INTERNATIONAL COMMISSION

FOR THE

NORTHWEST ATLANTIC FISHERIES

REDBOOK 1965

PART II RESEARCH REPORT BY MEMBER COUNTRIES

PART III SELECTED PAPERS FROM THE 1965 ANNUAL MEETING

Issued from the Headquarters of the Commission
Dartmouth, N. S., Canada

1965

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

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PARTS II AND III

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II. Biological Studies

1. Cod. On the same line of stations occupied in April and early May 1963 southeast of Hamilton Inlet Bank (Redbook 1964, Part II) half-hour otter trawl tows (No. 41 net at 3 1/2 knots) were made by the A. T. Cameron between 31 March and 4 April at depths from 238 to 732 m. The large quantities of spawning and post-spawning cod found in this area in April and early May 1963 were not found in 1964 nor were any trawlers seen fishing at cod depths in this area. Bottom temperatures at cod depths were higher and presumably the spawning schools were further northward than in 1963. The best catch was 960 kg of small cod (mainly immature, average weight 0.5 kg) in 238 m at 3.4°C, where temperatures were almost a degree higher than in 1963. Below this depth cod were larger but scarcer with catches of 290 kg (average weight 1.0 kg) in 278 m at 3.1°C and 165 kg (average weight 1.0 kg) in 319 m at 3.3°C. The catch was 120 kg of smaller cod (average weight 0.6 kg) in 362 m at 3.5°C, 7 kg (average weight 2.6 kg) in 459 m at 3.4°C and no cod in 551, 638 and 737 m at 3.4 to 3.5°C.

Strong westerly winds prevailed during this cruise and the area east of Hamilton Inlet Bank gradually became covered with ice. On attempting to reach cod grounds further northward on 1 April, about 30 European trawlers were encountered east of Hamilton Inlet Bank retreating southward before the advancing ice.

By 2-4 April, 62% of the 78 mature female cod examined were spent, 8% had some clear eggs and 31% opaque eggs. By 11-16 May in this same area at 200-220 m, of 137 mature females 135 were spent and the 2 remaining were close to spawning, one possessing some clear eggs and the other with more than 50% of the bulk of the eggs clear.

An attempt was made to tag cod southeast of Hamilton Inlet Bank on 2 April. From a 10-min otter-trawl set at 278 m 12 lively cod were placed in the tagging tank. These cod were taken where the bottom temperature was 3.1°C while the surface water temperature was about -1.5°C. Water temperature in the tagging tank was -1.2°C or slightly lower. Some of the cod swam immediately to the bottom of the tank in a normal fashion but within a minute all were floating belly up and lifeless in the tank.

In May 1,152 cod were tagged in Div. 2J, southeast of Hamilton Inlet Bank and north of Hawke Channel, at a depth of 194-220 m and 768 were tagged in Div. 2J, south of Hawke Channel, at a depth of 183-241 m.

From the tagging southeast of Hamilton Inlet Bank about half the recaptures were from the inshore fishery, about 75% in Labrador and 25% in Newfoundland. From the tagging in Div. 2J south of Hawke Channel over half the recaptures were from the inshore fishery, about 50% in Labrador and 50%

in the Newfoundland northeast coast inshore fishery.

Near Smokey in southern Labrador (54°15'N), 1,152 cod were tagged in July in 18-37 m and 1,152 cod were tagged at Saglek Bay in northern Labrador (58°20'N) in 6-18 m in August. Many cod tagged in previous years in the inshore shallow water of Labrador and Northeast Newfoundland have been taken in the offshore deep-water trawler fishery in winter and spring on the continental slope east and southeast of Hamilton Inlet Bank (Div. 2J).

2. Redfish, Sebastes mentella Travin and Sebastes marinus (L.). The same line of stations, southeast of Hamilton Inlet Bank and just north of the seaward entrance to Hawke Channel, fished by the A. T. Cameron in early April 1963, was again fished by this vessel, 2-4 April, 1964, at depths from 238 to 737 m. Mentella redfish were more than 140 m deeper and marinus redfish more than 180 m deeper than the summer-autumn levels. Catches per half-hour tow were less than 3 kg per tow in depths from 238 to 362 m at bottom temperatures of 3.1 to 3.5°C. Beyond these depths, at 459, 551, 638 and 737 m, catches were 3,970, 930, 1,050 and 70 kg of mentella and 140, 9, 0 and 0 kg for marinus redfish at bottom temperatures of 3.4 to 3.5°C.

Of 101 mature mentella females from this area, 2-4 April, 6% were spent and 6% possessed unfertilized eggs. The remaining percentages were 1-4% hatched (1), 5-20% hatched (56), 30-60% hatched (22), 70-90% hatched (1) and partly spent (1). Of 58 mature marinus females only one was as far advanced as 30-60% hatched and three possessed unfertilized eggs.

3. American plaice Hippoglossoides platessoides (Fabricius). In the A. T. Cameron sets southeast of Hamilton Inlet Bank, 2-4 April, as described for redfish, the largest catch of American plaice per half-hour tow was 1,670 kg (average weight 1.1 kg) at 278 m. The only other significant catch was 205 kg (average weight 1.0 kg) at 551 m. At other depths from 238 to 459 m catches ranged from 5 to 40 kg and average weights from 0.3 to 0.4 kg. Only one plaice was caught at 638 m and none at 737 m. These American plaice had opaque eggs and were at least a month and possibly 1 1/2 months or more from the beginning of spawning.

4. Witch flounder, Glyptocephalus cynoglossus (L.). In the same A. T. Cameron half-hour tows described above, a large catch of 3,320 kg of witch flounder (1.4 kg average weight) was taken at 551 m. In April 1963 witch catches of 1,180 and 670 kg were obtained at 549 and 640 m, but in 1964 the witch were much more concentrated, and only 11 and 3 kg were obtained in the sets immediately shallower and deeper than 551 m (at 459 and 638 m). As in 1963 female witch possessed small opaque eggs, usually less than 0.5 mm diameter, and were at least 1-1 1/2 months from the beginning of spawning.

Subarea 3

A. Status of the Fisheries

I. Cod

Canadian landings in 1964 were 166,000 metric tons (97% of which was landed in Newfoundland), 2% below those of 1963.

The bulk (90%) of the Newfoundland cod landings was from the inshore small boat fishery, which was 14% below the 1963 level. Catch per man in the inshore fishery has generally declined since 1956 on the northeast Newfoundland coast, coincident with the increasing offshore cod fisheries by European trawlers.

In the inshore sampling areas which have been examined most closely the trap fishery was poor on the east coast at Bonavista and only fair at St John's. In the Trepassey area the trap fishery was fairly good whereas at Burin it was poor The handline fishery at Bonavista was below the level of the 1963 fishery and can only be classed as fair. The longline and linetrawl fisheries at Bonavista, Trepassey and Burin were at about the same low level as in the 1963 season. The gillnet fishery at Trepassey and Burin was below the 1963 level.

