ADVANCED RESEARCH WORKSHOP

Deep Water Fisheries of the North Atlantic Oceanic Slope

Summary Report

Seafish Report No.438

March 1994

Sea Fish Industry Authority
Technology Division

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1-4th March 1994
Dennison Centre, Hull, England.

Summary Report of Workshop

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A. G. Hopper
Secretary to the Workshop

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1. INTRODUCTION

Until recently the Continental Shelf areas of the North Atlantic have provided adequate fish stocks for the purposes of professional fishermen. Today most of these stocks are fully exploited or over exploited and commercial fisheries are, of necessity, severely restricted. Inevitably this has led to a search for new resources and, in particular, there is an increasing interest in the deep water species of the Atlantic Slope (circa 500m to 2000m).

Although the biology of the fishes of the deeper water have been extensively studied by scientists for a century or more, there has been very little work on stock sizes. There is very little information to give to fishermen, or indeed to legislators who must exercise some restraint on these fisheries if the mistakes arising from too much effort on the Continental Shelf are to be avoided in deeper water. Up until now there has been only a limited amount of effort directed at these fisheries and for only a few species such as roundnose grenadier (*Coryphaenoides rupestris*), roughhead grenadier (*Macrourus berglax*), blue ling (*Molva dipterygia*), orange roughy (*Hoplostethus atlanticus*), black scabbard (*Aphanopus carbo*) and the more familiar Greenland halibut (*Reinhardtius hippoglossoides*).

Scientists agree that the ecosystems in which these species live are different from the Shelf ecosystem and that an extensive and ill-considered exploitation of these deep water stocks will put the future of this important resource at risk.

This, therefore, is the background to the Workshop. In discussions the Sea Fish Industry Authority (Seafish) and the Scottish Association for Marine Science (SAMS) felt that it was timely to ask scientists from states surrounding the North Atlantic to pool their knowledge and to make some carefully considered statements about the resources and, at the same time, identify new research and develop inter-institute collaboration to tackle some of these research tasks.

The Workshop was held in Hull, England, from the 1st to 4th March 1994 and was attended by 45 scientists, technologists, fishermen and administrators from 15 countries.

This report describes the main findings of the Workshop and gives abstracts of the 21 papers presented. The full papers will be produced in the NATO-AS1 series by Kluwer Academic Publishers of Dordrecht, the Netherlands. The Workshop has emphasised the pool of scientific knowledge on the subject, but it has also included some papers on the fishing technology and end-use of these species.

The Workshop was partially funded by NATO and by the EEC DGXII. It was organised jointly by Seafish and SAMS.

2. ORGANISATION OF THE WORKSHOP

The planning of the Workshop took almost two years, mainly because there was some uncertainty about the total funding being available. This, in hindsight, proved to be of considerable benefit as scientists were able to have ample time to prepare papers and, in some instances, slant their current research work to answer some of the questions which would inevitably arise at the Workshop.

A small steering group (see Appendix I) was formed to plan and review the programme and to ensure a balance of material. The group corresponded regularly and met in November 1993 to finalise plans.

The Workshop took place over four days, the first two of which were used to present the papers and permit some questions. The third day was allocated to 4 workshop sessions each with a chairman and rapporteur who were given the responsibility of drawing up a summary of findings from each workshop session. The fourth and final day was given to receiving the reports of the workshop chairman and making any final adjustments.

Various social events were organised in the evenings to help the delegates get to know each other and form new professional relationships.

3. ABSTRACT OF PAPERS

Paper No.1

Russian (USSR) Fisheries Research in Deep Waters (below 500m) in the North Atlantic.
F. M. Troyanovsky and S. F. Lisovsky, Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk, Russia.

Abstract

Russian investigations of the deep water species of the Atlantic commenced in 1963 and have continued until 1993. The work has been carried out on both commercial fishing vessels and research vessels.

On these cruises the environmental conditions of temperature and salinity were recorded together with the biological data and bathymetric and hydrographic information down to 2000m depth. Biological sampling was done with both midwater and bottom trawls, longlines and traps. Fish behaviour patterns and distribution have been studied using a manned submersible vehicle. The species investigated included Greenland halibut, roundnose grenadier, witch flounder, *Sebastes mentella*, alfonsino, orange roughy, tusk and ling.

Some of these results are given along with estimates of the commercial catches 1967 to 1991. In the peak year of 1971, 82,000 tonnes of roundnose grenadier were caught. The paper also makes some estimates of biomass and possible commercial catches of the main species of interest taken from outside of the economic zones of the Atlantic coastal states.

Paper No.2

Biology and Fishery of Roundnose Grenadier (*Coryphaenoides rupestris* Gunnerus, 1765) in the Northwest Atlantic.

D. B. Atkinson, Department of Fisheries and Oceans, St. John's, Newfoundland, Canada.

Abstract Exploratory fishing in the Northwest Atlantic by the Soviet Union during the early 1960s revealed substantial concentrations of roundnose grenadier (*Coryphaenoides rupestris* Gunnerus, 1765) inhabiting slope areas in depths greater than about 500m. Because of this, a commercial fishery began in 1967, and has continued to the present, albeit at relatively low levels in recent years. The biology and population dynamics of this species have been difficult to study because of its deep distribution coupled with its relative unimportance as a commercial species in the Northwest Atlantic. Nonetheless, over the years considerable information has been gathered, and this report summarises these findings as well as describing the history of the fishery and its management.

Paper No.3

Greenland halibut (*Reinhardtius hippoglossoides*): A Review of the Dynamics of its Distribution and Fisheries in the Northwest Atlantic with Special Emphasis on the Continental Slope of Labrador and East Newfoundland.

W.R. Bowering and W.B. Brodie, Northwest Atlantic Fisheries Center, St. John's, Newfoundland, Canada .

Abstract

Greenland halibut is distributed throughout the deep waters of the Northwest Atlantic from as far north as 78° N to as far south as the Grand Bank and Flemish Cap with no apparent break in the continuity of its distribution along the continental slope. It is also found in the fjords of West Greenland and the deep water bays of eastern Newfoundland and the Gulf of St. Lawrence. The biomass of the stock has been declining since the early 1980's although catches during recent years have reached unprecedented levels. This is mainly due to increased fishing effort primarily in Flemish Pass, Davis Strait and at West Greenland.

Paper No.4

Structure Over Time of an Exploited Deep Water Fish Assemblage.

Richard L. Haedrich, Department of Biology, Memorial University of Newfoundland, Canada.

Abstract

The structure of a fish assemblage on the upper continental slope of Canada's Labrador Sea was studied over 14 years. Greenland halibut (*Reinhardtius hippoglossoides*) and roundnose grenadier (*Coryphaenoides rupestris*) are the dominant regular members of the assemblage, and both are commercially exploited. Less abundant but regular members of the upper slope assemblage (*Antimora, Centroscyllium, Macrourus,* and *Nezumia*) are not the subject of a fishery, although all occur as by-catch. Overall biomass of the commercial species declined significantly during the period, and the mean size of Greenland halibut was reduced by half. The biomass of non-target species was apparently unaffected, neither did mean sizes of less abundant species change, except for broadhead wolffish (*Anarhichas denticulatus*) which almost doubled in size. There were no measurable environmental changes in the geographic area occupied by the assemblage, but there were population shifts, mostly from north to south. It is unclear whether these shifts, for example in Greenland halibut and witch flounder (*Glyptocephalus cynoglossus*), took place strictly within the region or were the consequence of more dramatic changes in these species that took place on the shallower adjacent continental shelf. The structure of the assemblage on Labrador's upper continental slope is compared to similar assemblages elsewhere, and the general nature of such assemblages (or communities) is discussed.

Paper No.5

Deep Water Fisheries, Policy/Management Issues, and the Sustainability of Fishing Communities.

Rosemary E. Ommer, Institute of Social and Economic Research, Memorial University of Newfoundland, Canada.

Abstract: Since the introduction of deep-sea fishing technology in the 1970s, fisheries policy in Canada has increasingly supported the large corporate enterprises of eastern Canada with their industrial structures and consequent higher productivity, as measured by output per worker. The deep-sea fleets have been seen as highly efficient operators in contrast to the smaller, 'low tech' inshore operations. These fleets essentially have replaced labour intensity with capital intensity, and have been centralised as much as possible in a few ports. With the fall-out from the current moratoria, however, such an approach is being re-examined since it is now considered likely that an over-abundance of poorly-managed but highly technical and efficient fishing effort may be the principle cause of the collapse of the ground fish stocks in the western North Atlantic. Along with concerns about an overcapitalised fleet go concerns about the sustainability of the many small communities of coastal eastern Canada whose inshore fisheries have suffered in the generalised failure of the stocks. The realisation is growing that consideration of fisheries management and science cannot be kept separate from the social context in which they operate. Fisheries are ultimately about employment for people and about the overall economic well-being of regions, not just of industry, although all are, of course, related. The meaningful debate that needs to be held is one that brings together, not compartmentalises, all the various stake holders in this remarkably diffuse resource sector. The sustainability of stocks is related to the viability of provincial economies, fishery firms and fishing

communities. Failure to recognise this inter-dependence has led to the current crisis in eastern Canada, and to a great deal of division and bitterness between the key players. As deep-sea fishing on the continental slope becomes a regular part of the industry, and as new deep-sea fisheries are contemplated and developed, it is essential that the mistakes of the past not be repeated. Regardless of how the fishery will be prosecuted and managed in the future, decision-making around this issue must have a clear understanding of the trade-offs involved in utilising new technologies not only in terms of a healthy business, or a healthy industry, but also of healthy communities. Debates on the sustainability of fish stocks, that is, must ultimately include the basic question of the sustainability of fishing communities.

