan pointed out the relevance of this type of study to the development of rope wings rising bellies and other devices where design is towards less damage and decreased drag.

There is a growing collection of video tapes which now includes a large number of fish reactions to gears made by a diver piloted wet vehicle or by a TV camera with remotely adjustable mirror that can be mounted on the gear in water working with daylight to 100 m.

A towed vehicle which will carry the TV to all parts of the gear without divers in attendance is being undertaken as a development of the diving/TV technique. A prototype vehicle was tested during this year in which horizontal and vertical position control is maintained using Magnus effect rotors. Observations were practical to 100 m using natural daylight.

USA Gear research and gear related fish behaviour studies in the United States are carried on by the National Marine Fisheries Service, state agencies, universities, and individuals. The emphasis in much of this work is on conservation as we have a recognised need to develop gear that is size and species selective. Another significant area of study is in the development of sampling gear to assess the resource. On a smaller scale, studies are done to improve safety and comfort at sea and to improve the efficiency of the gear.

Following is a list of gear and behaviour work currently underway, recently accomplished, or planned in the near future:

Shellfish Sampling System - An improved shellfish sampling system for surf clams and ocean quahogs has been developed for use in the Northwest Atlantic coastal waters. The System incorporates a large steel dredge with a 60" (152 cm) blade. Water, under pressure, is supplied to a manifold forward of the blade to dig and soften the bottom in front of the blade. Power is supplied to a 100 KW submersible pump on the nose of the dredge through an electrical cable from the vessel. This cable, independent of the towing cable, is stored on a slave winch that responds to the external stimulus of the towing of the towing cable. The dredge is set and hauled on a ramp installed in the chute of a stern trawler.

Beam Trawls - Beam trawls are under development both in the North Atlantic and Gulf of Mexico. They are being evaluated as juvenile samplers and as selective commercial gear.

Trawl Mesh Selectivity - Mesh selectivity studies were accomplished in the Northwest Atlantic effectively demonstrating that for the commercial codends now in use, an increase in mesh size would result in an increase in marketable catch.

Scallop Conservation Gear - Work is beginning on the study of existing gear used in the Northwest Atlantic to determine what changes can be made or new gear can be developed to make it less destructive and more size selective. Preliminary evidence indicates existing gear may be only 10 to 20 percent efficient while destroying another 10 to 20 percent of the population. Also, the size of scallops caught in a drag does not relate directly to the ring size used in the drag.

Trawl Mensuration - The National Marine Fisheries Service in cooperation with the state of Massachusetts is planning the development of a small self-contained portable trawl mensuration system that can be readily set up on commercial and research vessels to determine net mouth height and spread.

Gill Net Mesh Selectivity - Plans are being formulated for anticipated gill net mesh selectivity studies.

Shellfish Dredge Instrumentation - Instrumentation is under development that will allow direct real time monitoring of dredge speed over the bottom, distance covered, depth of blade cut into the bottom, water pressure, and flow.

Sea Turtle Conservation Shrimp Trawl - The incidental capture of sea turtles in shrimp trawls has become a problem of major concern in the United States. In response to this concern, a three-year research project was initiated in 1977 to evaluate incorporation of large mesh panels across the mouth of shrimp trawls to prevent the capture of turtles. Design goals are to reduce the incidental capture of turtles to near zero while maintaining an acceptable efficiency for shrimp. Initial results were good from cooperating commercial shrimp vessels

in the Gulf of Mexico and Atlantic. The excluder panels significantly reduced turtle capture, although some reduction in shrimp catch also was experienced. Shrimp loss, however, was sufficiently small to warrant continued development and evaluation.

Juvenile Sea Turtle Tracking - Small radio tags have been developed for tracking headstarted sea turtles as part of a research program to evaluate the value of headstarting as a means to increase dwindling populations of endangered sea turtles. The tags are mounted in a hydrodynamically stable float attached by a short lanyard to the carapace of the turtle. Overall weight of the tags is 25.3 grams.

Porpoise Tags - Several new concepts in tag design and marking techniques are being evaluated as part of a program to assess and monitor porpoise stocks in the Pacific. Prototype plastic disc tags were developed for attachment to dorsal fins of porpoises, and a portable liquid nitrogen freeze branding system was constructed. Flow tank and live animal testing of the tags produced good results, but field application trials yielded mixed results. Tests of the brand also produced mixed results, especially in the length of time a brand mark remained visible on test animals. This work is continuing.

Perpoise Containment System - The facility for handling porpoises at sea reported on last year is now being used operationally from chartered tuna seiners in the Pacific. The system is designed for handling up to 500 porpoises in such a way that they can be handled individually for collection of biological data.

Tuna Purse Seines - Work is continuing on modifications to purse seines used in the eastern tropical Pacific tuna fishery to reduce the mortality of porpoise caught incidental to tuna. Most of this work involves changes in the seines to prevent porpoise suffocation.

Satellite Tracking of Marine Animals - A 1000-gm satellite transmitter has been developed and tested on captive porpoises. The transmitter successfully linked to Nimbus-6 for location positioning accurate to about 5 kilometers. Tests scheduled this spring include wild animal tracking near Hawaii. Additionally, a larger transmitter is being developed for tests on sea turtles this summer.