II. Haddock, Melanogrammus aeglefinus (L.)

During the course of its short history, landings from the commercial haddock fishery on the Newfoundland banks, which began in 1945, fluctuated widely, with peak landings of 78,000 tons in 1949, 104,000 tons in 1955 and 80,000 tons in 1961. In the intervening years yields declined to lows of 43,000 tons in 1953 and 35,000 tons in 1959. Since 1961 the annual yield has declined rapidly from 80,000 tons to 35,000 tons in 1962, 15,000 tons in 1963 and 12,000 tons in 1964, of which Canadian trawlers landed about 7,000 tons, 23% lower than in 1963.

Although heavy exploitation has played its part in the present scarcity of haddock, the basic cause is the lack of successful survival of young. The last very successful year-class was that of 1955, which dominated in the catches during 1960-62. Since 1955, survival has been relatively poor and consequently the haddock fishery must inevitably continue to be at a low level until a good brood occurs and is recruited to the stock.

III. Redfish

Canadian landings in 1964 were 15,700 tons (15,000 by Newfoundland), which were 18% lower than in 1963, apparently due more to a reduction in

market demand than to scarcity of fish.

IV. American plaice and Witch flounder

Newfoundland landings of 29,000 tons of plaice and other flounders were 30% higher than in 1963, reflecting the increasing effort for plaice because of the scarcity of haddock and of some diversion of effort from redfish. Total Canadian landings were 39,500 tons, up 12% from 1963.

In 1963 the catch of American plaice per hour's fishing by Newfoundland trawlers fishing the Grand Bank was 760 kg for a total effort of 22,000 hours. Corresponding statistics for 1964 were 870 kg for a total effort of about 19,000 hours fished. In 1962 the average catch with a total effort of about 18,000 hours fishing was 620 kg per hour's fishing. Thus, although the present catch per hour's fishing is not as great as it was in the middle 1950's, it is encouraging that the downward trend in catch per unit effort, noted in the past few years, was reversed in 1963 and 1964 in spite of a general increase in effort.

V. Sea scallop, Placopecten magellanicus Gmelin

Canadian sea scallop landings from St. Pierre Bank (3P) amounted to 327 tons of shucked meats (2,710 tons, whole weight) in 1964. Except for small landings in 1963, virtually no Canadian scallop dragging effort had been expended here since 1958. The 1964 catch was divided fairly evenly between the beds on the northern and southern parts of this Bank.

VI. Harp seal, Phoca groenlandica Erxleben, and Hood seal, Cystophora cristata Erxleben

The Canadian fishery for harp seals in the spring of 1964 centred in Div. 3K. Ships, landsmen, and a few aircraft together took 71,000 seals on the ice as compared with 55,000 in 1963. Seventy-six percent were young animals. Seven hundred hood seals were taken, about the same number as in 1963.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. The 5 monitoring sections across the Labrador Current and continental shelf from Bonavista to the southern Grand Bank were occupied by the Investigator II between 23 July and 23 August.

In the triangular section extending eastwardly from Cape Bonavista, thence southwardly to the northern Grand Bank (Fig. 2) the volume of cold water below -1 and 0°C, both in the coastal and Grand Bank sections, was

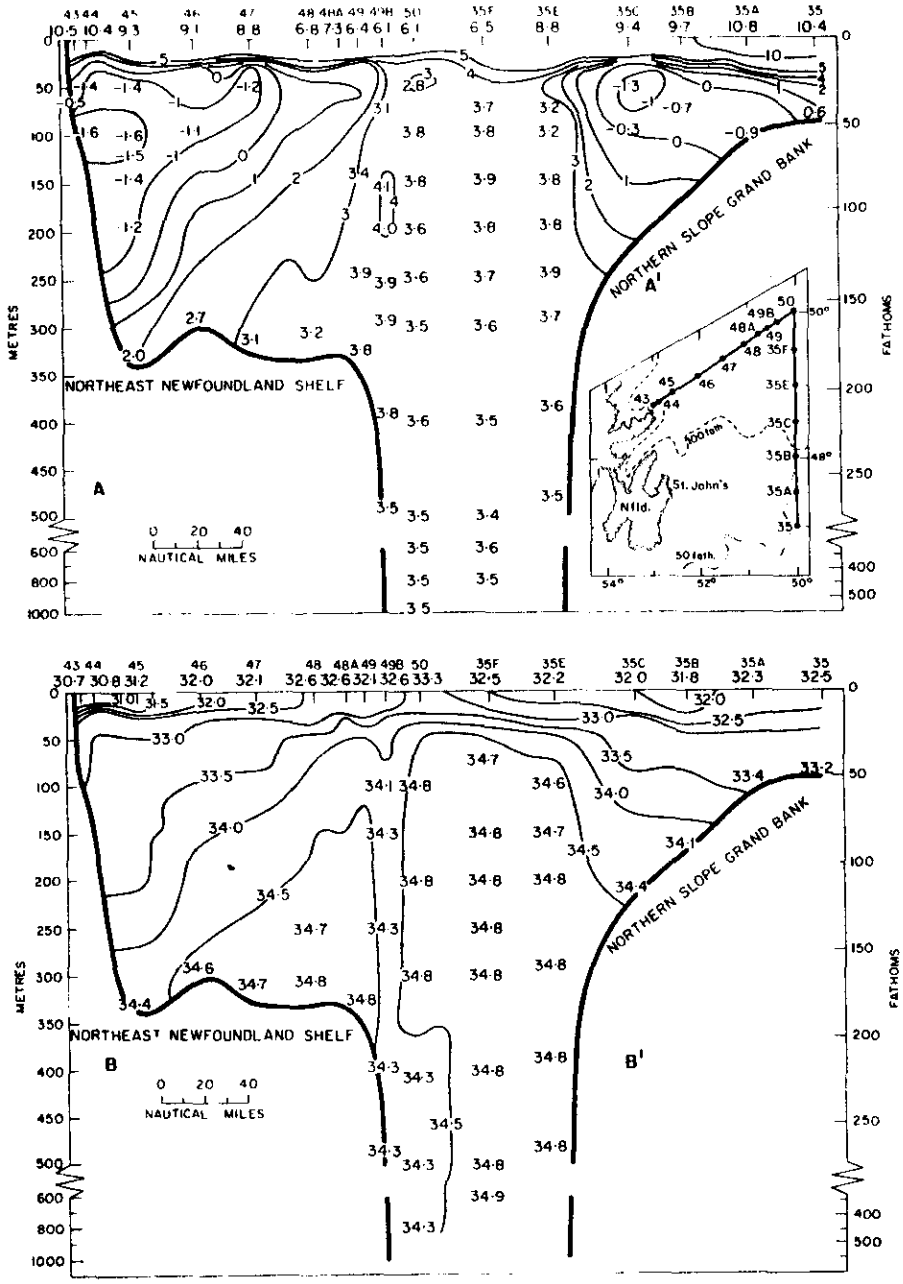


Fig. 2. A, A^1, temperature (°C) and B, B^1, salinity (°/oo) sections, over the Northeast Newfoundland Shelf off Cape Bonavista and southward to northern Grand Bank, A, B, 28-29 July 1964 and A^1, B^1, 24-28 July 1964.