Paper No.6

Experience with management of orange roughy (*Hoplostethus atlanticus*) in New Zealand waters, and the effects of commercial fishing on stocks over the period 1980-1993.

Malcolm Clark, Ministry of Agriculture & Fisheries, Wellington, New Zealand.

Abstract: Orange roughy (*Hoplostethus atlanticus*) occurs throughout New Zealand waters at depths of 700m to 1500m. Commercial fishing dates from 1980, with the discovery of large concentrations of spawning fish on the Chatham Rise. Since then, further spawning and feeding grounds have been identified, and fishing occurs in 8 separate regions of the New Zealand EEZ. Catches increased rapidly, and throughout much of the 1980s the total reported catch was 40-50 000 mt per year. This made orange roughy New Zealand's single most valuable fish species.

Management of the fishery has been based on a system of regional Total Allowable Catches (TAC), with the quota allocated amongst fishers, rather than on an open competitive basis. TACs were initially set using very limited research data. It has since been recognised that orange roughy are slow-growing and long-lived, with low fecundity, and low productivity. Combined with improved estimates of relative abundance from time-series of surveys, it is clear that for several of the stocks the initial TACs were set at levels considerably higher than sustainable in the long term. Sustainable yields are around 1.0 - 1.5% of virgin biomass, with the 'optimal' stock size at about 30% of virgin.

Several stocks have been overexploited, and reduced to levels of 15-20% of virgin biomass. Associated with such a decline in biomass on the north Chatham Rise and Challenger Plateau were contractions in the areas of high density, and the apparent fishing-out of some aggregations. However, no

marked biological changes have been observed. Size structure of the populations has not altered, and location and timing of spawning has remained consistent between years.

It is likely that orange roughy populations take a long time to recover from heavy fishing, yet can be quickly reduced to low levels by commercial fishing. The New Zealand experience shows that careful and controlled development of the fishery is required from the outset. Research should occur in advance of substantial fishing, so that baseline data on distribution, abundance, and biology are collected. This could avoid a number of management problems later on.

Current research in New Zealand is focusing on improving estimates of abundance (through trawl, acoustic, and egg-production surveys, and commercial catch-effort data analysis), stock structure, age and recruitment studies, and further development of modelling techniques for assessing the size and yield of stocks, and quantifying risks associated with various management strategies.

Paper No.7

Deep Water Fisheries of the North Atlantic Slope - French Surveys.

Anatole Charuau, IFREMER, Lorient, France.

Abstract: French commercial fishermen have been engaged in a deep water fishery for blue ling (*Molva dipterygia*) since 1973 and during this time roundnose grenadier (*Coryphaenoides rupestris*) was considered a by-catch species. As a consequence of the decline in the more traditional gadoid species on the Continental Shelf, increased effort was directed at the Slope fisheries from 1989 onwards. Today there are commercial catches of blue ling, roundnose grenadier, orange roughy (*Hoplostethus atlanticus*), black scabbard fish (*Aphanopus carbo*) and Portuguese dogfish (*Centroscymnus coelolepis*). The fishing vessels in this fishery range from 24m to 60m in length and 500kw to 2000kw in power.

Much work needs to be done on the biology of the Slope species and in France only blue ling, grenadier and orange roughy have been studied in any detail. Time series of growth, ageing and yield per area, have been started but these are still too short to make a complete analysis. There is a general concern that trawling in these areas will be a high ecological risk to the benthic communities and corals, and that as the fishery is taking place on virgin stock, these could become quickly over-exploited.

Paper No.8

Deep Water Resources in Faroese Waters to the South, Southwest and West of the Faroes. A Preliminary Account.

Jákup Reinert, Fiskirannsóknarstovan, Nóatún, Tórshavn, Faroe Islands.

Abstract: Data from groundfish trawl surveys and exploratory longline fisheries are used to illustrate the species composition and the relative abundance of the demersal fish assemblage in Faroese waters to the south, southwest and west of the Faroes. Based on the same data sources and data from exploratory trawl fisheries and commercial catch statistics, the resources of roundnose grenadier (*Coryphaenoides rupestris*) and scabbard fish, (*Aphanopus carbo*), are analysed regarding distribution, size and weight composition and catch rates. There appears to be some signs of reduced availability of these resources in most recent years. Moreover, a description is given of the deep water tangle net fishery for monkfish (*Lophius spp.*) and of the pot fishery for the deep water crab (*Geryon affinis*). The deep water tangle net fishery is well established at present, whereas the pot fishery still is in the pioneer phase.

Paper No.9a

Canadian Experience: Deep Water Fishing. Otter Trawling in the Pacific Ocean.

Andrew Duthie, Department of Fisheries and Oceans, Ottawa, Canada and Allan Marsden, FV Caledonia, British Columbia, Canada.

Abstract: Exploratory trawl fisheries on Pacific Ocean seamounts off the west coast of Canada reveal an abundance of groundfish species and the potential for the larger trawl vessels to expand commercial operations into deeper water. Initial explorations fished maximum depths of 475 fathoms. The trips, funded by the Canadian Department of Fisheries and Ocean and the Deep Sea Trawlers Association of British Columbia and undertaken by two commercial trawl vessels, gathered preliminary information on species mix, distribution and abundance of rough-eye rock fish *(Sebastes aleutianus)* and harlequin rock fish *(Sebastes variegatus)*. Limited hydrographic information of the individual seamounts was augmented through surveys undertaken by each trawl vessel. Samples were taken to determine the physical make-up of ridges and the ocean floor. The need for special gear and rigging, electronic fish detection and gear monitoring systems were identified, as was the need for processing techniques and marketing deep water species.

Paper No.9b

Canadian Experience: Deep Water Fishing. Gillnetting in the Northwest Atlantic Ocean.

Andrew Duthie, Department of Fisheries and Oceans, Ottawa, Canada and Allan Marsden, FV Caledonia, British Columbia, Canada.

Abstract: In 1993, commercial inshore gillnet vessels continued exploratory fisheries for Greenland halibut in the northwest Atlantic, off the coast of Newfoundland and Labrador. Catch rates doubled those of fisheries conducted in 1992; five vessels fishing to maximum depths of 800 fathoms, landed 518,790 kilograms of Greenland halibut and 4300 kilograms of roughhead grenadier. In the 1992 fishing effort, fishing depths and fishing gear for 22 inshore gillnet vessels (16.5 to 19.5 metres) were monitored in the northwest Atlantic. Greenland halibut catches were analysed to identify catch rates, average fish size, by-catch quantities, mesh size versus size of fish caught. Recommendations included expansion of deep water gillnet fishing into areas other than those explored in 1992. Due to a decline in the biomass of Greenland halibut, a detailed stock assessment study, analysis of fishing pressure impact and marketing and utilisation of the significant roughhead grenadier by-catch are also recommended. Fisheries for roughhead grenadier should be extremely selective with no by-catch of Green halibut.

Paper No.10

Environmental and Biological Aspects of Slope-Dwelling Fishes.

John D. M. Gordon, SAMS, Oban, Scotland; Nigel Merrett, Department of Zoology, The Natural History Museum, London, England; and Richard Haedrich, Department of Biology, Memorial University of St. John's, Newfoundland, Canada;

Abstract: Despite the fact that the areas of ocean bottom on the shelf and slope are roughly comparable, the readily accessible portions of the slope are far more restricted. This is due, not just to the depth involved, but also the complex topography and lack of flat areas. The system is a layered one, with strong gradients of many kinds associated with the change in depth, and oceanographic influences from regions far way make themselves felt quite locally.

Because the physical environment is layered, biological phenomena on the slope display vertical zonation patterns as well. Food availability, which declines logarithmically according to depth and which may also be seasonal in nature, is one of the most critical factors. Food availability leads to zonation in the fauna, with different species arranged in differential patterns of abundance and range across the slope. The species most characteristic of the slope are different from those of the shelf, and are far more diverse although individually less abundant.

The distinctiveness of the slope fauna extends to life histories as well, including especially patterns of reproduction as far as is known. For the great majority of species, the earlier life history stages are as yet unknown, and even the places where they occur in the ocean remain to be discovered. Many questions about deep water fishes are still unanswered and that includes the small handful (out of the total present) that might have

commercial potential.

The adaptations of slope fishes appear to stem mostly from the low food supply. Thus their growth (as confirmed by aging studies), population regeneration, and time for recovery from an impact such as heavy fishing mortality will all be very slow. The overall community impact of such disturbance is not possible to predict.

Paper No.11

On Deep Sea Fishes of the Icelandic Slope and Reykjanes Ridge - Distribution, Relative Abundance and Biology.

Jútta V. Magnússon and Jakob Magnússon, Marine Research Institute, Reykjavík, Iceland.

Abstract: This work describes the distribution and, in some cases, the relative abundance of several deep-sea species at Iceland. The information given is mainly based on deep-sea hauls carried out during numerous research cruises since 1976.

The main species dealt with are roundnose and roughhead grenadiers, blue ling, orange roughy, black scabbard fish, smooth-head, Rhinochimaeridae, several dogfishes and sharks, e.g. black dogfish and Portuguese shark. Biological information is given for some of the species. The roundnose grenadier is considered to be a self-sustained stock at Iceland. The spawning pattern of the blue ling is discussed. A possible connection between blue ling stocks at Iceland and the Faroes is mentioned. It is most likely that the orange roughy spawns at Iceland.

An extract from research notes of recent deep-sea cruise to the Reykjanes Ridge in March 1993 is given.

Paper No.12

Age determination of deep water fishes: experiences, status and challenges for future research.

Odd Aksel Bergstad, Institute of Marine Research, Flødevigen Marine Research Station, Norway.

