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TECHNICAL REPORT NO. 101

Exploratory Voyage by D.E.T. SWANELLA

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INDEX

INDEX

SUMMARY AND CONCLUSIONS

SUMMARY

In the Autumn of 1973 the diesel electric stern trawler SWANELLA was chartered on behalf of the Ministry of Agriculture, Fisheries and Food for an exploratory fishing voyage in deep water to the West and North West of the British Isles. The areas in question have not hitherto been exploited by commercial fishing vessels but in the twelve months prior to SWANELLA's voyage they had been surveyed in part by Fishery Research Vessel CIROLANA.

At the depths in question, between 400 and 700 fathoms, practically no fish were caught of the species which are currently marketed in the U.K., such as cod, haddock or hake. Several other species were caught however some of them which have since been shown to have reasonable market potential. Of these, however, only the grenadier (Coryphaenoides Rupestris) and various species of shark were found in quantities which would be likely to sustain commercial fishing activity.

Although the catch rates of grenadiers and sharks were promising in certain areas, notably to the North West of Ireland, further work will be required to establish the commercial viability of these stocks.

The SWANELLA is owned by J. Marr and Sons, Hull, and the co-operation of the Company, and the Skipper and Crew of the vessel, is gratefully acknowledged.

CONCLUSIONS

The information obtained on the voyage of the SWANELLA and from earlier cruises of FRV CIROLANA have established that bottom living species are available in depths of 400 to 700 fathoms off the edge of the Continental Shelf to the West and North West of the U.K. in quantitites which could yield catch rates of commercial importance. Preliminary assessment has indicated that three species have palatable white flesh which could be attractive to the British market. These are grenadiers (Coryphaenoides Rupestris), scabbards (Aphanopus Carbo) and Gephyroberyx. Of these three, grenadiers were the only ones found in quantities which are likely to be of commercial significance. They comprise 80% of the catch in certain hauls but were generally about 40 - 60% of the catch. They are widespread.

In addition to those three, various species of sharks, comprising about 20% of most hauls, have reasonable marketing prospects for export, and they may also have a limited domestic potential.

In particular, grenadiers and scabbards can be processed to form good quality laminated blocks which would be commercially acceptable. Several other types of processing and outlets should be possible for these and a few other species.

The catch rate per hour of those species which are likely to be marketable, including the sharks, is about 0.48 tonnes which, with an effective fishing time of about 10 hours in each 24 at those depths, would yield about 5 tonnes per day. This figure, however, is based upon exploratory fishing results (with the exception of the brief period of commercial-type fishing during SWANELLA's voyage) and further voyages which are entirely commercial in character will be required to establish the real potential of this deep water fishery.

FURTHER ACTION

(a) Immediate

1. The work at Torry Research Station on the market acceptability of the species in question, and products made from them, is nearing completion and at the time of writing demonstrations to the trade are in hand.

2. Work is in hand at Fisheries Laboratory, Lowestoft, to establish the long term viability of the stocks in question and a report on this subject will be issued in due course.

3. A commercial type voyage for grenadiers and sharks, probably lasting 10 - 14 days, is planned for February 1974, using a commercial stern trawler on charter.

(b) Long Term

If the current programme confirms that a commercial fishery could be established in these waters the following development action will be needed.

4. Development of improved fishing gear, since it is unlikely that that used on SWANELLA was ideal, and to include pair bottom trawling techniques to allow the older side trawlers to participate.

5. Design and/or development of improved deck machinery, especially main trawl winch.

6. Selection and development of improved fish detection equipment and the production of suitable fishing charts.

WHITE FISH AUTHORITY
Industrial Development Unit

Technical Report No. 101 — 7th January, 1974.

EXPLORATORY VOYAGE BY D.E.T. SWANELLA

1. INTRODUCTION

With the current international trends as regards fishing limits and the level of exploitation of existing stocks there is an obvious need to locate new stocks of fish which may be exploited by the British fishing fleets and which will result in fish or fish products which are acceptable to the British market. For this reason the Ministry of Agriculture, Fisheries and Food provided funds in 1973 for an exploratory fishing programme to be carried out in the deep water towards the edge of the Continental Shelf to the West and North West of the British Isles. The range of depth in which fishing took place was from 400 to 700 fathoms and this should be compared with existing commercial practice which never exceeds 400 fathoms and very seldom goes deeper than 300 fathoms. In fact well over 90% of the work of the British deep sea fishing fleet is in waters of less than 200 fathoms.

The exploratory fishing programme was managed by the White Fish Authority on behalf of M.A.F.F. and was under the joint technical control of the Fisheries Laboratories at Lowestoft and Aberdeen, the Torry Research Station, Aberdeen and the Industrial Development Unit of the W.F.A.

The foundations for the exploratory programme had been laid previously by a gear development programme by the W.F.A. and by a survey programme by Lowestoft Fisheries Laboratory. The former was aimed at adapting standard bottom trawls to allow them to be used at depths of 700 fathoms without requiring existing ships to carry additional warp. This was successfully accomplished and was used in the latter programme in which F.R.V. CIROLANA carried out fishing surveys in deep water from the West of Shetlands to the South West of Ireland. On the charter voyage of the SWANELLA the same gear configurations were used and the results of the CIROLANA's voyages were taken into account in the planning of the voyage.

This report on the SWANELLA's voyage and on the subsequent programme of work by Torry Research Station to establish the market acceptability of the various species was compiled jointly by the Fisheries Laboratory, Torry Research Station and the W.F.A.

2. OBJECTIVES

The objectives of the charter voyage were defined as follows:-

"The project is to be carried out on behalf of the Ministry of Agriculture, Fisheries and Food, by the White Fish Authority, Industrial Development Unit. Technical responsibility rests jointly with M.A.F.F., Fisheries Laboratory, Lowestoft, D.A.F.S., Marine Laboratory, Aberdeen, M.A.F.F. Torry Research Station, Aberdeen, and the Industrial Development Unit of the White Fish Authority.

"The objectives of the proposed survey is to locate commercially significant quantities of fish which could be exploited by the British deep sea fishing fleets and to determine their suitability for marketing in the U.K. and elsewhere. Associated objectives may have to include development of, or refinement of, methods for detection, capture and preservation of the catch.

"If these objectives are to be met then once fish are located in reasonable quantities a sufficient amount of time must be spent in actual fishing to give an indication of the potential catch rates, in commercial terms. Also, enough fish must be brought back in good condition to enable an assessment to be made, first of all by Torry Research Station and subsequently by the Fish Trade, of the market acceptability of the various species concerned.

"It is assumed that most effort will be devoted to demersal species, but if shoals are detected in mid-water which would appear to be of commercial interest the pelagic trawl will be used."

3. VESSEL AND EQUIPMENT

When the voyage requirements were known, tenders for the charter were called for from all relevant owners. The vessel eventually chosen was the D.E.T. SWANELLA, a Distant Water Stern Freezer Trawler, owned by J. Marr and Sons of Hull. The SWANELLA is 245ft. long and has a frozen fishroom capacity of 600 tons; full technical details appear in Appendix I to this report.