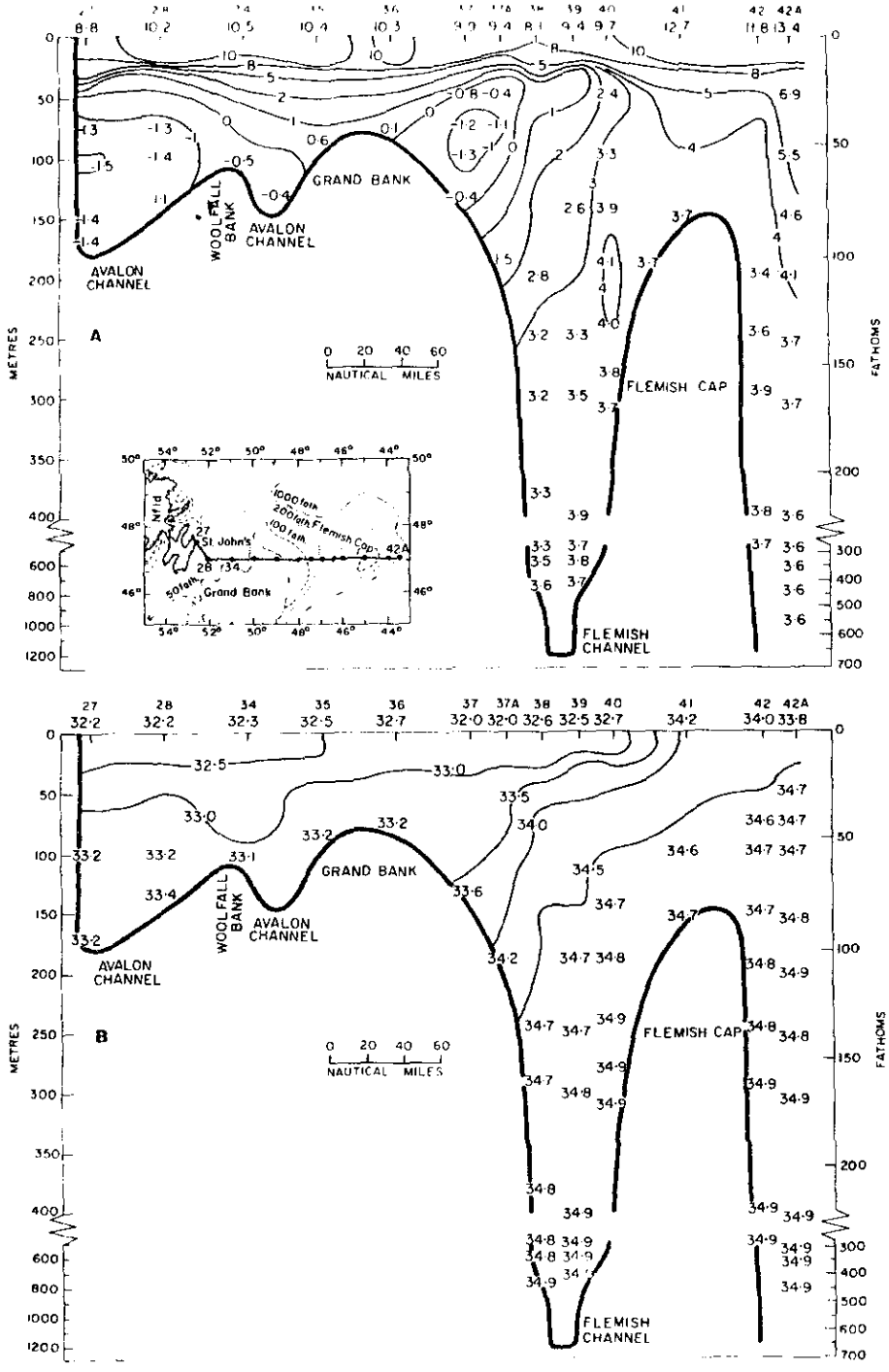


Fig. 3. A, temperature (°C) and B, salinity (°/oo) sections, St. John's-Grand Bank-Flemish Cap, 23-26 July 1964.

approximately similar to that in 1963, but the lowest temperatures were -1.6°C compared with -1.4°C in 1963. Bottom temperatures on the offshore part of the continental shelf off Bonavista were a little lower but temperatures of the water above 300 m beyond the continental shelf were a little higher than in 1963. The salinity pattern showed an unusual column of lower salinity water at the edge of the continental shelf off Bonavista, extending very deeply between two masses of higher salinity water.

In the section from St. John's across the northern part of the Grand Bank and Flemish Cap (Fig. 3) there was considerably more water in the Avalon Channel below -1°C than in 1963 with the lowest temperatures -1.5°C, and cold water of -1.4°C extended to the bottom at the deepest part of the Channel compared with a lowest temperature of -1.3°C and a deepest bottom temperature in the Avalon Channel of -0.7°C in 1963. On the other hand the volume of water below 0°C was less than in 1963 and temperatures over the surface of the Grand Bank along this line were greater, 0.1 to 0.6°C, compared with -0.2 to -0.4°C in 1963. On the eastern slope of the Grand Bank (the western side of Flemish Channel) the volumes and temperatures of water below -1 and 0°C were approximately similar to those of 1963. On the deeper part of the slope, however, there was colder water, 3.3 to 3.6°C, in 1964 compared with 3.6 to 3.8°C in 1963. Temperatures on the western side and top of Flemish Cap were very similar to those of 1963 but the eastern slope of the upper part of the Cap showed the results of lower water temperatures, 3.4 to 3.6°C, in 1964 compared with 3.8 to 3.9°C in 1963. In general the salinity picture in this section from the upper eastern slope of the Grand Bank to the coast was similar to that of 1963 and did not reflect the differences in temperature, showing that the same type of water was present in both years although colder in some places and warmer in others than in 1963. From the western side of Flemish Cap to the surface, along the western slope of the Cap and in the deeper parts of Flemish Channel salinities were slightly higher than in 1963 although temperatures were very similar in both years.