Abstract: A review is presented of the literature on aging of deep water fishes and of experiences from studies of *Coryphaenoides rupestris, Argentina silus, Molva molva, Molva dipterygia, Brosme brosme,* and *Glyptocephalus cynoglossus* of the Skagerrak.

It is suggested that the otoliths provide the most reliable age readings. The otoliths of many deep water species show growth zones which are similar to those interpreted as annulli in shallow water species. Indeed, in many deep water species the otolith zones are exceptionally distinct, particularly those deposited after the juvenile period. In some species, the number of growth zones and hence the age estimates become very high (100 - 150 years). Recent attempts to validate such readings for deep water fishes are reviewed.

In view of the significance of information on age for studies of growth, population structure, mortality, production, and hence the assessment of sustainable yield, the importance of age studies and in particular validation of the aging techniques is stressed.

Validation of age readings, inter-calibration of readings and improvement of preparatory techniques for more species from different environments are challenges for the future.

Paper No.13

Developments in Deep Water Trawling.

Gudmundur Gunnarsson, Hampidjan HF, Reykjavik, Iceland.

Abstract: Fisheries are the mainstay of the Icelandic economy, accounting for around 80% of total national export revenues. The following paper deals with the development of deep water trawling technology. Some 64% of the Icelandic fleet's total landed catch is produced by bottom and midwater trawls.

This paper begins by describing a new model of high capacity freezer trawler which Icelandic operators have been introducing over the past two years, along with an outline of its bottom trawl gear and fishing techniques.

Afterwards there is a survey of mid-water trawling which has been on the increase in and outside the Icelandic fishing zone over the past five years. Major advances have been made in midwater trawl design, led by the "midwater giant", and the Gloria trawl, which has proved particularly effective for Oceanic Redfish (*Sebastes mentella*).

Paper No.14

Report of Deep Water Fishing with Longlines.

Hans Edvard Olsen, Directorate of Fisheries, Bergen, Norway.

Abstract: Experimental fishing with longlines for deep-water fish was carried out by the Directorate of Fisheries, Bergen off North Norway in 1990, west of the British Isles and along the Reykjanes Ridge in 1991 and on the Hatton Bank in 1992.

Along the edge of Tromsoeyflaket off North Norway, the total catch on 48 hours fishery was 7,900kg roughhead grenadier and 2000kg of other fish. The catch was taken on 26,400 hooks between depths from 350 to 500 fathoms. However, the sale of the catch of roughhead grenadier was difficult and the price was too low to give a profitable fishery, therefore, vessels were not interested in starting on this fishery.

Along the Reykjanes Ridge the experiments were carried out between depths from 280 to 520 fathoms. The catches consisted of torsk, blue ling, halibut, red fish and sharks. The bottom conditions were rough. Owing to the bottom conditions, the vessel suffered loss of fishing gear.

West of the British Isles and along the Hatton Bank the fishery was carried out between depths from 250 to 600 fathoms.

Besides the types of fish usually caught with longlines west of the British Isles, commercial quantities of mora and sharks were caught. It was, however, difficult to obtain a profitable fishery mainly owing to low prices and marketing problems. Plans for experimental fishing with longlines in 1993 were not carried out owing to the price and marketing difficulties.

Paper No.15

The Irish Experience of Deep Water Fishing in the NE Atlantic

Richard Mc Cormick, An Bord Iascaigh Mhara, Dublin, Ireland.

Abstract: Deep water species fishing trials commenced in Ireland in 1988 assisted by the European Commission's Exploratory Fishing Voyage scheme. The objective was to develop a fishery for unexploited non-quota species and divert fishing effort from existing quota species. The first species targeted was Blue Whiting (*Micromesistius poutassou*) quickly followed by Argentines, also known as Silver Smelt (*Argentina silus*), progressing to a wider range of species in even deeper water such as Grenadiers (*Corphaenoides rupestris*), black scabbard (*Aphanopus carbo*), Portuguese Shark (*Centroscymnus coelolepis*) etc. This involved pelagic and demersal fishing techniques at a cost of considerable material damage. In tandem with technological and human consumption processing trials carried out by BIM, the state fisheries development agency, biological studies were undertaken by the Department of Marine's Fisheries Research Centre. This paper summarizes the progression from 1988 to date in the Irish context and points out, that whilst much has been learned, considerably more R&D needs to be undertaken to ensure an economically viable and biologically sustainable future for this emergent fishery.

Paper No.16

Line Fishing for Black Scabbard fish (*Aphanopus carbo* Lowe, 1839) and Other Deep water Species in the Eastern Mid Atlantic to the North of Madeira.

Rogélia Martins and Carlos Ferreira, Instituto Português de Investigação Marítima (IPIMAR), Lisboa, Portugal.

Abstract: From 1980 until 1986 nine cruises were carried out on board of the RV NORVEGA to study the black scabbard fish (*Aphanopus carbo*) fishery in Madeira waters in what concerns new fishing grounds and the introduction of new technologies. The results of these studies pointed out that the drifting vertical longline made from monofilament has more workability and longer durability as well as a higher catch efficiency than the one used by Madeira fishermen which is made from hemp fibre.

The seamounts with a higher abundance of black scabbard fish were the Seine, the Lion and the Susan.

We think that the better results in black scabbard fish landings in Madeira after 1982 can be due to the fact that fishermen changed the traditional drifting vertical longline to the monofilament drifting vertical longline and some boats with a better equipment had started to fish in other fishing grounds with a higher yield.

(Paper No.16 was circulated at the Workshop but the authors were not present.)

Paper No.17

Comparisons Between Longlining and Trawling for Deep Water Species - Selectivity, Fish Behaviour, Quality and Catchability.

Nils-Roar Hareide, Møre and Romsdal Research Foundation, (Møreforsking), Ålesund, Norway.

Abstract: A review of the literature on comparative fishing trials for deep-sea species using both trawl and longline is presented. Most attention is given to length and species selectivity. Other issues discussed are fish behaviour, energy consumption and quality of the products.

The conclusion is that there are possibilities for both trawling and longlining in deep waters. The trawl is the most efficient gear on dense concentrations. However, trawling on dense concentrations may be harmful to the stocks. On the scattered concentrations and on fish species with large body size the relative catchability of longlines compared with trawls will be higher.

In some fisheries longlining will give the highest long term yield. For some fisheries the catchability is too low for longlines and, therefore, trawling would be the best method for exploitation of these stocks.

Paper No.18

A Comparison of Deep Water Trawl and Longline Research Fishery in the Davis Strait.

Ole A. Jørgensen, Greenland Fisheries Research Institute, Copenhagen, Denmark.

Abstract: In August 1991 a longline and a bottom trawl survey, covering depths between 950 and 1450m, was conducted off west Greenland and great differences in catch composition and length frequency of Greenland halibut and roughhead grenadier were observed in the two types of gear. Calculation of relative selection showed that longlines were up to 30 times more effective in catching large fish, and yield per recruit for Greenland halibut was larger and obtained at lower F value with longlines compared to trawl.

Paper No.19

Experimental Utilisation and Marketing of By-Catches and Deep Water Species in Iceland.

Grimur Valdimarsson and Halldur Petur Thorsteinsson, Iceland Fisheries Laboratories, Reykjavik, Iceland.

Abstract: The importance of fisheries in the economy of Iceland is stressed. The annual catch is about 1.5 million tonnes of which about 1.0 million are reduced to fish meal, but the total export value is about 1.1 billion US$ annually. Better utilisation of the catch and the exploitation of unconventional species are important research tasks. The By-Catch Bank was established in 1990 for this purpose. It guarantees minimum prices for under utilised species which are then frozen and then test marketed in collaboration with Icelandic processors. This has been successful in achieving utilisation of these new species and has built up good relations with fishermen, producers and exporters. The importance of good handling of these fish is emphasised.

The following papers were submitted but not formally presented at the meeting:

Paper No. 20

Spanish Fisheries on Deep Water.

Sergio Iglesias and J. Paz, Instituto Español de Oceanografía, Vigo Spain.

Abstract: The Spanish fishing fleet catches deep water species on both sides of the Northern Atlantic ocean. In terms of catches, the most important fishery is that of Greenland halibut on the NAFO Divisions 3L, 3M, 3N. Deep water sharks and anglerfish are the main species fished in the eastern Atlantic.

Most research effort has been focused on the Greenland halibut fishery which has been monitored by scientific observers on board the commercial fishing vessels since the very beginning.

Paper No.21

Engineering Consideration in Vessel Design and Power for Deep Water Fishing.

Alan G. Hopper, Secretary to the Workshop.

Abstract: A review of early work by Seafish into the power levels and the forces acting on a vessel during the trawling operation and how these are likely to be modified when towing in deep water.

4. REPORTS FROM WORKSHOP SESSIONS

Workshop I International Management of Deep Sea Resources

Need for urgency - how we can tackle the problem - what needs to be done to give advice at this stage?

Chairman, Malcolm Clark, New Zealand
Rapporteur, Phil MacMullen, England

The discussion centred on three main areas:

1. General description of the resource.

- The main species regarded as 'deep water' were identified, in order to give a general feeling of the types of commercial fish resources on the continental slope. The list was intended to be indicative, not exhaustive: Greenland halibut, roundnose grenadier, roughheaded grenadier, black scabbard fish, argentines, deepsea sharks (e.g. *Centroscymnus, Centrophorus, Deania*), skates, blue ling, ling, crustaceans (shrimps, *Geryon, Neolithodes*, crabs), monkfish, cardinal fish, alfonsino, orange roughy, deep water squids, witch flounder, smoothheads.

- These species include some which are heavily exploited in some areas, some which have developing fisheries, and some which are not yet exploited.