The SWANELLA was commanded on the charter voyage by her normal skipper, E. Fox, and a crew of 23 were carried including three deck officers and three engineer officers.

The following staff from the various fisheries establishments involved sailed on the vessel:-

Three from the Fisheries Laboratory Lowestoft; for fish stock assessments.

Three from the Torry Research Station, Aberdeen; for fish handling and preservation and assessment of fish as a food.

One from the Marine Laboratory Aberdeen; for fish stock assessments.

Three from W.F.A., Industrial Development Unit, Hull; for navigation, general management of survey and supervision of electronic aids.

In addition to the vessel's normal fish finding, navigational and processing equipment the following extra equipment was supplied and installed by W.F.A. prior to the charter voyage.

1. NIO towed body containing Humber Gear transducer and 45m of cable.
2. Davit for towed body, and power source.
3. MS44 echo sounder, bottom lock and helical recorder, all supplied and modified for deep water by Kelvin Hughes.
4. Loran C navigation equipment (2 off, supplied by Atlas A/S and Teledyne)
5. Small work table in wheelhouse.
6. Two trawl temperature measuring equipments.

7. Bathythermo device supplied by M.A.F.F. Lowestoft.

8. Charts, logsheets and logbook.

9. Filleting bench.

10. A Baader 694 de-boning machine.

11. Labels for iced and frozen fish identification (supplied by T.R.S).

12. Dividing panels for vertical plate freezers.

13. 15 tons of ice, loaded in sacks in the vessel's fishroom. Fifty 1 cwt fishboxes.

4. FISHING GEAR

It has already been mentioned that W.F.A. have developed trawl gear modifications permitting the use of broadly conventional fishing gear in depths up to about 700 fathoms.

The main problem is that existing ships have trawl winches designed to take only about 1200 fathoms of trawl warp per side; therefore in depths of 700 fathoms, the warp length/depth ratio is less than 2:1, whereas conventional fishing gear is designed for a ratio of 3:1. Therefore, to avoid the trawl being pulled off the bottom due to the steeper warp angle, parts of the gear have to be weighted for deep water operation.

Also any floats used must of course be selected to suit the greater depths, to avoid implosion.

It was decided to use the SWANELLA's normal ground trawls throughout the survey; these were the 96ft headline "Stella" manufactured by CoSalt Limited of Grimsby. The modifications for deep water fishing were:-

Solid rubber groundrope bobbins, instead of the usual hollow iron ones.

'XX' headline floats, and plastic Nokalon floats, instead of the usual 8 inch diameter aluminium ones.

"Fearnought" rectangular trawl doors increased in weight from 1.0 to 1.5 ton each.

The modified trawl gear is shown in Figures 2 to 5.

A 1600 mesh x 200 mm Engels midwater trawl was also carried for pelagic fishing.

Small mesh liners, of 60 mm mesh, were fitted in the cod ends of all trawls used. These were to retain small fish for biological studies.

5. VOYAGE NARRATIVE

5.1. Programme

The voyage programme allowed for a two-part voyage with a landing at the port of Ullapool in between.

Part I was to last for about 20 days, including the voyage out. After a brief sampling of grounds already visited by F.R.V. CIROLANA, the ship was to survey all possible grounds in the depth range 300-700 fm on the edge of the Continental Shelf from West of Northern Ireland to South West of Faroe.

The vessel would then land pre-determined samples of iced fish in Ullapool, re-fuel, and exchange scientific staff.

Part II allowed for about 10 days' simulated commercial fishing at the best grounds discovered so far in the survey, followed by further survey work on the edge of the Shelf S.W. of Ireland, on the edge of Porcupine Bank; total duration of Part II to be about 22 days including voyage home.

5.2. Catch Recording and Processing

Throughout the various survey periods, fish was caught in tows of about 1½ hours duration. When the catch was brought on board, scientists from the Laboratories weighed it and took samples for biological study.

Staff of Torry Research Station then supervised the crew in processing the catch. "Trash" (mainly undersized fish) was rejected overboard, and the remainder gutted and frozen in the ship's vertical plate freezers, then stowed in the refrigerated fishroom. Some of the catch was however, at suitable stages of the voyage, iced for landing as wet fish, and some of course was cooked and eaten on board.

During the simulated "commercial" fishing period in Part II, it was not possible to weigh the whole of the catch. The size of each haul was therefore estimated visually (as is the practice on commercial vessels). Processing was still supervised by T.R.S. staff, and the number of blocks of frozen fish was checked against the estimated catch.

5.3. Catch Weight Nomenclature

It is the normal practice on British trawlers to assess a catch in terms of a number of "baskets" of fish; this term remains from days when fish was loaded into the fishroom in baskets, and these could be counted.

Therefore the catch log on SWANELLA was recorded in "baskets" and for the sake of members of the Industry who may read this report, the term is retained in the following pages.

However, the normal weight definition in scientific circles is the kilogram (Kg) or Tonne (i.e. 1000 Kg) and therefore the tables which follow are made out in Kg.

A further confusion arises in that a freezer trawler tallies its catch by the number of blocks of frozen fish, and this is also referred to later.

Correlation on board SWANELLA was achieved by check weighing many baskets and blocks of fish; the density of both was of course different from traditional species and was as follows:-

1 basket of ungutted deep water fish = 37 Kg
1 block of gutted deep water fish = 37 Kg
27 baskets of ungutted fish = 1 Tonne
27 blocks of gutted fish = 1 Tonne

5.4. Narrative : Part I

SWANELLA sailed from Hull on August the 20th. 1973 and proceeded South about through the Channel to grounds previously fished by CIROLANA, and where worthwhile catches had been obtained. These grounds are all on the edge of the Continental Shelf between S.W. Ireland and the Hebrides. (See Figure 6). As anticipated from previous results, the two tows on South Farm Bank S.W. of Ireland yielded poor results. However, the Tory grounds again proved a good prospect with yields of 46, 102 and 78 baskets (see note above) each for 1½ hour tows. Barra and Flannan also gave similar results. Unfortunately, the gear did not appear to have bottomed off St. Kilda. This problem arose on several occasions throughout the survey in depths in excess of 550 fathoms.

Two days were spent along the 200 fathom contour around the Rockall Bank. This was at the request of D.A.F.S. Marine Laboratory, Aberdeen, and was an attempt to locate Blue Whiting stocks at this time of year. The special heavy trawl doors were changed for the vessel's own doors at this point. Results were poor however, and few other fish were caught in a total of nine demersal and one pelagic tow. The latter tow had to be curtailed when the net transducer signal was lost due to a flooded cable. Few pelagic fish marks were seen and no concentrations or shoals of any size. Trawling was very difficult in depths of less than 200 fathoms owing to trawl damage caused by coral.

The vessel then proceeded to the deep water on the S.W. edge of Rockall Bank. Three tows yielded only one useful indication; a haul of 9 baskets in 450 fathoms. Unfortunately, "locked doors", another frequent occurence in deep trawling, was encountered here, and one heavy door was damaged during recovery. The second set of heavy doors was brought into use. At this time also the iron "bunt" bobbins and scuttle danlenos were replaced by a complete rubber rig.