In the section from St. John's to the southeastern slope of the Grand Bank (Fig. 4), the volumes of water below -1°C and below 0°C were not greatly different from those of 1963 but the lowest temperatures were -1.5°C compared with -1.3°C in 1963. The cold branch of the Labrador Current on the eastern slope of the Grand Bank was colder and in greater volume than in 1963. Lowest temperatures in this branch were -1.4°C compared with -1.0°C in 1963. Temperatures over the surface of the Grand Bank showed little difference from those of 1963. Salinities over most of the Grand Bank and in the deeper water of the Avalon Channel were generally slightly higher than in 1963. In the deeper parts of the eastern slope of the Grand Bank below 270 m salinities were lower, 34.3-34.7 °/oo, than in 1963, 34.5-34.9 °/oo.

In the section at about 75 m extending along the southwestern slope of the Grand Bank (Fig. 5) the volume of water below 0°C in and near the Haddock

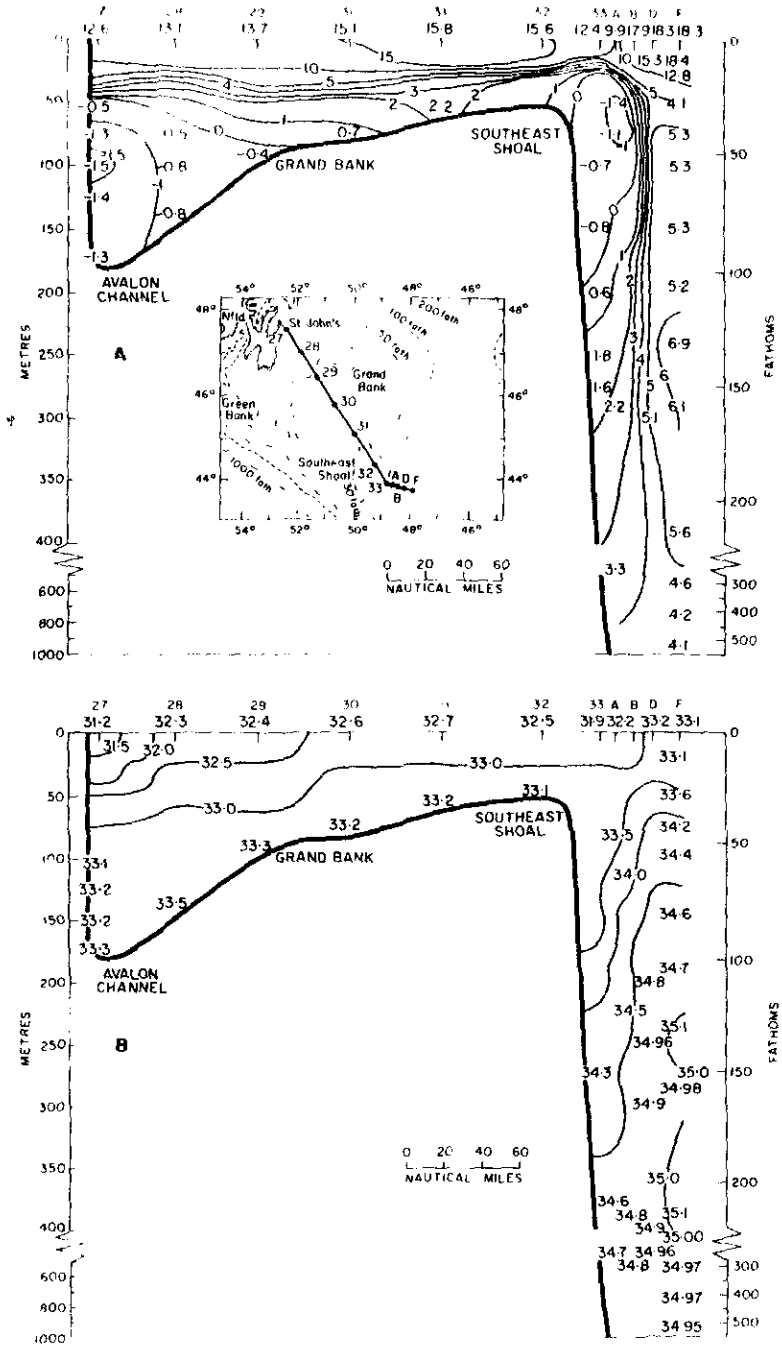


Fig. 4. A, temperature (°C) and B, salinity (°/oo) sections, St. John's-SE slope Grand Bank, 17-19 August 1964.