- Depth distributions were not defined, as depth ranges of many species overlap, and extend from relatively shallow water into the deep. It was agreed that artificial boundaries, such as depth, should not be imposed on research and management of species. The maximum practical depth for commercial exploitation was regarded as 2000m at this time.

- The species encompass a range of fish types, but differ from shelf commercial species in several general characteristics:

  i. slow growth, high longevity;
  ii. low reproductive potential;
  iii. low productivity;
  iv. more vulnerable to overfishing; and
  v. slow recovery from overfishing due to points i), ii) and iii).

2. Research

Existing research.

- In general there is little detailed information on stock sizes or status of deep water stocks. There are extensive descriptive data on distribution (both geographical and vertical), and biological aspects (e.g. size, reproductive condition).

- There is a need to compile available information from the range of sources and countries to put together a complete picture of our knowledge of the North Atlantic. This is also necessary for evaluating future research and management requirements.

Future research.

- Data on distribution, abundance, stock structure, biological aspects (e.g. age and growth, reproduction, trophic relationships, recruitment, size structure) and catch are required for effective management. This discussion was left for consideration by Workshop IV.

3. Management

Existing management

- Some management of the deep water species currently occurs in several ways:

  i. National jurisdiction with 200 mile EEZs. Examples are TACs for Greenland halibut and roundnose grenadier in Canadian waters, and Greenland halibut, oceanic redfish and tusk in Icelandic waters.

  ii. NAFO undertakes co-ordinated management of straddling stocks in the NW Atlantic.

  iii. NEAFC has management responsibilities for oceanic redfish in the NE Atlantic.

  iv. ICES provides scientific and other advice on a number of species in areas off Greenland, Iceland, Faroe Islands, Norway, Russia and the Barents Sea.

  v. EC employs 'precautionary' TACs.

The application of existing management strategies (e.g. TACs based on target fishing mortality levels in multi-species fisheries) has, in general, had limited success in northern hemisphere fisheries. The greater vulnerability of deep sea species to overfishing necessitates effective management from the outset. It is not adequate to extend current practices and strategies to these deeper water fish. Instead the development of new fisheries must include investigatations of alternative management techniques or improvements of existing ones.

Future Management

- The need for urgency in setting in place research and management structures was recognised because of the low productivity - high vulnerability - slow recovery characteristics of the deep water species.

- It was agreed that as an interim management structure:

  i. Individual nations should develop strategies and exercise management of fisheries within their 200 mile EEZs.

  ii. ICES and NAFO scientific committees should continue to give scientific advice on management.

  iii. NAFO and NEAFC are existing management bodies able to undertake co-ordinated management of deep water resources of the North Atlantic.

- Management objectives need to be clearly stated (e.g. long term sustainability, short term economic yield, etc.).

- Consideration needs to be given to the most appropriate form of management (e.g. TACs by area, effort control, etc.).

- There is a need for integrated fisheries management, where the effects of fishing on inter-related species/stocks are recognised.

- Need to consider different types of management for target vs mixed species fisheries, and the views of a range of interested parties (e.g. scientists, industry, environmental people) should be included in the management advice process.

- Some high seas fisheries in international waters are currently hard to manage, even with regional organisations. Resolution of ongoing UNCLOS discussions is needed before this is likely to change.

- Enforcement of international agreements is necessary to ensure measures are effective.

- Co-ordinated research effort on both commercial and non-commercial species is necessary for effective management.

- Adaptive management strategies could be considered to gain information rapidly. Under adaptive management, in the absence of detailed data on size or status of a stock, the stock is fished at a certain level, and changes are monitored. Changes are compared with expectations based on scientific predictions and results used to adapt catch levels and management strategies as appropriate. Such strategies, however, need to be planned carefully so that the effects of fishing can be measured and results used in estimating the size and status of the stock. Even so, because of slow growth, impacts may not be detectable for many years after fishing begins.

- Collection of good quality catch data is essential.

- The keyword must be CAUTION. Development of commercial fisheries for deep water fish must not be rushed.

Workshop II Processing, Marketing and End Use

International effort to carry out research and technical development to make best use of these resources.

Chairman, Alan G. Hopper, England
Rapporteur, Grimur Valdimarsson, Iceland

The discussion on this subject was based mainly on Icelandic, New Zealand and Norwegian experience where some of the delegates had first-hand knowledge of research and marketing studies for deep water fish. The findings are summarised as follows:

1. The deep sea species are not yet in demand by the main fish markets of the world. There is at present an adequate supply of traditional species, even though an increasing volume of these are now imported from parts of the world outside of the North Atlantic.

2. The experience of the Canadian Atlantic cod fishery, however, should be a salutary lesson in how rapidly a fishery can decline and virtually cease to exist. Further failures of this type will inevitably increase pressure on new resources, including those from deep water.

3. On the upper slope of the Atlantic Basin there are 300 to 400 species variably distributed throughout the whole region. To date only a few have been judged to be marketable.

4. There is little to be gained by catching deep water species and expecting the markets to accept them as alternatives unless there is a planned promotional campaign. In the event of short supply of traditional fish, the customer would frequently turn to alternative protein foods, such as chicken, in preference to an uncertain fish product.

5. The success in New Zealand with orange roughy probably provides a model. Here a specific marketing plan from catching through processing to the consumer was followed in detail. The target market was the sales of white fish fillets to the USA and the ingredients of success were: (a) a known resource; (b) established processing techniques; (c) a well researched market; and (d) a commitment to succeed. Once the market accepted the product, there were then further opportunities to introduce value-added products.

6. The new market opportunities in which deep water fish may find a niche are Russia where there is a large unsatisfied market and SE Asia where the market is growing in value and volume.

7. Many of the names used to describe deep water fish are unattractive - rat-tail fish, catfish, dogfish, rabbit fish, etc. These names are impossible to promote but some care has to be exercised in choosing alternative popular names as they can cause confusion in the market place. For example, orange roughy is known on the French market as emperor fish. Thorsteinsson and Valdimarsson listed 25 deep sea species with the English, Latin and Icelandic names.

8. It was recommended that research should be carried out to select the North Atlantic deep water species with most potential and which exist in volume and could be reliably caught most of year. Markets should then be studied in close collaboration with fish processors and international traders to develop market niches.

9. It was recommended that the marketing of these fish needed a long term strategy. Results could not be expected quickly.

10. It was also recommended that, as well as food value, many of these species may have value in the field of medicine and pharmaceuticals.

Workshop III Technical Development - Gear and Vessels

Chairman, John Tumilty, England
Rapporteur, Richard McCormick, Ireland.

This workshop convened on 3rd March 1994 and following issues were considered:

1. Review of current vessel types in the deep water fishery.
2. Review of four potential deep water fishing gear types:
   - Trawling (pelagic and demersal)
   - Gill netting
   - Longlining
   - Potting and trapping
3. Economic Assessment of fishing methods
4. Selectivity and impact assessments of fishing methods.
5. Fish behaviour aspects and their implications to the fishery.
6. Recommendations.

1. Review of current trawl vessel types in the deep water fishery.

As trawling is considered likely to be the dominant fishing method, the discussion opened with a short presentation indicating the two extremes of trawler types currently found in the deep water species fishery. The upper end of the scale was illustrated by a 67 metre length vessel with 4000hp main engine, towing trawl gear with a total weight in excess of 38 tonnes, a considerable capital and energy input. At the lower end, an example was given of a vessel of 25m and 900hp, its size and power being dictated by EU restrictions. From extensive surveys on the Mid Atlantic Ridge the Russians have concluded that a freezer trawler of 55 - 60 metres in length, with a 4000hp main engine and fitted with 4000 metres warp capacity, was an optimum deep water species trawling vessel.

Whilst towing, one can consider the fishing method as a single elastic system, consisting of trawler plus warp plus gear, which when it flexes and vibrates, can generate significant energy losses. If one assumes a fixed energy output from the propeller, the smaller class of vessel may be unable to optimise its fishing performance, due to increased towing energy requirements with increasing depth. An example given illustrated that the towing load on a 26m vessel with 970hp main engine, could increase from 1.4 tonnes with 600m of 24mm diameter warp towed, to 4.26 tonnes with 1,000m. It may well be proven that smaller vessels of less than 1000hp will only be capable of efficiently prosecuting a trawl fishery down to 900m depth, whilst fishing opportunities certainly exist down to 1,500m and the French are currently fishing down to 2,000m.

Extreme weather conditions are often encountered when fishing on the edge of the continental slope, and there may be a safety and stability risk to small vessels in such conditions. There is an urgent need to have increased knowledge of the various vessel operational parameters that could influence performance in this fishery. It was postulated that traditional trawling techniques at extreme depths may require modifying to adapt the technique for deep water conditions e.g. single warp systems. One delegate remarked that single warp sampling systems caught equally as many grenadiers as conventional trawling but less sharks, black scabbards or smootheads.

2. Review of four potential deep water fishing gear types

It was generally agreed that there was no one specific gear type that was entirely suitable for all conditions and species. Each has specific advantages and disadvantages. In the case of species that aggregate close to seamounts and pinnacles, the most feasible method is likely to be pelagic trawling. With widely dispersed species, the techniques most likely to be deployed are demersal trawling, gill netting and longlining.

The Russians operate pelagic trawls fishing for grenadier and Beryx spp. near seamounts, towing the pelagic trawl at 2.5 knots within one metre of the seabed, whilst still retaining adequate power in reserve, plus the capability of operating safely in poor weather conditions. Norwegian experience indicates, that of 12 seamounts on the North Atlantic ridge, only two were suitable for short duration demersal trawling (15-20 minutes). Good fish concentrations are essential for success at trawling in this region and, for more widely dispersed fish, longlining may be more appropriate though material losses are likely to be high on difficult terrain.