The vessel proceeded to the South end of the Hatton Bank in about 57^{o}N 20^{o} West. However, winch brake failure and poor weather stopped fishing at this point. In view of the conditions it was decided to proceed direct to the Hatton Bank proper, thus missing out stations 7 and 8 of the survey. Twenty two tows were made on Hatton and India Bank at varying depths. The first few were interfered with by gale force winds and a very heavy swell. The vessel laid for twelve hours on one occasion owing to the swell. Fishing at the greatest depths 650 - 690 fathoms required the gear to be "settled" for periods of 15 to 20 minutes with the vessel almost imperceptibly moving ahead. Though clear tows were obtained in 400 to 500 fathoms, the general situation was that the ground was difficult and fasteners frequent in these depths, although from 600 to 700 fathoms the ground was smooth and trouble free. This situation worsened as the survey moved North along the banks. An attempt to fish the top of the bank at 59^{o}N 16^{o}W, in 290 fathoms ended disastrously with the loss of most of the trawl, ground gear and one door. The new trawl was rigged with iron bunt bobbins danlenos and a rubber "bosom" rig. The door previously damaged was repaired and that set of doors again brought into use.

Fishing the North end of the Hatton Bank proved impossible due to the hard ground in depths of less than about 630 fathoms. Generally results were disappointing with only two good hauls of 49 and 48 baskets in 550 and about 650 fathoms respectively. It must also be mentioned that this particular sea area is liable to very bad weather conditions for most of the year due to its position relative to the paths of Atlantic low pressure systems.

The vessel proceeded to the West side of George Bligh Bank where tows in 540, 480 and 360 fathoms all proved difficult with fasteners and damage. Two tows were made in 600 and 500 fathoms respectively off the N.W. edge of the Rockall Bank. The ground again proved very rough and the gear was badly damaged on one tow.

The Eastern edge of the George Bligh proved impossible to trawl over. An extensive echo survey was carried out after an abortive attempt to fish there; no trawlable ground was found up to 700 fathoms.

Results on Lousy Bank on the South side were disappointing. Again the only trawlable depths appear to be in excess of 600 fathoms. The West side of Lousy Bank yielded 64 and 22 basket hauls again in depths of greater than 600 fathoms. The East side of the bank gave poor fishing results with similar bottom conditions. Generally speaking the Northern and Western sides of these outer Banks yielded better results than the Southern and Eastern edges. Echo traces (Atlas 860) of all the above mentioned areas of Hatton and the other Banks were taken during tows and when surveying.

The vessel proceeded finally to the Northern edge of Bill Bailey Bank. The ground here appeared much more trawlable although there were gullies and occasional "pinnacles". Unfortunately a case of "cable laid" gear with fouled doors and cables was incurred here. However, the second tow, in 570 fathoms, yielded a total of 33 baskets. The vessel then steamed overnight to the tows off the Flannans where good catches had previously been taken by Cirolana as well as Swanella. The intention was to ensure a catch of fish on the final day's fishing to be landed "iced" at Ullapool. Several tows were made in 300 to 400 and 500 to 600 fathoms. Again good catches were taken with two hauls of about 50 baskets and one haul of 60 baskets.

The general catch composition pattern had changed in this survey from that found during Cirolana's cruise of July 1973. The early Swanella hauls yielded greater proportions of Grenadiers than Smoothheads. However, from about the middle of the Hatton Bank northwards the opposite was the case, with Smoothheads being the predominant species. Sharks made up a large proportion, often one third of the bag.

The final days' fishing West of the Flannans (15 hours fishing 4 hauls) yielded a total of 173 baskets (6.4 Tonnes)

The SWANELLA landed 38 boxes of iced fish at Ullapool, and these were immediately transported by road to Torry Research Station, Aberdeen. Some items of replacement fishing gear - rubber bobbins, a set of trawl doors, and codend liners for both bottom and pelagic trawls - were taken aboard. Shore technicians serviced the echo sounder and a bottom lock scale expander facility was fitted to the Atlas 860 sounder. The ship was re-fuelled.

5.5. Narrative : Part II

Stress of weather and other factors had resulted in the Part I survey work being incomplete at this stage, and therefore it was decided to finish off this work at the start of Part II of the voyage. The simulated commercial fishing period was reduced to 8 days to allow for this.

5.5.1. Completion of Survey of North West Banks

This involved steaming from Ullapool to the South side of Bill Bailey Bank where tows were carried out in 600, 550 and 400 fathom areas. Hauls varied between 20 and 30 baskets for 1½ hours. The ground was "catchy" but only really rough in depths of 400-500 fathoms.

The western edge of Faroe Bank was then tried in 600 fathoms. The catch consisted of 27 baskets, mainly Grenadiers. Only one tow was carried out in these depths owing to very rough ground shown by echo survey.

The vessel then steamed south towards Rosemary Bank 59.5N, 10.5W. However, while on passage across Bill Bailey Bank, very dense fish marks were observed near the bottom in 105 fathoms. This presented an ideal opportunity to compare the performance of the towed body transducer with that of the identical hull mounted transducer. The trawl was shot and towed for just under one hour, in company with two French trawlers. The fish located proved to be large saithe. A total of 23 baskets of fish was caught, including 19 of saithe. Interesting echo traces have been retained from this tow.

Rosemary Bank was fished without difficulty, in depths ranging from 360 to 660 fathoms. $1\frac{1}{2}$ hour tows yielded between 15 and 40 baskets. The predominant species overall was grenadier. The ground was trawlable in all depths on the West side, though rough where shallower than 600 on the South East edge. One day was spent from 04.00 hrs to 23.00 hrs fishing on Rosemary Bank. At this point the areas projected for Part I had been covered and it was decided to try some "commercial" fishing on the most promising of the banks previously surveyed.

5.5.2. Simulated Commercial Fishing

From Rosemary Bank the vessel steamed westwards for about fifteen hours to deep water off the North edge of Hatton or India Bank in position 59.5N, 17^{o}W. Ten tows were carried out here, mostly of about $2\frac{1}{2}$ hours duration. The total time spent in this area was 47 hours. One tow was abortive owing to "locked doors"; the total time involved including clearing the foul gear was equivalent to that which would have been involved had the vessel made a $2\frac{1}{2}$ hour tow. All these tows were made in over 600 fathoms. The ground is good over an area of about 10 miles East and West of this position and deeper than 600 fathoms.

A total of about 475 baskets, (about 17 tonnes), was taken during this period. This is an average of nearly 2 Tonnes per tow of $2\frac{1}{2}$ hours.

SWANELLA left this area at 14.00 hours on the 18th and steamed South Eastwards for 25 hours to grounds West of Tory Island. This area had been fished twice previously by CIROLANA, and also earlier in the trip by SWANELLA. The edge is very steep here and at first sight appears to be a series of pinnacles. However, this appearance is deceptive and in fact it is quite trawlable. Some relatively minor damage was suffered. However, this was sufficient to reduce catch rates. Tows were generally of about 2 hours unless curtailed by damage. One haul yielded 120 baskets and one 100 baskets, predominantly Grenadiers. Other tows, where damage did not interfere, yielded between 50 and 60 baskets, comprising 50 to 60% grenadiers. The other predominant species were sharks - up to 25% on some hauls. Several baskets of

Gephyroberyx, a large redfish, were taken on two hauls here, the first time any quantity of this species had been found.