Shrimp Assessment - A shrimp detector and counter system is being developed as a potential means to assess shrimp stocks. An electrical pulse generator is used to stimulate a characteristic jump response of shrimp from the bottom, and the character of the resulting Doppler signal is used to discriminate between shrimp and other animals by a detector/counter.

Squid Fishing - The National Marine Fisheries Service has supported squid fishing studies in the Gulf of Maine with trawls and jigs and fishing in Nantucket Sound using lights.

Trawl Doors - Both the Massachusetts Institute of Technology (MIT) and the University of Rhode Island (URI) have been studying trawl doors. MIT is doing basic research into otter board design, and they

are producing specifications for a new door. URI has under development and test the "Point Judith" Polyvalent door.

Kort Nozzle - URI is also studying the effectiveness of a Kort nozzle on a local fishing vessel.

Hydroacoustical Research - The United States has conducted hydroacoustical research for a number of years on both the East and West Coasts. There is an important international joint USA-USSR meeting on "Hydroacoustical Methods for the Estimation of Marine Fish Populations" to be held in Cambridge, Massachusetts, USA during 25-29 June 1979. The goals of this meeting are (1) to form definite statements relative to the current state of the development of hydroacoustical methods, (2) to identify further research and potential improvements, and (3) to discuss the effectiveness of hydroacoustical methods in relation to, and in consonance with, other fisheries resource assessment teachniques.

USSR There are a great many studies continuing concerned with the reaction of fish to fishing gears these include: The understanding of mechanisms of electric fishing including electric field parameters and their application; Modelling and other computer techniques are used to understand and predict the behaviour of schooling fish as well as experiments at various research institutes: Fish swimming ability, speed and endurance are studied including the effects of electrical stimulation. Underwater observation by Scuba divers by various techniques are used to observe the reaction patterns of fish in gears particularly pelagic gears. Recently differences in reaction of small and large schools of horse mackerel and sardine have been observed.

8 General Contribution

The following contributions were presented for discussion at the meeting.

i Selectivity

Experiments with a selective trawl for Nephrops written contribution by J Prado.

ii Reaction Observations

a) Preliminary observations of the reactions of small coastal pelagic fish to a pelagic trawl in the Gulf of Gascoyne written contribution by N Diner and D Guerault.

b) Fish behaviour in the vicinity of the purse seine published paper by E H Sabourenkov.

c) Avoidance of capture in coastal fishing nets by migrating Atlantic salmon, Salmo salar L. written abstract by A D Hawkins.

d) Behaviour of Gadoid species during hooking verbal presentation of work of I. Huse by K Olsen.

iii Echo Surveys

Target strength measurements on live fish description of current work by K Olsen.

9 Reaction of Fish to Rope Trawls

During earlier discussions of this meeting it became clear that there was a wide interest in how fish might and do behave when reacting to the new rope trawls. This special discussion was framed around the following main points.

i Rope spacing, angle of attack and colour.

ii Length of ropes and extent and transition towards codend.

iii Ropes or big meshes and the likely difference in reaction

iv The relation between towing speed, depth and selectivity

v How important is light level.

The discussion had one major conclusion that observations of reaction to these gears was nearly nil and efforts to make observations should be encouraged. A number of possible cooperative studies were generated by this discussion.

10 Discussion of the schooling behaviour of fish in relation to the catching process

A written contribution by Dr T J Pitcher, title: "The role of schooling in fish capture", was presented by Dr Wardle and used as a framework for the discussion.

The subjects outlined were discussed and extended in detail by those present and it was suggested that this paper should be presented separately by Dr Pitcher to the Fishing Technology committee as an ICES paper. (C.M. 1979/B:5 Fishing Technology Committee Ref Pelagic Fish Committee.)

11 Films and Video Tapes

As part of the meeting a 16 mm colour film title "Divers Observe Seine Nets Fishing" was presented. This was a film made to show most of the important underwater cine film made by the Aberdeen Marine Laboratory diving scientists during study of fish behaviour in the Danish Seine net fished by the Scottish Fly-drag technique. A selection of video tape extracts showing trawls and fish reactions and scallop dredges made by the same team with a TV camera was also shown.

12 Recommendations

1 The meeting confirmed particularly during discussion of the reaction of fish to rope trawls and the role of schooling that there are many points of behaviour as yet unknown and of great importance in improving both the selectivity specificity and efficiency of fishing gears. It was a general feeling that countries should continue to encourage and support the study of behaviour and reaction of fish to fishing gears and that the Working Group should meet again in conjunction with the Working Group on Research on Engineering Aspects of Fishing Gear, Vessels and Equipment at Reykjavik May 5 to 9 1980. (See also Rapport General (C.M. 1979/B:) on combined Fishing Technology committee Working Groups Goteborg 7 to 11 May 1979.)

2 This Working Group will develop a practical bibliography concerned with the subject of 'The Reactions of Fish to Fishing Operations".

3 At the next meeting, in addition to the general discussions, this Working Group will discuss "Selectivity in fishing gears and the possibilities of species specific fishing".

C S Wardle

4 September 1979