Gill netting was considered to be a low cost and low technology option, already being used by many countries on the edge of the continental slope for monkfish, sometimes by flag of convenience vessels. However concerns were expressed that there could be an explosion in the number of vessels using this type of gear, but with the increased risk of lost 'ghost' nets there is a risk that some of these may well continue fishing for some time in deep water. UK trials have indicated that gill nets lost in shallow water posed little risk of 'ghost' fishing due to rolling through tidal influences and fouling with weed. It was suggested that research should be undertaken to devise biodegradable netting materials or, in the interim, gill nets should be mounted to their headlines by degradable materials. Most studies however conclude that gill netting can be a very size- and species-selective technique, which may certainly require regulation and control, though a ban on the technique was not suggested.

Longlines were considered to be highly selective in general but trials in the deep water species fisheries indicated their viability is still questionable. Vessel conversion costs are high and the method is limited to only certain deep water species. Some species, such as orange roughy, will not take bait. Thus no firm recommendation could be made for the adoption of wide scale longlining in the deep water fisheries. At least three countries are currently involved in deep water trials, which should be encouraged. There would nevertheless need to be a substantially stable price differential for the viability of deep water longline caught fishing to be assured. The Russian delegate stated that pots and traps

would be unsuitable due to the extreme lengths of rope required. Accurate positioning and recovery of traps could be problematical in very deep waters.

3. Economic Assessment of fishing methods

It was recommended as a matter of priority, that economic assessment studies of the various combinations of vessels and gear types be undertaken. These should include vessel size and power requirements, winches, electronics, all potential gear types and also include an analysis of the return on capital invested.

4. Selectivity and impact assessments of fishing methods

It was considered important to assess the effectiveness of all gear types in relation to the likely number of commercial species available. Practical cause and effect relationship studies between different deep water fishing gear types and species should be established, as is currently being undertaken in Canada on traditional continental shelf species. As marketing considerations may well limit the number of species acceptable to the consumer, responsible fishing practices should be adopted to minimize impacts on non-target species. Every effort should be made to incorporate or adapt current best selectivity practices to the deep water species fisheries, particularly when trawling in mixed species situations, to avoid unwanted discards.

5. Fish behaviour aspects and their implications to the fishery

It was recognised that a better understanding of the behaviour of deep water species would lead not only to a better understanding of fish reactions to both static and mobile fishing gear, but also considerably enhance the possibilities of devising strategies and devices for assisting the development of selectivity technology.

6. Recommendations

(a) There is an urgent need to acquire increased knowledge of all operational parameters influencing vessel fishing performance in this fishery, including engineering, electronic, safety and stability aspects.

(b) Studies on the potential effects of 'ghost fishing' of gill nets in deep water should be undertaken immediately. Research to devise biodegradable gill net material should be encouraged and the feasibility of mounting the floatlines of gill nets with biodegradable material should be investigated as an interim measure.

(c) Despite the problems experienced to date, continued deep water longline research should be encouraged, though trials co-ordination between experimenting nations would be advisable.

(d) It was recommended that economic assessment comparison studies of the various vessel types, fishing gears and ancillary equipment deployed in the deep water fishery be undertaken as a matter of priority. Optimum cost benefit relationships should be established and a linkage with recommendation (e) established if possible.

(e) Gear effectiveness studies in relation to specific target species should be initiated. Practical gear technology, cause and effect relationship studies should be included in this analysis, including an assessment of the effects on sensitive non target species.

(f) Every effort should be made to incorporate or adapt current best selectivity practices to the deep water species fisheries, particularly when trawling in mixed species situations to avoid unwanted discards.

(g) Deep water fish behaviour studies should be initiated.

Workshop IV Joint Research into Deep Sea Stocks

What are the outstanding issues - who is doing what and who else should be involved - how fragile is the resource - are some species more at risk than others?

Chairman John D. M. Gordon, Scotland
Rapporteur, Odd Aksel Bergstad, Norway

In view of the limited information available on deep water fisheries resources, it is generally recommended that collaborative efforts should aim at assembling and collecting documented information on population biology and community ecology of deep sea fishes with the objective of improving the basis for assessment and management of deep water fisheries.

The views expressed during the workshop have been summarised in the form of 16 specific recommendations which were presented and generally approved during a plenary session 4th March. Some of these refer to the conduct of research on deep water fishes, others are suggested research topics which should be given priority. The sequence in which the recommendations are listed is somewhat arbitrary.

1. In order to achieve consistency between areas, time periods and countries, data collection procedures should be documented and standardised (e.g. length measurements, survey methodology, species identification).

2. Introduction of new common names should be avoided and scientific names should be used to avoid confusion and misinterpretation.

3. Catch records of all species should be kept by using updated identification keys. In fisheries where catches of several species are lumped or when discarding occurs, onboard sampling by observers is necessary.

4. In studies of abundance and biomass, the entire depth range of the species must be considered and not just in areas where exploitable concentrations occur. Inter-disciplinary efforts would seem very valuable, e.g. collaboration between physical oceanographers and fish biologists is recommended, particularly in studies of distribution.

5. When studying abundance and biomass, several estimation techniques should be considered (e.g. trawl surveys, hydroacoustics, direct observation by underwater vehicle), and efforts should be made to further develop and adapt available methods for deep water studies (e.g. hydroacoustics using towed vehicles).

6. In certain areas, e.g. the northern Mid-Atlantic Ridge, repeated stratified trawl surveys may be a possible means of obtaining information on trends in abundance in relation to exploitation.

7. Stock structure and migration should be studied by analysing distributions, age distributions, growth patterns, reproductive biology, etc, but also chemical methods should be utilised (e.g. DNA techniques, trace elements in otoliths and others).

8. Development and adoption of validated aging methods should have high priority and inter-calibration of age readings between laboratories and countries is strongly recommended.

9. Studies of the reproductive biology of more species from different environments should be determined in order to estimate reproductive capacities and probable regeneration times.

10. Early life history studies should be conducted for more species and areas. Laboratory studies of egg and larval development should be combined with field studies in relevant areas and depth ranges.

11. Analyses of probable responses to exploitation, such as the scope and timescale of compensatory growth and recruitment, should be made based on information on life histories and physiology.

12. Food-webs and species associations should be described and inter-specific effects of exploitation should be analysed.

13. Widespread and intensified deep water fishing may adversely affect previously untouched populations and ecosystems. To facilitate assessments of possible impacts, records of community structure and by-catches (e.g. non-target species and potentially vulnerable invertebrates) and the physical habitat should be undertaken before and after a fishery has started.

14. The development of massive gill net fisheries with potentially adverse effects due to long-term ghost fishing calls for monitoring of catches and gear loss/recovery practices. Bio-degradable net material seems to be a goal worth working towards.

15. Available information on biology and ecology suggests that deep water fishes are vulnerable to exploitation even when exploitation rates appear low compared with the pre-exploitation abundance and biomass. An evaluation of the need for particular protective measures for the deep water resources should be made in view of the growing interest for deep sea fishing.

16. The workshop considers the ICES Study Group on the Biology and Assessment of Deep Sea Fisheries Resources as a particularly important forum and the terms of reference for this group (see Annex) are timely and appropriate. The workshop stresses the need for further international collaboration and co-operation, particularly concerning ageing, abundance estimation and determination of stock and community structure.

Annex to Workshop IV

The workshop has aroused considerable interest at ICES and it has been seen as complementary to the ICES Resolution No.2.6.20 which is set out below for general information.

2:6:20 A Study Group on the Biology and Assessment of Deep Sea Fisheries Resources will be established under the chairmanship of Mr. B. Jones (UK) and will meet at ICES Headquarters from 24-30th August 1994 to:

a. describe the fisheries for deep water species (e.g. orange roughy, anglerfish, grenadiers, scabbard fish, rabbit fish (Chimaerids), forkbeards, sharks, Moridae) in the ICES area, and summarise all available information on catches and fishing effort by species, fleets and gear;

b. report on the existing biological data for the deep water species and describe the biology of these stocks;

c. advise on additions to the list of species for which national catch data are required;

d. report on possible methods of assessment for these stocks, provide an inventory of the data available for assessment purposes and identify shortcomings and data requirements;

e. assess the need for future international collaborative research activity and data collection programs on the biology and assessment of deep water stocks in the ICES area and recommend appropriate plans;

f. identify species or stocks, if any, which may already be subject to excessive or unsustainable exploitation and suggest appropriate management actions.

APPENDIX I

Steering Committee

John E. Tumilty	Technical Director, Sea Fish Industry Authority, England.
Dr. John D. M. Gordon	Scottish Association for Marine Science, Scotland.
Prof. Richard L. Haedrich	Department of Biology, Memorial University of Newfoundland, Canada.
Nils-Roar Hareide	Møreforsking, Ålesund, Norway.
Alan G. Hopper	Secretary to the Workshop, England.

APPENDIX II

List of Delegates

Mr. Peter Chaplin, Chief Executive, Seafish, UK.

Mr. John Tumilty, Technical Director, Seafish, UK.

Mr. Philip MacMullen, Manager Marine Technology, Seafish, U.K.

Mr. Alan Hopper, U.K.

Prof. Alasdair McIntyre, U.K.