Altogether fourteen tows were attempted, three were abortive due to damage or to hauling early when the sounder indicated a "cliff face" type of bottom ahead of the trawl. Eleven effective tows were therefore carried out during 54 hours in this area. An estimated 437 baskets, about 16 tonnes were caught.

One feature of this fishery which caused a problem during the commercial tows was the occurrence of codend damage. This was apparently due to captured sharks attacking the twine in an effort to escape. It may also have been at least partly caused by the abrasive skins of sharks and grenadiers damaging codends. For this reason it was thought unwise to tow for more than about two hours (see also Section 7.3).

5.5.3. Fishing Survey of Porcupine Bank Deeps

On completion of the commercial fishing exercise on Tory Island grounds, SWANELLA proceeded Westwards to the North East corner of the Porcupine Bank area in 54^{o}N, 13.5^{o}W approximately. CIROLANA had previously fished some 50 miles to the East of this position. These tows were referred to as "West of Eagle Island". Trawlable ground was found without much difficulty along the West and South edges of this area, as far South as 51.5N in 15^{o}W. In fact a feature of this area was the almost total absence of gear damage.

CIROLANA had previously fished along the South West edge of this area, "South Farm Bank", and to the South East, "West of Dingle" and "West of Bantry". SWANELLA filled in the gaps, shooting in depths varying between 400 and 700 fathoms. Unfortunately, catch rates South of the aforementioned 54^{o}N, 13.5W position were very low. This was the experience of CIROLANA on these grounds. With the exception of the first two hauls on the N.W. edge, where hauls of 57 and 27 baskets were taken during 1½ hour tows, the best haul was 20 baskets with the average being about 10 baskets for 1½ hours.

Altogether 12 effective deep water tows were carried out during this period and a total of 183 baskets was taken.

During the period spent on outer "Porcupine", a fleet of Spanish trawlers was observed fishing within two miles of the deep edge, in about 200 fathoms. It was decided to try one tow in this depth. Hauling after two hours there were only about $2\frac{1}{2}$ baskets of fish in the codend, of which about $\frac{1}{2}$ a basket was hake and $\frac{3}{4}$ basket small blue whiting. In fact there were quite a number of blue whiting in the meshes of the square and baitings when the trawl surfaced.

Dense marks, like small fish, were observed during the last half hour of the tow, mainly about 2 fathoms off the bottom. It is suspected that these were blue whiting, through the trawl headline height was probably too low to catch these. The 200 fathom contour was the depth at which large hauls of blue whiting were taken at Rockall in the spring by F.R.V's SCOTIA and THALASSA.

An attempt was made to check the sea bottom temperature at this depth but was not possible as a watertight seal failed on the recorder during immersion. An echo sounder record of the marks with the bottom scale expansion has been retained.

The last seventeen hours of the cruise were spent fishing on the better tows along the North West edge of the above area. Catch rates of 35, 20, 35 and 15 baskets for tows of $1\frac{1}{2}$ to 2 hours were recorded. However, gale force winds and a very heavy Westerly swell were experienced during this time and in fact fishing was stopped during the night. The objective of this final period of fishing was to obtain freshly caught fish of all the main species found, to be subsequently landed in ice for evaluation.

SWANELLA eventually steamed South Eastwards, before a very heavy following sea, towards Brixham and Hull, leaving the grounds on the 28th at 0.9.45 GMT. The Channel pilot was picked up at 22.00 GMT on the 29th September.

SWANELLA docked at Hull at 07.30 GMT on Monday, October 1st.

6. CATCH STATISTICS

The following tables 1 to 10 give weight of ungutted fish taken in all valid survey hauls (i.e. net not seriously damaged and gear judged to be on the bottom).

Each table refers to a particular ground, and the catch is noted for each depth fished at that ground, with the number of hours towing at each depth.

The catch is divided into categories annotated as follows:

M (Marketable). Refers to Hake, Saithe, Ling, Blue Ling, Torsk, all flatfish, Rays, Angler. These are all species commonly landed for sale in U.K.

PM (Potentially Marketable). Refers to:-

Grenadier (Coryphaenoides Cupestris)
Black Scabbard (Aphanopus Carbo)
Gephyroberyx and other redfish
Mora Moro.

Sharks Refers to all species caught and described later.

Trash Refers to:-

Smooth head (Alepocephalus Bairdii)
Rabbit Fish (Chimaera Monstrosa)
Miscellaneous small species
Juveniles of otherwise marketable species

Total Kg/hr Refers to the total catch per hour towing.

Kept Kg/hr Refers to the total catch per hour, with trash deducted. Note that not all fish in this category was in fact retained and processed; quantities of shark were from time to time rejected along with the trash, due to handling difficulties.

Tables 11, 12 and 13 gives the results of the simulated commercial fishing periods at Hatton, Tory Bland and Porcupine respectively.

The diagrams, Figure 1, summarise Tables 1 to 12 in histogram form.

TABLES OF CATCH STATISTICS

GROUND : FARM

HOURS TOWING	1·6	1·6	3·2
DEPTH FMS.	450	550	ALL DEPTHS
M. Kg.	19	29	48
P.M. "	157	41	198
SHARKS "	120	42	162
TRASH "	112	110	222
TOTAL "	408	222	630
TOTAL Kg/Hr	255	139	197
KEPT Kg/Hr	185	70	128

TABLE 1

GROUND : TORY

HOURS	2·6	1·5	1·5	1·55	7·15
DEPTH FMS.	350*	400	450	500	ALL DEPTHS
M.	120	20	53	33	226
P.M.	884	1266	2644	1920	6714
SHARKS	559	250	606	720	2135
TRASH	130	201	478	231	1040
TOTAL	1693	1737	3781	2904	10,115
TOTAL Kg/Hr.	651	1158	2521	1874	1415
KEPT Kg/Hr.	601	1024	2202	1724	1269

TABLE 2

* ST. 87 FROM PART 2

GROUND : BARRA

HOURS	1·5	1·5	3·0
DEPTH FMS.	400	550	ALL DEPTHS
M.	62	3	65
P.M.	908	131	1039
SHARKS	538	74	612
TRASH	217	50	267
TOTAL	1725	258	1983
TOTAL Kg/Hr.	1150	172	661
KEPT Kg/Hr.	1005	139	572

TABLE 3

M. = MARKETABLE
P.M. = POTENTIALLY MARKETABLE

15

TABLES OF CATCH STATISTICS

GROUND : ROCKALL

HOURS	4·5	3·0	3·0	1·5	12·0
DEPTH FMS	200	250	300	450	ALL DEPTHS
M.	199	301	87	15	602
P.M.	371	538	46	88	1043
SHARKS	3	13	26	179	221
TRASH	1030	511	450	74	2065
TOTAL	1603	1363	609	356	3931
TOTAL Kg/Hr	356	454	203	237	328
KEPT Kg/Hr	127	284	53	188	156