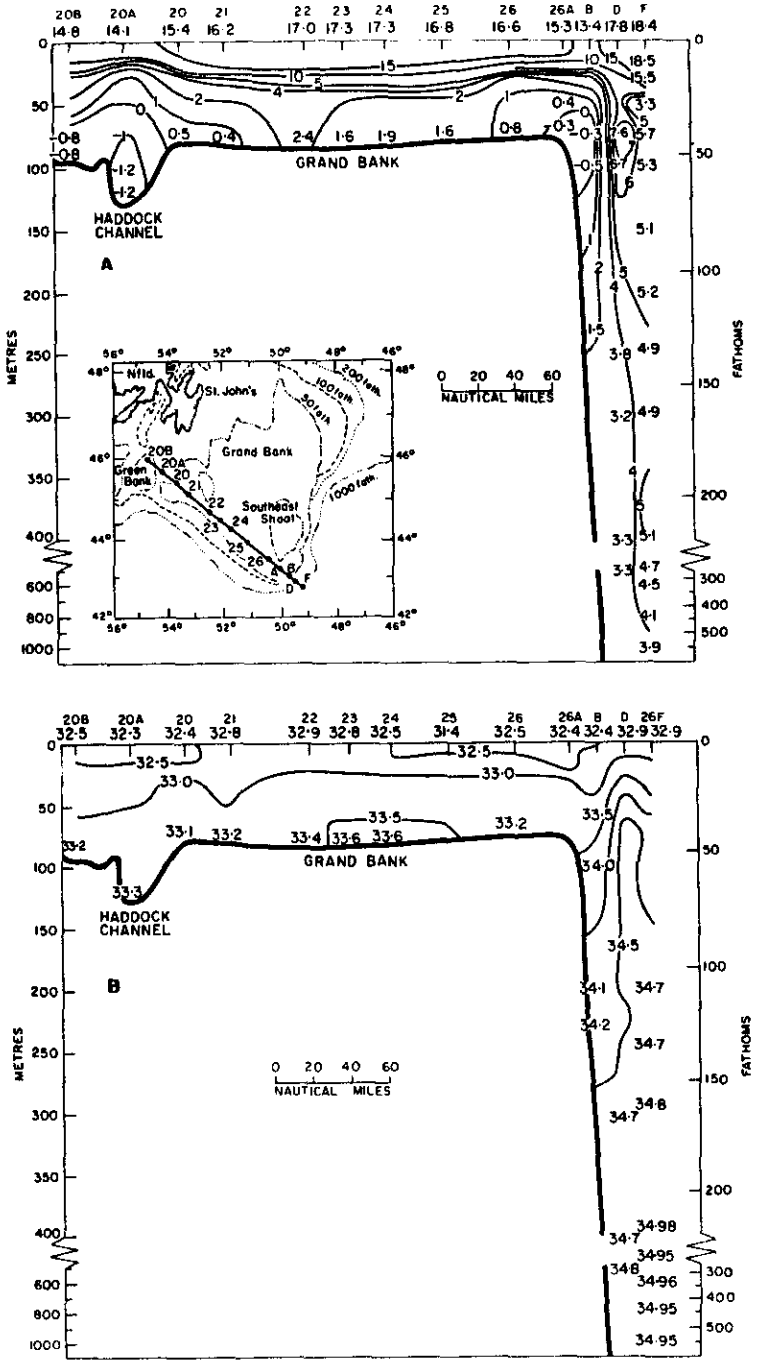


Fig. 5. A, temperature (°C) and B, salinity (°/oo) sections, Green Bank-SE Grand Bank, 20-23 August 1964.

Channel was approximately the same as in 1963 but the lowest temperatures were -1.2°C compared with -0.9°C in 1963. At the eastern edge of the Grand Bank the volume of water below 0°C was less and its lowest temperatures were higher than in 1963, -0.5°C compared with -1.1°C. Water temperatures over the surface of the Grand Bank were variable, slightly higher in some parts of the section and slightly lower in others than in 1963. Although as usual the upper water salinities were low in this section, salinities over the top of the Grand Bank and its western approaches were usually 0.1-0.5 °/oo higher from bottom to surface than in 1963.

In the section at 275 m along the southwestern edge of the Grand Bank (Fig. 6) temperature conditions in the eastern half of the section were generally similar to those of 1963 although the lowest temperatures were slightly higher, -0.9°C, compared with -1.2°C in 1963. In the western half temperatures were generally lower than in 1963, with a lowest temperature of -1.2°C, compared with 2.3°C in 1963, and a highest temperature in water deeper than 125 m of 6.3°C, compared with 7.6°C in 1963. There appears to be an upwelling or residue of cold water at Station 17 to the west of the Southeast Shoal producing considerably lower temperatures than at neighbouring stations from 50 m to the surface. In 1963 a similar upwelling or occurrence of cold water occurred at Station 19, which is in line with the western edge of the Shoal. Salinities in this section were generally similar to those of 1963 and in both years at Station 15 water with higher salinities and temperatures than at neighbouring stations extended from the 150 m level to the surface.

Station 27, at 176 m, 2 nautical miles off Cape Spear near St. John's, has been maintained since 1950 and to a lesser degree since 1947 as a year-round hydrographic station and is occupied once to several times monthly throughout the year. Water temperatures from top to bottom at this station (Fig. 7) are usually lowest in March to early April. Bottom temperatures are lowest from March or April to October or November. Surface temperatures, highest between late July and early September, are above 12°C for only a brief period. The effect of surface warming during the warmer part of the year begins to affect the bottom waters by late November, and, with surface cooling in autumn and winter, water temperatures are approximately the same from top to bottom by January-February. The deeper water was colder in 1964 than in 1963 and the period with upper-layer temperatures above 10°C shorter.

II. Biological Studies

1. Cod. In the inshore Newfoundland area, routine sampling of the inshore cod fishery by various gears was carried out in the spring, summer and fall in regular sampling centers at St. Anthony, Twillingate, Bonavista, St. John's, Trepassey and Burin. At St. Anthony the trap fishery was supplied by fish of ages 5-8. Fish taken by handline were largely 7-year-olds. Nine- and 10-year-old fish were well represented in the gillnet catches. Trap fish

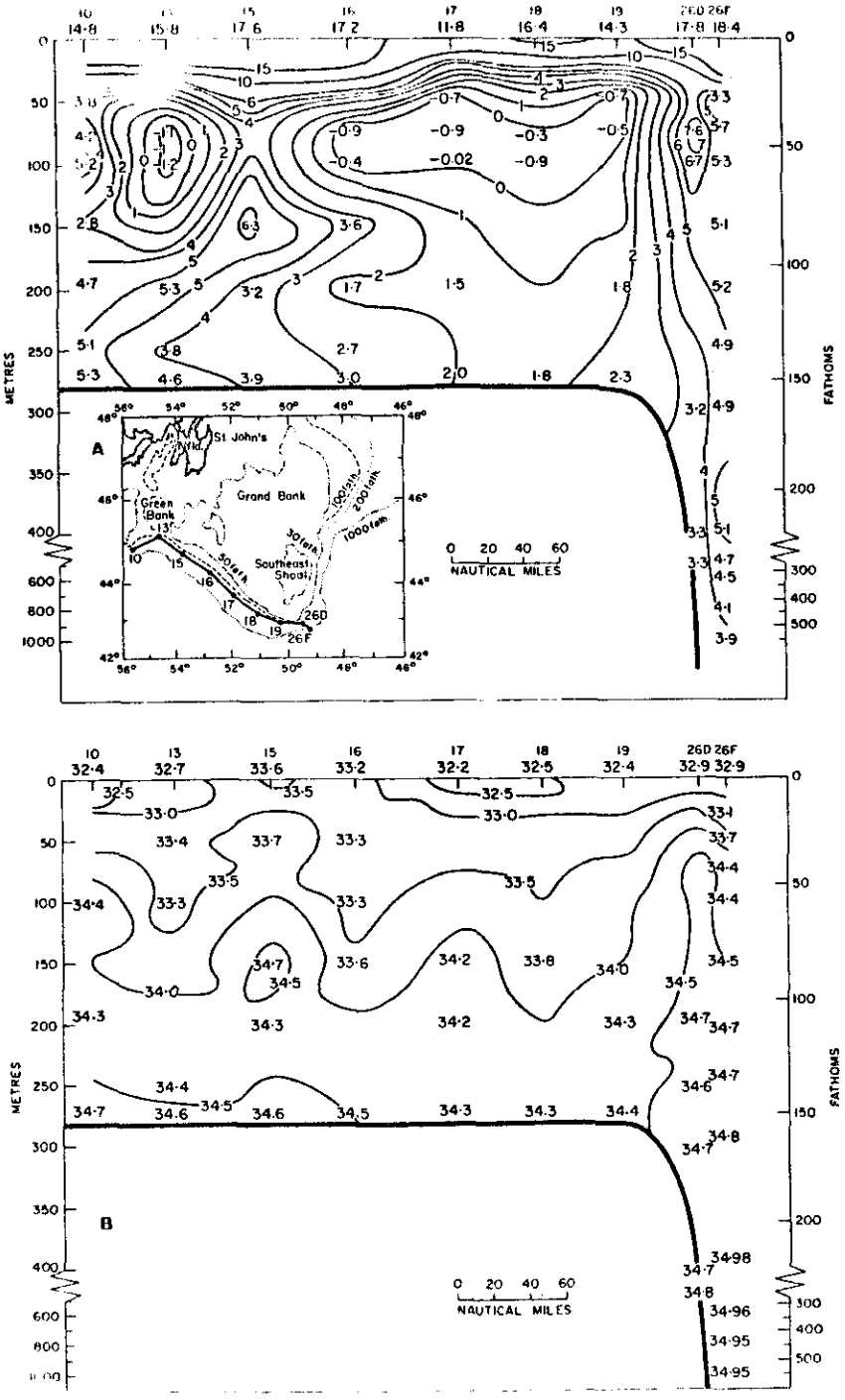


Fig. 6. A, temperature (°C) and B, salinity (°/oo) sections, along the SW slope of the Grand Bank, 20-23 August 1964.