Dr. Stanislav Lisovsky, PINRO, Russia

Ms. Valentina Volkova, PINRO, Russia

Mr. Bruce Atkinson, Department of Fisheries & Oceans (DFO), Canada

Prof. Dick Haedrich, Ocean Sciences Centre, Canada

Dr. Rosemary Ommer, Institute for Social & Economic Research, Canada

Dr. Malcolm Clark, Ministry of Agriculture & Fisheries, New Zealand

Dr. Grimur Valdimarsson, Icelandic Fisheries Laboratories, Iceland

Mr. Halldor Peter Thorsteinsson, Icelandic Fisheries Laboratories, Iceland

Dr. Anatole Charuau, IFREMER, France

Dr. Jakup Reinert, Fiskirannsoknarstovan, Faroe Islands

Mr. Bjarti Thomsen, Fiskirannsoknarstovan, Faroe Islands

Dr. John Gordon, Scottish Association for Marine Science (SAMS), Scotland

Mr. J. E. Hunter, SAMS, Scotland

Dr. Nigel Merrett, Natural History Museum, U.K.

Dr. Jutta Magnusson, Marine Research Institute, Iceland

Dr. Jakob Magnusson, Marine Research Institute, Iceland

Dr. Odd Aksel Bergstad, Institute of Marine Research, Norway

Mr. Gudmunder Gunnarsson, Hampidjan Nets, Iceland

Mr. Hans Edvard Olsen, Directorate of Fisheries, Norway

Mr. Richard McCormick, BIM, Ireland

Mr. Nils Roar Hareide, Møreforsking, Norway

Mr. Per Stoknes, Møreforsking, Norway

Ms. Greta Garnes, Norway

Mr. James Hind, J. Marr, U.K.

Dr. Mike Pawson, Directorate of Fisheries Research, U.K.

Dr. John Hislop, SOAFD Marine Laboratory, U.K.

Mr. Roger Bailey, ICES, Denmark

Dr. Ole Jorgensen, Greenlands Fisheries Research Institute, Denmark

Dr. Luis Lopez-Abellan, Instituto Espanol de Oceanografía, Spain

Dr. Paul Connelly, Department of Marine, Ireland

Mr. Ciaran Kelly, Department of Marine, Ireland

Mr. Alistair Smith, University of Aberdeen

Mr. Andrew Duthie, DFO, Canada

Mr. W. R. Bowering, DFO, Canada

Mr. Alan Marsden, DFO, Canada

Mr. Willem Brugge, Commission of the European Communities, Brussels

Mr. Graham Patchell, Sealord Products, New Zealand

Mr. Sergio Iglesias, Instituto Espanol Oceanographico, Spain

Mr. David Symes, U.K.

Mr. Terry Thresh, Boyd Line, U.K.

Mr. Mike Tipple, Boyd Line, U.K.

Mr. Stephen Kilvington, J. Marr, U.K.

Mr. H. R. English, UK.

Mr. E. Oakshott, SOAFD, Scotland.

Mr. Carlos Sousa Reis - not attended, paper received

APPENDIX III

Copies of Bulletins

Delegates were kept informed about the Workshop and the content of papers by means of Bulletins throughout the planning stage.

Iceland. Dr. Jutta V. Magnusson of the Marine Research Institute in Iceland is to prepare a joint paper with her husband Dr. Jakob Magnusson on the relative abundance of deep sea species on the Icelandic Oceanic Slope based on data collected since 1976. The results of their scientific and commercial survey down the Reykanes Ridge to Lat. 60°N carried out in March 1993 will also be described.

Norway. Mr. Hans Edvard Olsen of the Fiskeridirektorat in Bergen is to present the findings of the experimental fishing with longlines off North Norway west of the British Isles, Reykanes Ridge and Hatton Bank between 1990 and 1992. The findings also include a profitability analysis of this type of fishery based on the catch data/effort.

Norway. Dr. Odd Aksel Bergstad of the Institute of Marine Research at Flødevigen, Norway, will describe the current knowledge of ageing of deep water fish from his research in the Skagerrak *(C. rupestris Argentina silus and Lotinare spp).* This is an essential part of the assessment of sustainable yields and the validation of techniques and collaborative effort in this field will be an important area of collaborative work in the future.

Iceland. Mr. Christian Gunnar Svarrsson of Hampidjan Nets, Reykjavik and Mr. Gudni Thorsteinsson of the Marine Research Institute will present a joint paper describing the gear used by the large Icelandic trawlers for both bentho pelagic and pelagic fish.

Portugal. Dr. Carlos Sousa Reis of INIP, Portugal, will describe the traditional line fishery for Black Scabbard *(Aphonopus carbo)* and other species on the sea mounts in the eastern mid Atlantic to the north of Madeira.

New Zealand. We are very privileged to have Dr. Malcolm Clark from MAF in New Zealand who will describe the experience with orange roughy *(Hoplostethus atlanticus)* in New Zealand waters and the effects of commercial fishing on stocks over the period 1980-93. The roughy is found in depths from 700 to 1500m and fishing occurs in eight separate regions. The initial TACs were set too high and several of the stocks are now over exploited. The New Zealand experience shows that careful and controlled development of the fishery is required from the outset and research to establish the baselines should be in advance of commercial development. The lessons gathered over a 13 year period must be of immense value to the way in which the North Atlantic stocks are managed in future.

ADVANCED RESEARCH WORKSHOP
Deep Water Fisheries of the North Atlantic Oceanic Slope
HULL UNITED KINGDOM 1-4 MARCH 1994

Co-ordinating Office.
SEA FISH INDUSTRY AUTHORITY
Seafish House, St. Andrew's Dock,
Hull HU3 4QE, United Kingdom.
Tel. + 482 27837 Fax. + 482 223310

BULLETIN

OCTOBER 1993

LETTER FROM THE TECHNICAL DIRECTOR OF SEA FISH INDUSTRY AUTHORITY

Welcome to this first edition of the Workshop Bulletin. Its purpose is to keep everyone up-to-date who has expressed interest in attending the Workshop or receiving the papers.

The idea was originally proposed in May 1992 by my predecessor as a suitable subject for a NATO Advanced Research Workshop. We felt that because of the increased interest in commercial exploitation of deep water species on the oceanic slopes of the North Atlantic there should be a review of what was known about these species. The wealth of biological and taxonomic research carried out since the 1860's will be helpful in making commercial judgements but also it will be invaluable in exercising some restraint on the exploitation of what is the last major untapped marine resource on this planet.

The response to the idea has been most encouraging and we are confident that scientists and technologists from at least 14 countries will be attending. Because of their long connection with deep ocean research our colleagues from the Scottish Association for Marine Science at Oban are acting as our partners in hosting this Workshop. We have also set up a Co-ordinating Committee to ensure the papers are well balanced and there is adequate coverage of the subject.

I am pleased to announce Alan Hopper, my predecessor, is on this Committee and is also acting as Secretary to the Workshop.

You will find many more details in this Bulletin and I look forward to welcoming as many of you as possible to Hull in March 1994.

JOHN E. TUMILTY

THE VENUE
THE DENNISON CENTRE

The Dennison Centre is the University of Hull's business training and conference facility. It is pleasantly located in a residential and university area on the outskirts of Hull. Hull has good communications by rail, road, sea and air to other parts of the U.K. and Europe. It is an elegant building with restaurant, conference and meeting room facilities and it is well equipped with everything necessary for a Workshop of this type. Seafish have already held a EEC Seminar on selectivity of towed gears at the Dennison Centre in May 1993. We are confident you will find it and Hull more than adequate for your needs.

Telephone: +482 466451 Fax: +482 471393

THE STEERING COMMITTEE

John E. Tumilty	Seafish, Hull.
Alan G. Hopper	Former Technical Director, Seafish, Hull.
Richard L. Haedrich	Ocean Sciences Centre, St. John's, Newfoundland.
John D. M. Gordon	Scottish Association for Marine Science, Oban.
Nils-Roar Hareide	Moreforsking, Åalesund, Norway

The first meeting is scheduled in the U.K. in December.

ASSESSMENT OF THE DEEP WATER COMMERCIAL ACTIVITIES IN THE NORTH ATLANTIC IN 1993

Currently these fisheries are limited by the market demand and the abundance of other more well known fish especially now available from Norway and Russia. However, there are an increasing number of commercial voyages principally by French, Faroese and Icelandic vessels to the deep water to the west of the British Isles, and the banks to the south of Faroe and the oceanic slope south of Iceland.

The main target species is orange roughy *(Hoplostethus atlanticus)* and blue ling *(Molva dipterygia)* for which there is a good market in France and the U.S.

In recent years the former Soviet Union fleet took large quantities of grenadiers (both *Macrourus berglax* and *Coryphaeonides rupestris*) but most of these vessels would appear to be now concentrating on the demersal shelf species Barents Sea. European effort on the deep water species probably is resulting in landings of less than 10,000 tonnes.

Along the Reykanes Ridge there is a pelagic fishery for Ocean Perch *(Sebastes mentella)* which is found as deep as 1000m. .In the Western Atlantic a few Canadian vessels are involved in fishing for grenadier and greenland halibut on the Labrador Coast and there is apparently some effort in the area of the Tail of the Bank and Flemish Cap by various nations including "flag of convenience" vessels for deep water species.

The largest vessels engaged in the fishery are 4000h.p. (3000kw) stern trawlers operating with 32mm diameter warp, 3800kg otterboards and heavy rockhopper gear. These are already working in depths of 1400m but this could go deeper until an economic depth limit is reached. It is believed that concentrations relate primarily to water temperature rather than depth.

A line fishery for deep water fishes is being revived off the banks to the southwest of the Faroe Islands.

Longlining is practised in the Norwegian Sea off the coast of Norway, North Iceland and Greenland mainly for greenland halibut. A line fishery with a long tradition operates from Portugal for the black scabbard fish *(Aphonphus carbo)* in areas to the north of Madeira.