TABLE 4

GROUND : HATTON BANK

HOURS	2·9	1·83	3·0	3·0	1·5	13·23
DEPTH FMS	450	500	550	600	650	ALL DEPTHS
M.	31	47	35	64	23	200
P.M.	579	534	437	363	909	2822
SHARKS	287	403	177	136	95	1098
TRASH	313	1570	537	550	743	3713
TOTAL	1210	2554	1186	1113	1770	7833
TOTAL Kg/Hr	417	1396	395	371	1180	592
KEPT Kg/Hr	309	538	216	108	685	311

TABLE 5

GROUND : LOUSY BANK

HOURS	2·85	3·0	1·5	7·35
DEPTH FMS	600	650	700	ALL DEPTHS
M.	42	40	9	91
P.M.	627	288	46	961
SHARKS	822	332	77	1231
TRASH	1235	405	27	1667
TOTAL	2726	1065	159	3950
TOTAL Kg/Hr	956	355	106	537
KEPT Kg/Hr	523	220	88	311

TABLE 6

M. = MARKETABLE
P.M. = POTENTIALLY MARKETABLE

16

Tables of Catch Statistics

Ground: Flannan

Hours	1·5	2·0	1·5	1·5	6·5
Depth Fms	350	400	450	550	All Depths
M.	167	258	64	11	500
P.M.	593	566	1821	722	3702
Sharks	593	313	730	688	2324
Trash	559	842	192	759	2352
Total	1912	1979	2807	2180	8878
Total Kg/Hr	1275	990	1871	1453	1366
Kept Kg/Hr	902	568	1743	947	1004

Table 7

Ground: Bill Bailey Bank

Hours	1·5	3·0	1·45	5·95
Depth Fms	350	550	600	All Depths
M.	79	33	48	160
P. M.	183	1034	327	1544
Sharks	231	520	165	916
Trash	289	614	575	1478
Total	782	2201	1115	4098
Total Kg/Hr	521	734	769	689
Kept Kg/Hr	329	529	372	440

Table 8

Ground: Rosemary Bank

Hours	3·0	1·5		4·5
Depth Fms	350	450		All Depths
M.	130	40		170
P. M.	1364	548		1912
Sharks	254	188		442
Trash	420	154		574
Total	2168	930		3098
Total Kg/Hr	723	620		688
Kept Kg/Hr	583	517		561

Table 9

M. = Marketable
P.M. = Potentially Marketable

17

TABLE OF CATCH STATISTICS

GROUND PORCUPINE

HOURS	2.15	1.5	1.05	4.5	4.3	1.5	1.5	13.5
DEPTH FATHOMS	200	300	350	450	500	550	600	ALL DEPTHS
M	34	38	75	42	35	–	7	181
P.M.	39	91	91	58	211	320	547	1276
SHARKS	20	40	56	336	324	381	103	1260
TRASH	1	37	67	514	71	316	1631	2737
TOTAL	94	206	158	950	741	1017	2288	5464
TOTAL Kg/HR	44	137	150	211	570	678	1525	404
KEPT Kg/HR	43	113	87	97	438	467	438	201

TABLE 10

M = MARKETABLE

P.M. = POTENTIALLY MARKETABLE

COMMERCIAL FISHING

HATTAN BANK 650 FATHOMS

											TOTAL	%	Kg/HR
HOURS TOWING	2.33	2.60		2.60	2.40	2.33	1.20	2.60	2.20	1.75	19.81		
TOW Nº	75	76	77	78	79	80	81	82	83	84			
M	40	60	-	40	120	20	-	20	40	100	440	2.9	22
PM	1105	651	-	845	300	240	110	40	376	437	4104	27.3	207
SHARKS	258	107	-	200	590	92	137	50	266	609	2309	15.4	117
TRASH	655	577	-	1177	4411	296	310	187	388	250	8171	54.4	412
TOTAL	2053	1395	-	2262	5421	648	557	217	1070	1396	15024		
Kg/HR	881.11	586.5	-	870	2258.7	278.1	464.1	90.4	486	797			
KEPT Kg/HR	602.11	314.6	-	417.3	420.8	151.0	205	45.8	310	654			

TABLE 11

TORY ISLAND 300-600 FATHOMS

														TOTAL	%	Kg/HR
HOURS TOWING	2.25	2.00	2.60	0.25	1.66	1.85	2.45	-	2.0	1.90	2.5	2.0	1.33	22.29		
TOW Nº	85	86	87	88	89	90	91	92	93	94	95	96	97			
M	25	40	120	-	-	-	-	-	-	-	-	20	-	205	1.2	9
PM	1650	1671	884	-	174	1880	20	-	300	1460	577	1020	-	9636	56.6	432
SHARKS	1503	418	559	-	135	789	-	-	540	541	109	755	-	5349	31.4	240
TRASH	171	172	135	-	101	603	30	-	150	130	90	244	-	1826	10.7	82
TOTAL	3349	2301	1698	-	410	3272	50	-	990	2131	776	2039	-	17016		
Kg/HR	1488	1150	1653	-	246	768.6	20.4	-	495	1121	310.6	1019	-			
KEPT Kg/HR	1412	1064	601.6	-	186	1642	816		420	1053	343	892.5				

TABLE 12

PORCUPINE 500-600 FATHOMS

					TOTAL	%	Kg/HR
HRS TOWING	2.05	2.0	2.0	1.5	7.55		
TOW Nº	113	114	115	116			
M	10	-	-	-	10	0.2	1
PM	415	322	920	192	1849	45.6	245
SHARKS	807	52	209	315	1383	34.1	183
TRASH	141	441	204	30	816	20.1	108
TOTAL	1373	815	1333	537	4058		
Kg/HRS	669.7	477.5	666	358			
KEPT Kg/HR	600	187	564	338			