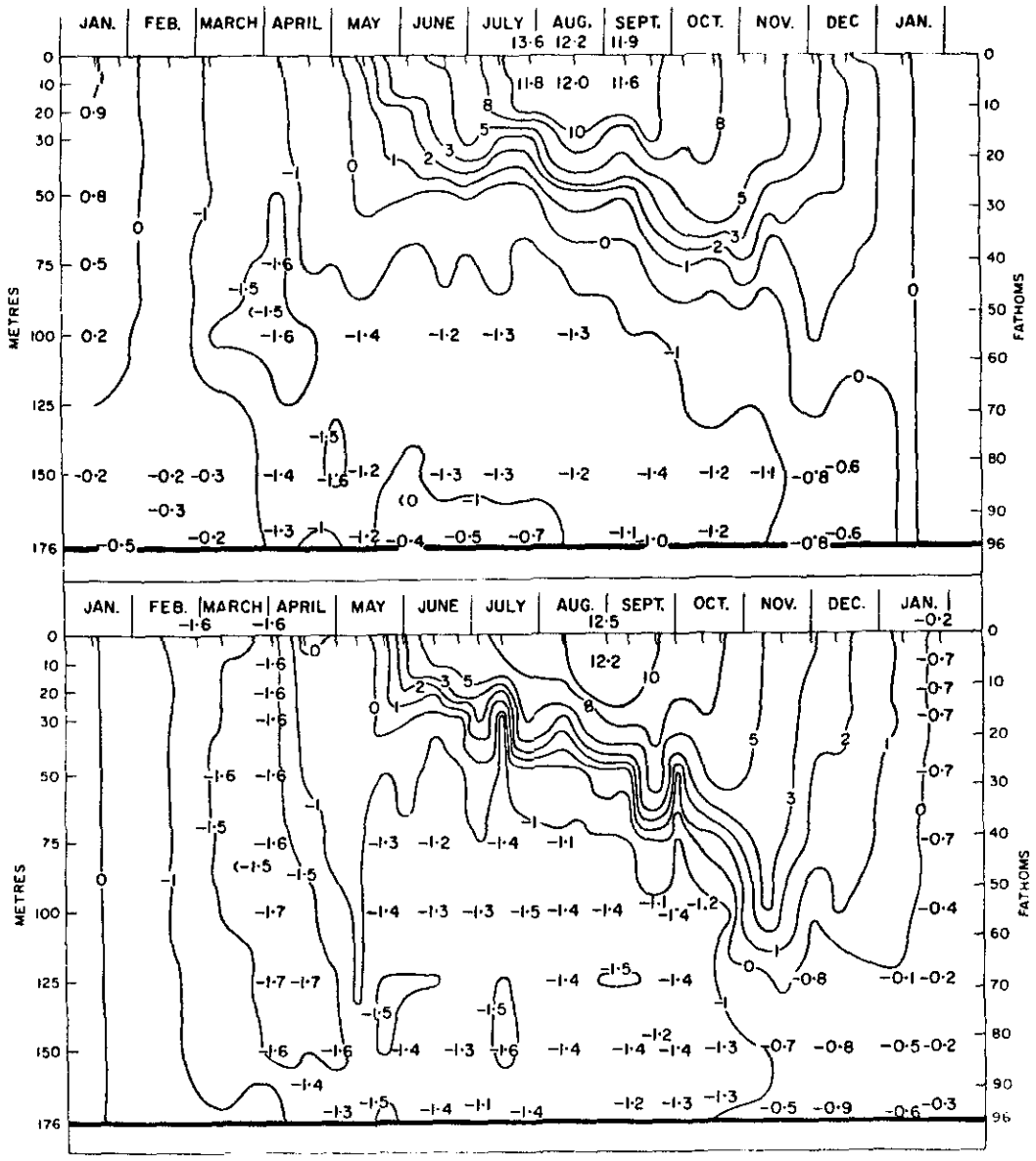


Fig. 7. Temperatures °C, above, 1963 and below, 1964 at Station 27 (see Fig. 3, 4, inset), 2 nautical miles off Cape Spear near St. John's.

at Twillingate were small and young, while fish caught by the other gears were larger with a greater range of ages. Although ages have not been determined for the 1964 samples, the length frequencies indicate that the trap fishery in Bonavista and St. John's was probably supported by fish of ages 4, 5 and 6 but that 7-year-old fish were also important contributors. In the Burin trap fishery the fish were of extremely small size with 4-year-old fish probably being the most numerous. The handline fishery at Bonavista was probably supported by fish of ages 5, 6 and 7, but there is an indication of 4-year-old fish of the 1960 year-class entering the fishery for the first time. The longline fishery in Bonavista and Trepassey was supported by older fish, the length frequencies indicating that the 6-, 7- and 8-year-old fish were probably the most important contributors. The gillnet fishery in Burin and Trepassey was supported by old fish, also, but indications are that a narrower range of sizes and ages is represented here (fish greater than 7 years of age).

The annual survey designed to obtain information on the inshore distribution and relative abundance of small cod up to 2 years of age was carried out from 5 September to 22 October. Beaches in areas selected in previous surveys were seined using a small-meshed Danish seine with the codend lined with fine-meshed nylon.

During the survey 157 successful hauls were made on beaches from St. Mary's Bay to the northern part of Notre Dame Bay, with small cod, ranging in numbers from 1 to 576, being taken in 94% of the sets. Cod in their first year (zero cod) made up 22% of the total cod caught in all areas and 1+ cod 78%. The number of zero cod caught suggests only moderate survival and settlement of the 1964 year-class but the abundance of 1+ cod indicates a good survival of the 1963 year-class.