New gill and tangle net fisheries are developing on both the Canadian Atlantic coasts and off Hatton and Rockall Banks to the west of the British Isles in depths of 500m and more. The target species is angler fish *(Lophius spp).*

PAPERS TO BE SUBMITTED

Confirmation to attend has been received from a number of delegates. Outlines of some of their papers are given overleaf. It is hoped that by publishing this information in advance other delegates will be able to ensure that their own contribution is not significantly duplicating other work. Other outlines will appear in the next Bulletin in December.

PUBLICATION OF THE PROCEEDINGS. NATO have appointed the Kluwer Academic Publishers BV to publish the proceedings during the summer of 1994. Each author will be invited to publish his or her paper and have it refereed by a colleague from the Workshop or someone else in the chosen field. It is therefore important that we receive your papers as soon as possible even in draft form as we have a very tight schedule. We are only too willing to help any of you with English syntax or any other problems; so please ask. Each author will be receiving from us a set of notes for the typing of the final paper and a request that the paper be included in the published proceedings.

SLIDE AND OVERHEAD PROJECTOR FACILITIES. These will be available throughout the Workshop in the main conference room.

TRANSPORT. A mini-bus will be provided daily between each of the two hotels and the Dennison Centre.

THE LATEST ABSTRACTS. In the first Bulletin we gave preliminary abstracts of six papers. Six more have now been received:

Canada. Richard L. Haedrich of Newfoundland will describe the investigations carried out over 14 years of the structure of a fish assemblage on the upper slope of Canada's Labrador Sea coast. Greenland halibut and roundnose grenadier are dominant members of the assemblage and both are fished commercially. The biomass of these species has declined markedly in the 14 year period.

Canada. Rosemary Ommer will talk about the importance of fisheries to the communities of Atlantic Canada and the need for policy and management issues to be squarely faced if these communities are to be sustained in the future. The relevance of careful use of deep water resources will be seen in this context.

U.K./Canada. John Gordon, Nigel Merrett (U.K.) and Dick Haedrich (Canada) are joining together to produce a paper which will describe the deep sea species and why they are different from the shelf stocks. It will include the zoogeography of the deep water fishes and their relationship with the cold and warm water masses.

Faroe. Jákup Reinert will describe the Faroese experience in the deep water to the south and southwest of Faroe including some work on the deep water crab *Geryon affinis* and the tangle net fishery for monkfish *(Lophius spp).*

Norway. Nils-Roar Hareide has recently carried out longline research in the Davis Strait and will draw comparisons between longlining and trawling in terms of selectivity by size and species, fish behaviour, quality and catchability.

France. Anatole Charuau from IFREMER will describe the results of French research and commercial developments of the fisheries for blue ling, grenadier and orange roughy on the north eastern Atlantic Slope in depths from 1200-1500m.

Ireland. Richard McCormick of BIM will present a short paper on the work carried out by research workers and commercial fishermen since 1988 - but beware, Richard confesses he can talk forever.

Alan G. Hopper/Secretary to the Workshop

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Co-ordinating Office.
SEA FISH INDUSTRY AUTHORITY
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BULLETIN NO. 2

DECEMBER 1993

CO-ORDINATING COMMITTEE MEETING 29TH NOVEMBER 1993

The Committee have met to discuss the progress of the planning stage of the Workshop. With three months to go the papers and abstracts are starting to come in and things are starting to take shape. We are certain the Workshop will be an important contribution to the knowledge of the deep sea resources. There are 17 papers.

In this Bulletin we are able to give details of the final programme and some more abstracts of the papers so far received. There is also some information of a general nature.

John E. Tumilty
Seafish Technical Director

PROGRAMME

TUESDAY 1ST MARCH

Plenary Session

Morning **Resources and Management of Deep Sea Stocks**

1. Review of Russian surveys and research in the North Atlantic. *F. Troyanovski, Russia*
2. The fisheries for Greenland halibut and grenadier in the Labrador Sea. *Bruce Atkinson, Canada*
3. The structure over time of an exploited deep water fish assemblage in the Labrador Sea. *Richard Haedrich, Canada*
4. Policy/Management issues and the sustainability of fishing communities in Atlantic Canada. *Rosemary Ommer, Canada*
5. Experience with orange roughy in New Zealand waters and the effects of commercial fishing on stocks 1980-93. *Malcolm Clark, New Zealand*

Afternoon

6. French developments of deep water fisheries for blue ling, grenadier and orange roughy on the eastern Atlantic Slope. *Anatole Charuau, France*

7. A description of the deep water resources in Faroese waters based on trawl, longline and tangle net fisheries. *Jákup Reinert, Faroe*

Fish Technology and Engineering

8. Product development/process technology and markets for deep water species. *Grimur Valdimarsson, Iceland*
9. Engineering considerations in vessel design and power for deep water fishing. *Seafish*

Evening **Civic Reception by the Hull City Council**

WEDNESDAY 2ND MARCH

Morning **Biology and Ecology of Deep Water Fishes**

10. The special features of deep sea fishes compared to shelf fishes and the zoogeography of the North Atlantic Basin. *John Gordon, John Merrett, UK Richard Haedrich, Canada*
11. The deep sea species of the Iceland Slope and Reykanes Ridge - biology and relative abundance. *Drs. J.V. and J.Magnusson, Iceland*
12. Experience with the Skaggerak stocks - including ageing studies. *Odd-Aksel Bergstad, Norway*

Afternoon **Fishing Technology**

13. Trawl gear design for bottom and semi-pelagic deep water fisheries. *Gunnar Svarsson, Iceland*
14. Norwegian experience with longlines for deep water fishing in the eastern Atlantic and Norwegian Sea. *Hans Edvard Olsen, Norway*
15. Irish experience of deep water trawling in the eastern Atlantic. *Richard McCormick, Ireland*
16. The traditional line fishery for black scabbard and other species in the eastern mid Atlantic to the north of Madeira. *Carlos Sousa Reis, Portugal*
17. Comparisons between longlining and trawling for deep water species - selectivity, fish behaviour quality and catchability. *Nils-Roar Hareide, Norway*

Summing up of the first two days and stressing the importance of an international approach to management and exploitation. *ICES*

Evening **Social dinner preceded by shopping trip**

THURSDAY 3RD MARCH

Morning Workshop I International Management of Deep Sea Resources - need for urgency - how we can tackle the problem - what needs to be done to give advice at this stage. *Chairman Malcolm Clark*
Rapporteur Phil MacMullen

Morning Workshop II Processing, Marketing and End Use - international effort to carry out research and technical development to make best use of these resources. *Chairman Alan Hopper*
Rapporteur Grimur Valdimarsson

Afternoon Workshop III Technological Development - gear vessels
Chairman John Tumilty
Rapporteur Richard McCormick

Workshop IV Joint Research into Deep Sea Stocks - what are the outstanding issues - who is doing what and who else should be involved - how fragile is the resource, are some species more at risk than others. *Chairman John Gordon*
Rapporteur Odd-Aksel Bergstad

Evening **Sherry Party**

FRIDAY 4TH MARCH

Morning Informal discussions, poster sessions, video presentations.
Afternoon Brief summaries from the Workshop sessions.

CLOSE APPROXIMATELY 3.00 P.M.

POSTER SESSION. Arrangements are in hand for a number of display panels (approx. 1.6m high x 1.0m wide) to be available for those institutes requesting poster space. A poster may describe the work of the institute in broader terms or the details of a piece of research relevant to the Workshop. The panels will be on display throughout and the morning of Friday 4th March will be reserved for time for delegates to explain their poster displays.

VIDEO PRESENTATIONS. One of the rooms will be equipped with a video set and this can be used by delegates to present any video film they wish to bring. We would prefer these to be shown separately from the main sessions and we would request that each video film is edited to a maximum of 20 minutes.

HOTELS. We have made arrangements with two hotels for rooms with en-suite facilities. The Royal Hotel is in the city centre and has been recently rebuilt and re-furnished. It has a lot of charm and character and will cost £40 per night including continental breakfast. The second is at the Pearson Park Hotel which overlooks parkland and is a good class of hotel. This will be £37.50 including full English breakfast. We can obviously find more modest hotels at around £30 but we believe the two named are good value. Please let us know your requirements.

HOSPITALITY. All coffee and tea refreshments at the Dennison Centre are provided free to invited delegates along with a buffet lunch. The Hull City Council will provide a reception buffet on Tuesday 1st March at the Guildhall at 7.00pm. The Sea Fish Industry Authority will give a dinner for delegates on Wednesday 2nd March at a venue still to be decided.

POSTER SESSION

Arrangements are in hand for a number of display panels (approx. 1.6m high x 1.0m wide) to be available for those institutes requesting poster space. A poster may describe the work of the institute in broader terms or the details of a piece of research relevant to the Workshop. The panels will be on display throughout and the morning of Friday 4th March will be reserved for time for delegates to explain their poster displays.

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HOSPITALITY

All coffee and tea refreshments at the Dennison Centre are provided free to invited delegates along with a buffet lunch. The Hull City Council will provide a reception buffet on Tuesday 1st March at the Guildhall at 7.00pm. The Sea Fish Industry Authority will give a dinner for delegates on Wednesday 2nd March at the Fergusson Fawcitt Arms, Walkington. This is a traditional English pub which we have taken over for the evening. SAMS will host a sherry party on Thursday 3rd March at the Pearson Park Hotel.

PUBLICATION OF THE PROCEEDINGS

NATO have appointed the Kluwer Academic Publishers BV to publish the proceedings during the summer of 1994. Each author will be invited to publish his or her paper and have it refereed by a colleague from the Workshop or someone else in the chosen field. It is therefore important that we receive your papers as soon as possible even in draft form as we have a very tight schedule. Some of you have requested that you have time to refine your papers at the meeting - fine, but please remember our time scale. We are only too willing to help any of you with English syntax or any other problems; so please ask.