M = MARKETABLE
PM = POTENTIALLY MARKETABLE

TABLE 13

TABLES OF CATCH STATISTICS

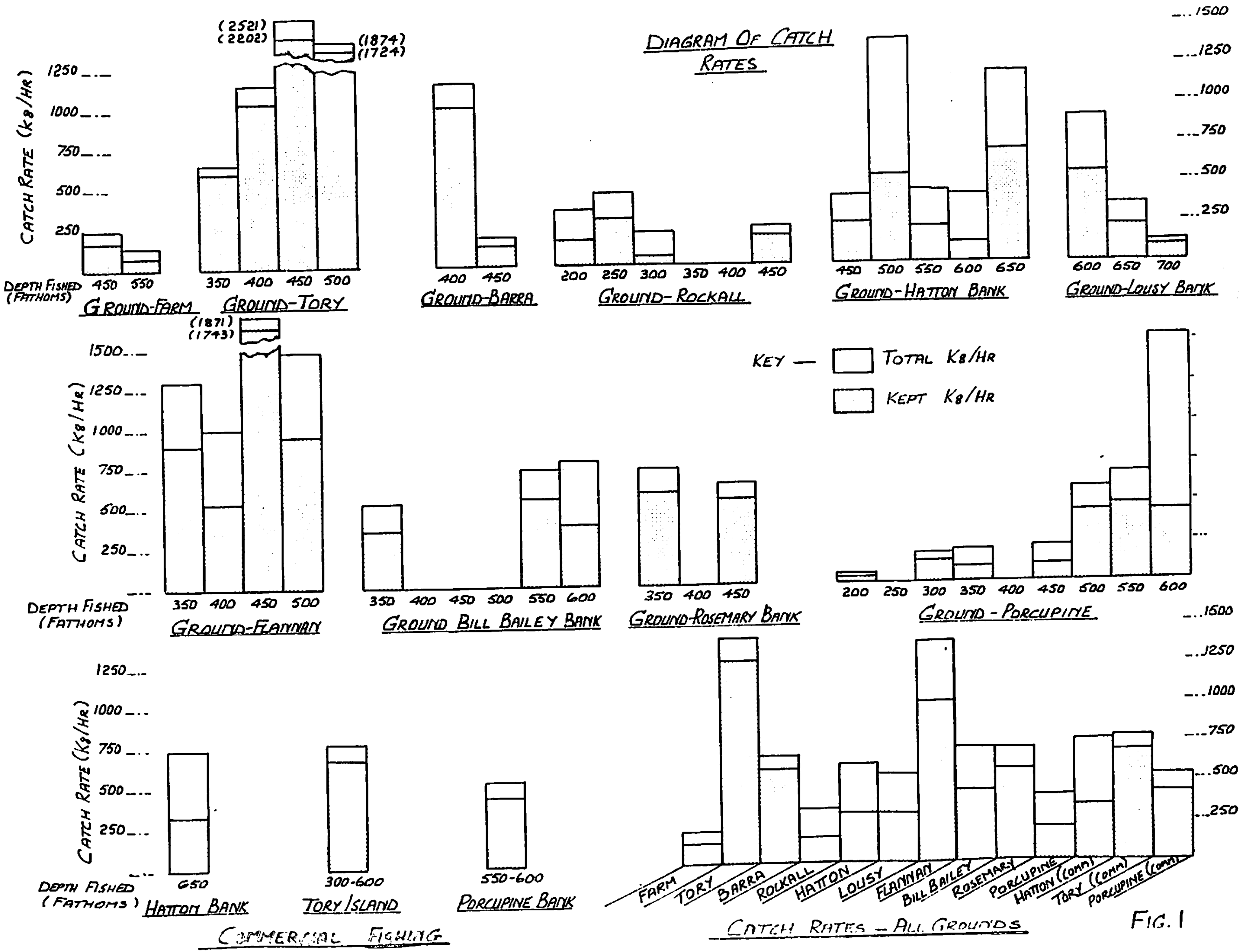
DIAGRAM OF CATCH RATES
CATCH RATE (KG/HR)
DEPTH FISHED (FATHOMS)
GROUND-FARM
GROUND-TORY
(2521)
(2202)
(1874)
(1724)
GROUND-BARRA
GROUND-ROCKALL
GROUND-HATTON BANK
GROUND-LOUSY BANK
GROUND-FLANNAN
(1871)
(1743)
GROUND BILL BAILEY BANK
GROUND-ROSEMARY BANK
GROUND-PORCUPINE
KEY — TOTAL KG/HR
KEPT KG/HR
HATTON BANK
TORY ISLAND
PORCUPINE BANK
COMMERCIAL FISHING
FARM
TORY
BARRA
ROCKALL
HATTON
LOUSY
FLANNAN
BILL BAILEY
ROSEMARY
PORCUPINE
HATTON (COMM)
TORY (COMM)
PORCUPINE (COMM)
CATCH RATES – ALL GROUNDS
FIG. 1

7. FISHING TACTICS

7.1. Shooting the Gear

Experience from previous trials had indicated the need to allow the trawl to settle adequately before commencing to tow when fishing with a 2:1 warp depth ratio. If this is not done the trawl may lift off the bottom as soon as the vessel starts to tow and of course no groundfish will be caught. The main problem is that after the trawl warps have been completely payed away it is essential that the vessel merely maintain sufficient headway to prevent the gear collapsing, but not so much as to keep the gear off the bottom. This has to be maintained for a period of up to 15 minutes. The normal ship's log is not sensitive enough to record such low speeds and only the warp load meters give some indication of the state of the gear, although even this indication is very doubtful with so much warp out and in such depths. This problem is of course only really critical in depths in excess of 500 fathoms, and would not apply if the vessel were equipped with larger winch drums and could therefore carry more warp.

The speed of the vessel must be increased only very slowly during the first fifteen minutes after "all square". It should reach about 2½ to 3 knots (normal towing speed) only twenty minutes or so after all square. Obviously submarine currents, ships drift caused by wind or surface current etc., all affect this period but as it is very difficult to know if the gear has settled properly even after the above proceedure it is obviously better to err on the safe side.

Towing loads are normally up to 2 tons per side higher fishing in these depths with up to 1200 fathoms of warp out, than in normal depths.

7.2. Fish Finding

The towed body echo sounder fitted experimentally to attempt to increase the range of detectable fish echoes did not function satisfactorily owing to electronic problems. Therefore no fish echoes were detectable in these great depths.

The Atlas sounder gave reasonable ground discrimination, but, operating in deep water, the signal return was very much delayed, and this greatly reduces the usefulness of the equipment especially when shooting the gear. This equipment was also intermittently faulty.

7.3. Duration of Tows and Effective Fishing Time

A commercial trawler will normally carry out six three-hour tows per day; the total cycle time from one haul to the next is about $3\frac{3}{4}$ hours, the extra 45 minutes being used in hauling the warps, handling the fishing gear, and shooting the trawl again. Time is also consumed in returning to a particular desired tow position, or lengthy net mending. Broadly, most vessels average 15 to 18 hours towing per day.

Compared with this, deep water fishing as evolved on SWANELLA was less efficient.

Towing time was limited to 2 hours for reasons given previously, i.e. damage to cod end probably caused by captured fish.

Shooting 1250 fm of warp in 650 fm depth requires care, and time has to be allowed for the gear to settle; total shooting time is therefore about 45 minutes.

Hauling and handling the trawl takes a further 45 minutes.

Thus the total cycle time is $3\frac{1}{2}$ hours, allowing time for other activities 6 hauls a day are still possible. However, it was found in practice that changing between different tow positions limited the number to 5 per day.

On present evidence therefore the average fishing rate on the deep water grounds is likely to be 10 to 12 hours tow time per day. This is of course a distinct disadvantage and can only be improved by further developments in fishing gear and ship's machinery.

7.4. Navigation (Refer to Figure 1)

A considerable part of the area fished was outwith the present Decca navigator system coverage. However the recent introduction of automatic receivers for the Loran C system was taken advantage of. Two such receivers manufactured by American manufacturers, Teledyne and Epsco were used. These proved invaluable and during daylight hours gave precise position fixes. "Night effect" did sometimes leave only one reliable line of position useful. However, this was used adequately in conjunction with depth contours. In the absence of a much more frequently updated satellite fixing system than is presently available the use of Loran C with automatic receivers is essential in the Rockall, Hatton, Bill Bailey and Lousy Bank areas.