Offshore investigations have included surveys of distribution and abundance in relation to season, depth and temperature, and biological collections for various purposes. Cod catches during surveys of the Grand Bank and St. Pierre Bank by the A. T. Cameron in June were usually small, with catches approaching commercial size only in shallow depths (about 75 m) at bottom temperatures of 0.4 to 1.4°C. Catches on Flemish Cap in September and on the eastern Grand Bank in October and off Labrador and northeast Newfoundland Shelf in October-November were generally small, seldom exceeding 450 kg per half-hour tow.

Cod were tagged in the following places, depths, dates and numbers: North Cape Grand Bank, 185-192 m, April, 768; Woolfall Bank, 102-126 m, April, 1,152; Eastern Grand Bank, 170-194 m, April, 768; Funk Island Bank, 216-236 m, May, 384; northern Grand Bank, 177-192 m, May, 768; Flemish Cap, 124-150 m, July, 768; Bonavista, 48-102 m, October-November, 1,152; Baccalieu, 51-113 m, November, 768.

At Funk Island Bank in 214-225 m on 18 May, of 61 mature females, 60 were spent and 1 had more than 50% of the bulk of the eggs clear.

2. Haddock. An otter-trawling survey over the haddock region on the southern half of the Grand Bank was carried out in early June by the A. T. Cameron. Of 82 drags in depths ranging between 45 and 275 m, only three haddock catches (310, 200 and 145 kg) were larger than 90 kg. At most of the fishing stations on the slope and adjacent bank areas water temperatures were favourable for haddock.

An otter-trawl survey in mid-June on St. Pierre Bank produced only five catches of any significance (160-660 kg) and these occurred at five stations along the western slope in 145 m, where there was an abrupt change in the temperature of the water mass near the bottom from near 0°C immediately shallower to 6°C or higher immediately deeper. Fishing for haddock has been insignificant on this bank since the fishery on the very abundant 1949 year-class came to an end in 1957.

From the length and age frequencies of samples taken during the June survey of the Grand Bank, about 70 and 15% of the catches were 2- and 3-year-old haddock of the 1962 and 1961 year-classes respectively and below commercial size. Haddock of the abundant 1955 and moderate 1956 year-classes, which were dominant in the surveys of 1959-61, were insignificant in the 1964 survey. Considering, however, that the catches per unit effort since 1962 were considerably lower than those of previous years both in number and in weight, the apparent abundance of the 1962 and 1961 year-classes must not be overemphasized. For example, the average number of haddock per drag in research vessel cruises on the southern half of the Grand Bank was 579 in 1960, 79 in 1962, 72 in 1963 and only 32 in 1964.

3. Redfish. The A. T. Cameron continued the redfish survey of the Canadian area using half-hour tows. On a line on the seaward slope of Funk Island Bank at about lat 51°45'N, fished on 6-7 April, a large catch of 3,220 kg of mentella redfish was obtained in 225 m at 3.2°C, 640 kg of mentella redfish in 550 m and 820 kg of mentella redfish in 640 m. These two catches at the greater depths were only about one-third of the A. T. Cameron catches in these depths at the same locality in April 1963 and may reflect a decrease in abundance due to commercial fishing for redfish by European trawlers in this general area in 1963.

On Funk Island Bank and its seaward slope on 6-7 April, of 80 mature mentella females only 1% was spent, but 11% were close to spawning with 95-100% of the larvae hatched and ready for extrusion. Five per cent had unfertilized eggs.

In September a survey on two lines of stations from 185 to 730 m at Flemish Cap showed the centre of abundance of redfish to be rather deep, with best catches occurring in 460-640 m. To the north of Flemish Cap a good catch of 2,120 kg of mentella redfish was obtained in 550 m and on the eastern slope of the Cap catches greater than 1,090 kg of mentella redfish were obtained in 460, 550 and 640 m.

During the period 20-30 November four survey lines were completed on the southeast slope of the Grand Bank. Best redfish catches were obtained on the most southerly line (eastern side at the tail of the bank). In 185 and 230 m on this line catches of about 910 kg of mentella redfish were obtained but these fish were very small, averaging only 0.14 and 0.3 kg respectively. However, in 365 m an excellent catch of 4,770 kg of mentella redfish was obtained and these fish were of good commercial size (average weight 0.6 kg) On the three more northerly lines (to 47°00'N) catches were not large. Best catches were obtained in the 320 and 365 m levels, between 450 and 900 kg of mentella redfish.

Growth equations have been produced for male and female mentella redfish from the following areas and for marinus redfish for the last two areas: Hermitage Bay, Gulf of St. Lawrence, southwest slope of the Grand Bank, Flemish Cap and Hamilton Inlet Bank.

4. Herring, Clupea harengus L. Small herring of the 1963 year-class, about 10 cm in length, were very abundant in the coastal waters of the east coast of Newfoundland, being reported from St. John's, Conception Bay, Trinity Bay and Bonavista.

5. Squid, Illex illecebrosus (Le Sueur). In 1964 the A.T.Cameron took many squid by otter trawling on the southwestern slope of the Grand Bank between 29 May and 14 June. Catches up to 590 kg per half-hour drag were made and this is exceptional since these squid are not usually caught in such quantities by a bottom otter trawl. Catches of squid were taken between 90 and 275 m but in greatest abundance at 185 m. On this basis a successful forecast was made in June (Canada Dept. of Fisheries, Trade News, July 1964) of the unusually great abundance of squid which appeared later in the year in the Newfoundland inshore area after 2 years of relative scarcity.

III. Gear Studies

1. Experimental gillnetting for cod. During May and early June the Marinus fished nylon gillnets in St. Mary's Bay and Placentia Bay in areas and depths where commercial fishing is usually conducted. Gillnets of 165 and 178 mm mesh sizes were used and depths ranging from 20 to 140 m were fished. Generally, better catches were obtained in St. Mary's Bay than in Placentia Bay. In St. Mary's Bay slightly more cod were caught with the 178

mm mesh whereas in Placentia Bay slightly more were caught with the 165 mm mesh. The 178 mm mesh net caught fish of a slightly larger size and greater age than the 165 mm mesh net. About 70% of the cod caught with both mesh sizes were males.

2. American plaice. In a comparison of day and night otter-trawl catches by the A. T. Cameron on the eastern Grand Bank much smaller amounts of American plaice were caught in sets during the hours of darkness than in daylight. A comparison of the catches of American plaice using three different sizes of rollers on the footrope indicated that the 61 cm diam steel bobbins and the 36 cm diam rubber rollers toward the centre of the footrope gave similar results. The use of 15 cm diam rubber disks on the footrope gave an average catch less than that of the other two arrangements.

B. Subareas 4 and 5
by J. L. Hart

Canadian researches were carried out in Subareas 4 and 5 by the St. Andrews Biological Station and the Atlantic Oceanographic Group (Halifax) of the Fisheries Research Board of Canada. The Quebec Marine Laboratory at Grand River, the Department of Mines and Technical Surveys' Bedford Institute of Oceanography and the Arctic Station of the Fisheries Research Board also made important contributions. Many scientists at these laboratories contributed research results for compilation in this report. The names of those involved appear in the list of ICNAF scientists.