SLIDE AND OVERHEAD PROJECTOR FACILITIES

These will be available throughout the Workshop in the main conference room.

TRANSPORT

A coach will be provided daily between the Pearson Park Hotel and Hollies Private Hotel to the Dennison Centre. It will also be available for taking you to the social events. Private cars will be available from the Royal Hotel daily. Would Hollies residents please note that for the first day - Tuesday 1st March - transport will be in the form of a taxi.

SECRETARIAT

I will be available during the Workshop to help with any problems and to hassle you for your papers. Louise Allen who has either written or spoken to you during the preparation stages will be available most of the time.

Alan G. Hopper
SECRETARY TO THE WORKSHOP

ADVANCED RESEARCH WORKSHOP
Deep Water Fisheries of the North Atlantic Oceanic Slope
HULL UNITED KINGDOM 1-4 MARCH 1994

Co-ordinating Office
SEA FISH INDUSTRY AUTHORITY
Seafish House, St. Andrew's Dock,
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BULLETIN NO. 3

MARCH 1994

WORKSHOP
1st - 4th March 1994

Welcome to Hull and to the Advanced Research Workshop on the Deep Water Fisheries of the North Atlantic. We hope your travel was not too stressful and the hotel accommodation is to your satisfaction. In this Bulletin we have laid out the final programme with times.

John E. Tumilty
SEAFISH TECHNICAL DIRECTOR

PROGRAMME

TUESDAY 1ST MARCH

Morning **Resources and Management of Deep Sea Stocks**

0900-0930 Plenary Session *Peter Chaplin, Alasdair McIntyre*

0930-1015 Review of Russian surveys and research in the North Atlantic. *Stanislav Lisovsky, Russia*

1015-1100 The fisheries for Greenland halibut and grenadier in the Labrador Sea. *Bruce Atkinson, Canada*

1115-1200 The structure over time of an exploited deepwater fish assemblage in the Labrador Sea. *Richard Haedrich, Canada*

1200-1245 Policy/management issues and the sustainability of fishing communities in Atlantic Canada. *Rosemary Ommer, Canada*

Afternoon

1400-1445 Experience with orange roughy in New Zealand waters and the effects of commercial fishing on stocks 1980-93. *Malcolm Clark, New Zealand*

1445-1530 French developments of deep water fisheries for blue ling, grenadier and orange roughy on the eastern Atlantic Slope. *Anatole Charuau, France*

1545-1630 Deep water resources in Faroese waters and adjacent areas. *Jákup Reinert, Faroe*

Fish Technology and Engineering

1630-1715 The Canadian Experience: Deep water fishing - otter trawling in the Pacific Ocean and gillnetting in the Atlantic. *Andrew Duthie*

Evening **Civic Reception by the Hull City Council**

WEDNESDAY 2ND MARCH

Morning **Biology and Ecology of Deep Water Fishes**

0900-0930 The traditional line fishery for black scabbard and other species in the east Atlantic. *read by the Secretary*

0930-1015 The special features of deep sea fishes compared to shelf fishes and the zoogeography of the North Atlantic Basin. *Richard Haedrich, Canada* *John Gordon, Nigel Merrett, UK*

1015-1100 The deep sea species of the Iceland Slope and Reykanes Ridge - biology and relative abundance. *Jutta and Jakob Magnusson, Iceland*

1115-1200 Age determination of deep water fishes - experience status and challenges for future research. *Odd-Aksel Bergstad, Norway*

Fishing Technology

1200-1245 Trawl gear design for bottom and semi-pelagic deep water fisheries. *Gudmunder Gunnarsson, Iceland*

Afternoon

1400-1445 Norwegian experience of deep water fishing with longlines. *Hans Edvard Olsen, Norway*

1445-1530 Irish experience of deep water trawling in the eastern Atlantic. *Richard McCormick, Ireland*

1545-1630 Experimental utilisation and marketing of by-catches and deep water species in Iceland. *Grimur Valdimarsson, Halldór Pétur Thorsteinsson, Iceland*

1630-1715 Comparisons between longlining and trawling for deep water species - selectivity, fish behaviour, quality & catchability. *Ole Jørgensen, Greenland* *Nils-Roar Hareide, Norway*

Summing up of the first two days and stressing the importance of an international approach to management and exploitation. *ICES*

Evening **Dinner at Fergusson Fawcitt Arms, Walkington**

THURSDAY 3RD MARCH

Morning **Workshop I**

0915-1100 International Management of Deep Sea Resources - need for urgency - how we can tackle the problem - what needs to be done to give advice at this stage. *Chairman Malcolm Clark* *Rapporteur Phil MacMullen*

1130-1245 **Workshop II**
Processing, Marketing and End Use - international effort to carry out research and technical development to make best use of these resources. *Chairman Alan Hopper* *Rapporteur Grimur Valdimarsson*

Afternoon **Workshop III**

1400-1500 The special case of small vessels in deep water fisheries. *Seafish*
Technological Development - gear vessels *Chairman John Tumilty* *Rapporteur Richard McCormick*

1530-1730 **Workshop IV**
Joint Research into Deep Sea Stocks - what are the outstanding issues - who is doing what and who else should be involved - how fragile is the resource, are some species more at risk than others. *Chairman John Gordon* *Rapporteur Odd-Aksel Bergstad*

Evening **Sherry Party**

FRIDAY 4TH MARCH

Morning Informal discussions, poster sessions, video presentations.

Afternoon Brief summaries from the Workshop sessions.

CLOSE APPROXIMATELY 3.00 P.M.

APPENDIX IV

List of Institutes and areas of research where interest has been expressed.

Research Activities \ Institute	Seafish	PINRO	DFO Canada	Ocean Sciences & Marine Inst.	Inst for Social & Economic Res	Icelandic Fisheries Laboratories	IFREMER	Fiskirannsóknarstovan	SAMS	Natural History Museum	Marine Research Inst Iceland	Inst of Marine Research Norway	Directorate of Fisheries Norway	BIM, Ireland	Møreforsking Norway	DFR Lowestoft, UK	Marine Laboratory Aberdeen	ICES	J. Marr Ltd, UK	Greenland Fisheries Inst.	Instituto Espanol Oceanografia	Dept of Marine, Dublin	University of Aberdeen	MAF New Zealand	IPIMAR, Portugal
Marketing and end use of deep water species	⊘		⊘			⊘			⊘					⊘	⊘										⊘
Processing technology	⊘		⊘	⊘		⊘								⊘	⊘										⊘
Medical products research									⊘																⊘
Vessel performance in deep water	⊘		⊘	⊘																					
Engineering design of winches, electronics & safety	⊘		⊘	⊘																					
Ghost fishing of gill nets	⊘		⊘						⊘			⊘		⊘		○	⊘								
Economic evaluation of deep water fisheries			⊘			⊘			⊘					⊘	⊘					○					
Longline experimental fishing, eg Reykanes Ridge	○		⊘					⊘	⊘		⊘	⊘		⊘	⊘		⊘			⊘					⊘
Gear effectiveness studies in deep water	⊘		⊘					⊘	⊘		⊘			⊘	⊘		⊘			⊘					⊘
Selectivity of trawls, longlines and gill nets	⊘		⊘	⊘				⊘	○	⊘		⊘	⊘		⊘	⊘	⊘			○	⊘					⊘
Deep water fish behaviour studies			⊘						⊘			⊘	⊘		⊘	⊘	⊘			⊘			⊘		
Standardisation of methodology			⊘			⊘			⊘			⊘	⊘		⊘	⊘				⊘	⊘				
Collaboration on species identification in commercial catches			⊘	⊘		⊘			⊘	⊘		⊘	⊘		⊘	⊘	⊘				⊘	⊘			⊘
Distribution of species			⊘	⊘				⊘	⊘	⊘		⊘	⊘		⊘	⊘				⊘	⊘	⊘	⊘		⊘
Development of new technologies for measuring abundance & biomass			⊘					○	⊘	⊘		⊘			⊘	○	⊘			⊘			⊘		
Mid Atlantic Ridge stratified trawl surveys												⊘		⊘	⊘										
Stock structure and migration			⊘			⊘		⊘	⊘	⊘		⊘	⊘		⊘	⊘				⊘	⊘	⊘	⊘		⊘
Age determination techniques			⊘	⊘		⊘		○	⊘	⊘		⊘	⊘		⊘	⊘	⊘			⊘	⊘	⊘	⊘		⊘
Early life history studies of selected species			⊘					○	⊘	⊘		⊘	⊘			○				⊘	⊘	⊘	⊘		⊘
Forecasts of the consequences of exploitation by commercial vessels			⊘	⊘		⊘		○				⊘		⊘	⊘	⊘	⊘			⊘		⊘			
Food webs and the effects of exploitation of parts of the food chain			⊘	⊘				○	⊘	⊘		⊘	⊘		⊘	○									⊘
Categorisation of the physical habitats in likely target fishing zones			⊘	⊘		⊘			⊘			⊘	⊘		⊘										⊘
Evaluation of protective measures for deep water stocks			⊘			⊘			⊘			⊘	⊘	⊘	⊘	⊘	⊘					⊘			⊘
Supplementary Suggestions:						⊘																			
- Abundance estimations of *Sebastes mentella*								⊘				⊘								⊘					
- The relative importantance of adult and juvenile fish composition in deep water stocks						⊘		⊘	⊘	⊘		⊘				○									
- Quality standards for deep water fishes	⊘					⊘								⊘	⊘										
- Reproduction studies															⊘						⊘				

⊘ indicates positive interest

○ indicates interest but unlikely to become involved in actual work