8. HANDLING AND PRESERVATION

Details of the observations made and operations carried out on board SWANELLA are to be found in References 7 and 8. Some of the more prominent difficulties experienced are discussed below.

8.1. On the Ramp

A number of problems arose during the handling on board of many of the species caught. As a consequence of their rough skins and the almost complete absence of slime the fish, with few exceptions, would not flow down the ramp when the cod end was emptied. This happened despite the continual spraying of water onto the ramp and an alternative to manual transportation of the fish from the top of the ramp to the gutting pounds would need to be devised in a commercial fishery.

8.2. Gutting

Difficulties in gutting the fish were encountered due to the variety of shapes, and because, due to the depths from which the fish were hauled, their guts often everted through their mouths. Nearly all the fish have sharp spines, fins or teeth and very careful handling is required in order to avoid cuts and scratches during gutting and other handling operations. These factors reduced the speed of gutting and also its efficiency.

8.3. Conveying the Fish

Again because of their roughness the fish piled up inside the washers and did not flow through in a regular manner. Since many are slender in shape and/or have long thin tails the rubber belt conveyors continually jammed at junctions and at directioning gates. It is possible that conveyor belts of another type would not suffer this disadvantage but this has not been tested. The rough-skinned fish, when discharged from the conveyors, piled up in the freezer bins with no sideways flow or settling and this led to an overflow of the fish onto the staging between the bins and the freezers.

8.4. Freezing Problems

Good, compact frozen blocks could not be produced because of the shape and roughness of most species. This resulted in poor contact as well as small contact areas with the freezer plates and the necessity for longer freezing times. The blocks produced from these fish were easily broken during discharging from both freezer and cold store.

8.5. Handling of Sharks

Most of the difficulties described above were also experienced with sharks and in many instances (such as jamming on the ramp) they caused the main problems. A fifty percent increase in freezing times was found to be necessary with those sharks which could physically be placed in the plate freezers. Larger sharks had to be frozen individually in the cold store. Attempts to improve the freezing of sharks (and other awkward species) by incorporating water in the blocks were unsuccessful. (Reference 8).

8.6. Chill Storage in Ice

There is some indication that the deep water species, as a group, spoil somewhat slower than do cod and related species during the period up to 10 days in ice. Cod reach a similar stage of deterioration in 7 days on average. Beyond this stage the two groups are somewhat similar but the deep water fish do not become so offensive as the usual commercial species when storage is even further prolonged. The deep water fish usually tasted better than appearance and gill odours would indicate.

8.7. Filleting

It proved possible to fillet by hand fish of each species by adopting or adapting one or other of the normal techniques. Fillet yields varied according to species, ease of trimming, deboning and skinning but were on the whole within the range achieved with the familiar commercial ones. Among the particular problems which were encountered are the impossibility of deboning smooth-heads economically and the difficulty of removing the skin from grenadiers (because of its toughness) and from scabbards (because of its fragility). The grenadier's scales are troublesome and they must be removed efficiently before processing as must all pieces of cartilage from the *Deania*.

9. ACCEPTABILITY

This has been determined for each of the major species in a variety of forms and from a number of viewpoints. Much of this work is still in hand and finished reports are not yet available for inclusion in this report but certain preliminary accounts of some aspects of this phase of the work have been prepared and these are summarised below (see also References 3,4, 7 and 8).

However, it has not yet proved possible to assess trade reactions to these species and to products derived from them. This is to be done shortly and the results will be reported as soon as possible. Consumer reaction is a further unknown, particularly in view of the unusual shapes of most of these species, and it is possible that many, no matter how palatable, could only be marketed in some "disguised" form.

9.1. Acceptability by Species

The properties of nine major species (grenadier, black scabbard, rabbit-fish, smooth-head, *Deania calcea*, *Trachyscorpis cristulata*, *Trachyrhynchus* sp., *Gephyroberyx darwinii* and *Mora moro*) will be treated individually in this section. Most of the other species of fish will not be considered here because:-

a) they are already known to be marketable

b) they are too small in size or were caught in too small quantities to merit attention at this stage

c) work has still to be done on them

One major group, the sharks, have been looked at only superficially and these results are grouped together at the end of this section.

9.1.1. Grenadier (*Coryphaenoides rupestris*)

This would probably be acceptable to a large proportion of consumers resembling, as it does, cod in flavour and texture. Its keeping quality is much better than that of cod since spoilage flavours appeared only after 17 days in ice. Because of its appearance it is unlikely to be marketable in the round. It would need to be filleted or processed further.

Good quality cold smoked fillets and laminated blocks can be produced and highly acceptable fish fingers and fish cakes prepared.

Yields of flesh are reasonable although scales can be troublesome and care has to be taken at the filleting and skinning stages. The skin is tough and moderately difficult to remove manually. However, limited trials have shown that at least one commercially available skinning machine can deal with it effectively.

All sea frozen samples, including fillets, had a good colour but the advantages of bleeding before freezing were apparent. Gaping does not appear to be the problem it is with cod.

This species should prove a good commercial proposition, particularly if processed, although its somewhat small average size might mitigate against whole-hearted acceptance by industry.

9.1.2. Black scabbard (*Aphanopus carbo*)

The eating quality of this fish is rather like that of plaice or, though not quite so strongly flavoured, of herring. Again keeping quality is excellent with rancid flavours, which are typical of those of herring, appearing only after 12 days and spoilage flavours appearing at 20 days in ice.

Commercially acceptable cold smoked fillets and good quality laminated blocks can be produced. Fingers cut from such blocks could be commercially acceptable and canned-smoked products of likely commercial value can be produced. The shape of the fish (long and thin) and of the fillets (ribbon-like) are rather against their use other than in a product.

Excellent yields can be obtained but the fillets are difficult to skin manually.

Sea frozen fillets had a slightly worse colour than fillets cut from thawed fish (which were very good) but again bleeding produced significant improvements.

Thawed sea frozen scabbard can give a good smoked product. This fish is commercially exploited and highly prized in other countries such as Portugal and Madeira. It is possible that it could be introduced into the U.K. markets in a number of forms but, in any event, reasonable prospects for export exist.

9.1.3. Rabbit-fish (Chimaera monstrosa)

Strong bitter flavours render this fish unpalatable. It is more bitter than dogfish but some method of treatment might be devised to make it less unacceptable. Off flavours appear after 13 to 15 days in ice.

The bitter flavours are still pronounced in cold smoked fillets although these have a very attractive appearance. Good quality laminated blocks can be prepared but the exercise is probably academic since the fingers cut from them would still be unacceptable in flavour.

Fillet yields are rather low.

On balance this is of very doubtful acceptability.

9.1.4. Smooth-head (Alepocephalus bairdi)

The junket-like texture makes this unacceptable to most consumers but keeping quality is good: spoilage flavours did not appear till after 17 to 21 days in ice had passed.

The flesh of this fish has a very high ($>$ 92%) water content which explains its textural properties. It is possible that dehydration (e.g. by salt drying) of smooth-head fillets would produce a better texture but the low level of protein ($\frac{1}{4}$ to $\frac{1}{2}$ normal fish levels) in the flesh and the large number of bones would render this of doubtful value. Furthermore the peculiar arrangement of the bones render their removal uneconomic despite very high fillet yields.

Smoked fillets would not be acceptable because of a continuing exudation of fluid.

Excellent laminated blocks can be produced, albeit uneconomically, and the fried fingers were marginally acceptable. Canned smooth-head is obnoxious. Sea frozen smooth-heads lost tremendous amounts of water on thawing without any apparent improvement in texture.

Unfortunately, this fish will probably be unacceptable in any form.

9.1.5. Deania calcea

This small shark has a typical dogfish flavour with some bitterness. Off flavours appear after 12 to 14 days in ice.

Good quality laminated blocks can be prepared but care has to be taken in removing every piece of cartilage. Skinning has to be done after filleting: the skin is too fragile to be removed by the technique normally used for dogfish. Because of these two factors fillet yields are poor.

This fish should be marketable as dogfish.

9.1.6. Trachyscorpia cristulata

This redfish has a pleasant flavour resembling cod with added margarine. Off flavours were detected, but only at a low level, after 14 and even 19 days in ice. Texture is very good. Fillet yields are low.

The prospects are good for commercial exploitation of this fish provided stocks are adequate and its size is in its favour.

9.1.7. Trachyrhynchus sp.

Even when fresh this has a rather unpleasant woody, slightly bitter flavour and a soft mealy texture: it is therefore not very palatable.

These fish are rather small and little work has been done on them.

This is unlikely to be commercially acceptable.

9.1.8. Gephyroberyx darwinii

This is very palatable with pleasant sweet, creamy, coconut flavours and a firm lobster-like texture. Off flavours were not detected even after 21 days in ice and at 30 days this fish would still be reckoned to be acceptable. The fish are large and the fillets thick and meaty.

Cold smoked fillets are very attractive and would be a commercial proposition while smoked steaks canned in oil emerged as quite a good product. The firm texture and pleasant flavour were also noticeable in a hot smoked product and it is concluded that if plenty of this fish was available it could be used by the industry.

9.1.9. Mora moro

This is very similar to cod in flavour and texture but keeps somewhat better since off flavours appeared only after 14 to 17 days in ice.

Yields of fillets are good and this fish should be a reasonable proposition for laminated block production should sizable catches be made.

9.1.10. Sharks

Six species, in addition to the Deania already dealt with, were tested. In each case specimens had been frozen at sea and thawing was carried out just prior to the tasting. The species concerned are: Centroscyllium fabricii, Apristurus sp., Galeus melastomus, Centrophorus sp., Centroscymnus sp. and a small unidentified black shark.

In general all the samples tasted are edible but did not rate a high level of acceptability. They were generally sweet and meaty but some had bitter tones which although noticeable were nowhere nearly as strong as those found in the rabbit-fish.

9.2. Acceptability by processes

Not every fish had been examined from the point of view of every process; obviously several would be non-starters. Most of the information given below can also be found in 9.1.1. to 9.1.9. and again it must be stressed that work is continuing on many aspects and detailed reports will not be available for some time yet.

9.2.1. Freezing at sea

Apart from the problems mentioned in 7.2, 7.3. and 7.4. freezing deep water fish whole or as fillets produced no new particular difficulties. *Rigor mortis* seldom seemed to introduce problems nor did bleeding. Many of the fish have low blood levels in the muscle and white fleshed products are comparatively easily obtained. Good quality smoke cures can be obtained using sea frozen grenadier and scabbard.

9.2.2. Smoking

Several of these fish can be processed to give what should be commercially acceptable smoked products: grenadier (cold smoked), scabbard (cold smoked), *Gephyroberyx* (hot or cold smoked) and, despite its bitter flavour, possibly rabbit-fish (cold smoked). The hot smoked products from grenadier and scabbard were not satisfactory on the grounds of appearance. Either type of smoking process applied to the smooth-head would not yield an acceptable product because of continuing exudation of fluid.

9.2.3. Laminated Block Production

None of the fillets from the five species (smooth-head, grenadier, rabbit-fish, scabbard and *Deania*) presented any special problems in packing into 483 mm x 252 mm x 58 mm waxed cartons in aluminium frames but those treated with polyphosphate were apparently easier to pack. The contact areas, homogeneity and regularity of shape of the frozen product were good and compared well with industrial products prepared from cod.

9.2.4. Fish Fingers

These were cut with a band-saw from laminated blocks and without any particular difficulty. The grenadier and scabbard yielded acceptable products of probable commercial value. Fingers cut from blocks made from polyphosphate treated fillets had less acceptable textures than those cut from blocks of untreated fillets but fingers of the two types were similarly acceptable in terms of flavour and appearance.

9.2.5. Fish Cakes

The fish flesh for these was prepared with a Baader 694 meat-bone separator and, once again, the grenadier and the scabbard appear to yield the better products.

9.2.6. Canned/Smoked Products

Lightly smoked fillets of grenadier, scabbard and rabbit-fish, and steaks of *Gephyroberyx* canned in oil yield products of good appearance. The bitter flavour of rabbit fish was still prominent while the eating quality of the scabbard and grenadier products was like that of haddock similarly treated. However the *Gephyroberyx* steaks canned in oil are the best prospect for this type of process and this product may merit further investigation.

9.2.7. Fish Burgers and other products from Minced Flesh

Some quite interesting natural and beef flavoured fish burgers have been made from stripped flesh but further work needs to be done to get the texture right. The interest in these types of product goes beyond the deep water species and further work will have to await the results of research of a longer term basis on currently exploited species.

It is concluded that grenadier, scabbard, *Deania calcea*, *Trachyscorpia cristulata*, *Gephyroberyx darwinii*, *Mora moro*, *Centroscyllium fabricii*, *Apristurus* sp., *Galeus melastomus*, *Centrophorus* sp., *Centroscymnus* sp. and the small unidentified black shark should be marketable in some form or other. Rabbit-fish is of doubtful commercial value while smooth-heads and *Trachyrhynchus* sp. are most unlikely to be accepted by the trade or the consumer.

APPENDIX I

DET SWANELLA:- Main Particulars

LOA	245.0 ft.
Breadth	40.5 ft.
Depth	26.5 ft.
Main Engine	Diesel Electric.
Type	Twin English Electric 12 CVSM
H.P.	1800 at 750 r.p.m.
Propeller	Stones "Scimitar" 4 Blades.
Aux.	2 x 300 KW from M.E.
Winch	Robertson 4 Barrel 350 hp 1300 x 3¼ in. circ warp per side.

Fish Detection Equipment:-

Kelvin Hughes Humber Gear

Atlas type 860

Accommodation:- 26 Officers and crew

9 Spare Berths

Halibut Room:-

Blast Freezer at $-20^{\circ}F$

REFERENCES

1) White Fish Authority Field Report No 057. "Deep Water Fishing on F.R.V. Cirolana."

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3) Torry Research Station - Report No. T.D.168

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5) M.A.F.F. Report. D. W. Fishing. Cirolana, April/May 1973

6) M.A.F.F. Report. D. W. Fishing. Cirolana, July 1973.

7) Torry Research Station - Report No. 265

8) Torry Research Station - Report No.278

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