Subarea 4

A. Status of the Fisheries

1. Cod

Canadian landings of cod from Subarea 4 continued to be higher than those for any other groundfish species. Total cod landings for the Canadian mainland fleet were about 2% lower in 1964 than in 1963, with the greatest decrease in landings from the Gulf of St. Lawrence (4T). Sizes of cod taken from the southern Gulf of St. Lawrence showed little change from 1963. Most of the fish landed were between 40 to 70 cm, and in the third quarter of the year the peak in the size distribution was at 46 cm. Discards of cod in 4T were low, less than 2% by number and 1% by weight. Discards in offshore 4VW were occasionally much higher, especially during summer fishing for other species. No major changes in size or age composition of cod landed from anywhere in Subarea 4 have been noted.

II. Haddock

Canadian mainland haddock landings in 1964 increased about 25% over those in 1963. Incomplete statistics suggest that part of this increase came from Subarea 4, particularly from Browns and LaHave Banks and other parts of Div. 4X. Currently these banks have replaced the Sable Island-Emerald Bank region (4W) in importance for the Canadian haddock fishery. Sizes of haddock landed were similar to those in 1963, with most fish between 40 to 60 cm, with a mode around 48 cm in the February-April period. Estimates of discards of haddock varied from 1 to 9% by weight, depending on season and area.

III. Pollock, Pollachius virens (L.)

Pollock landings were similar in 1964 and 1963. Decreased landings from the Bay of Fundy region of 4X were replaced by increased landings from offshore banks in 4X and 4W. Pollock landings still seem partially limited by demand.

IV. Flatfishes

Since preliminary Canadian statistics on flatfish are not separated for species or area, precise information about flatfish landings is impossible to provide. The following three offshore species contribute most to these landings:

American plaice. This species is of particular importance in the southern Gulf of St. Lawrence and off Cape Breton (4TV) and Sable Island region (4W). Landings and effort both appear to have increased in 1964. Discards of small American plaice remained high in 4T (70 to 80% by number).

Witch flounder (Greysole). This species has increased in importance over the past decade, with landings reaching about 10,000 metric tons by 1963. Landings in 1964 at about the same level came chiefly from off eastern Nova Scotia (4V), western Newfoundland (4R) and central Nova Scotia (4W). Danish seiners take about half the landings. Discards of small fish are negligible.

Yellowtail, Limanda ferruginea (Storer). Landings of this species from Subarea 4 have been increasing during the past 3 years and in 1964 about 5,000 tons were landed, mainly from Banquereau (4Vs) and Middle Bank (4W).

V. Halibut, Hippoglossus hippoglossus (L.)

Halibut maintained a high market value but landings were down somewhat from 1963, due mainly to decreased effort. No changes occurred in the areas exploited or in sizes of fish landed.

VI. Redfish

Total Canadian mainland landings increased about 7% over those of 1963. Most of the increase seems to have occurred in landings from the Gulf of St. Lawrence (4RST). Apparently local trawlers made use of the abundant new 1956 year-class recorded earlier from research-vessel surveys.

VII. Herring

Preliminary tabulations indicate that total Canadian herring landings of 141,000 tons were 26,000 tons (23%) greater than in 1963. Increased landings occurred chiefly in the Bay of Fundy region of 4X where an all time record catch of 84,000 tons was made. Herring landings in 4W, 4V and 4T were essentially the same as in 1963.

VIII. Swordfish, Xiphias gladius L.

Total Canadian landings of swordfish in 1964 amounted to 7,994 tons round weight. This was 568 tons (7%) less than in 1963. The decrease was due mainly to smaller landings from the Nova Scotia Banks (4V and 4W). Fishing is now a year-round operation although efforts from January to May are, for the most part, outside the ICNAF area.

IX. Mackerel, Scomber scombrus L.

Mackerel landings in 1964 amounted to 10,829 tons, an increase of 3,028 tons or 39% more than in 1963. Significant increases in landings occurred mainly in 4T and 4W. No effort statistics are available and there is no basis for predicting catches in 1965.

X. Bluefin tuna, Thunnus thynnus (L.)

Most of the Canadian fishery for bluefin tuna takes place in Subarea 5. Landings in 1964 in Subarea 4 amounted to 323 tons round weight, an increase of 92 tons over the 1963 landings.

XI. Sea scallops

Scallop landings by the offshore fleet in this subarea were entirely from 4X and included approximately 227 tons of shucked meats from Browns Bank and 100 tons of shucked meats from the lower Bay of Fundy (1,883 and 829 tons, whole weight, respectively). Compared to the previous year, this was a 53% reduction in landings by the offshore fleet in this subarea. An additional 5,295 tons (whole weight) were landed from this region (4X) by the inshore fleet, an increase of 17% over 1963 landings.

The inshore fishery in the southern Gulf of St. Lawrence (4T) landed 230 tons of shucked meats (1,909 tons whole weight), the highest landings on record for this area. Experimental marketing of adductor muscles with attached roes was undertaken by this fishery in 1964.

XII. Harp Seal

The Canadian fishery for harp seals centred in Division 4T. Ships, aircraft and landsmen took 63,000 seals on the ice as compared with 87,000 in 1963. Eighty-three per cent were young of the year. Fifty hood seals were taken as compared with 100 in 1963.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. Monitoring of oceanographic conditions was continued in 1964 at coastal stations and along established sections. The salient features of the water temperatures along the Canadian Atlantic coast, this past year, are the large negative anomalies mainly from the Scotian Shelf (4VW) to the Bay of Fundy (4X) during summer and autumn. Surface temperatures in the Gulf of St. Lawrence (4T) also indicated below average temperature conditions but to a lesser degree than in the other divisions. Bottom temperatures in the Bay of Fundy (4X) and along the Halifax monitoring section (4W) indicated large negative anomalies. In general the 1964 means, at surface and along the bottom, were lower than those of 1963.

The monitoring section off Halifax (4W) was covered seven times in 1964. The temperature and salinity distributions of four crossings are given in Fig. 8 and 9. In general, the conditions along this section were similar to those of 1959, another "cold year". However in late autumn 1964, at the times of observations, the conditions over some of the offshore banks are the result of an intrusion of offshore waters.

Circulation studies were continued. The wind-driven circulation in the Gulf of St. Lawrence (4RST) has been modelled by means of electrical analogs. Studies of non-tidal drift were continued in all areas and augmented in some of them. Compilation of drift bottle and seabed drifter data was emphasized in 1964. Folio 7 of Serial Atlas of the Marine Environment (American Geographical Society) on the surface circulation over the continental shelf pertains among other regions to Subarea 4.

Four hydrographic cruises were made in the Chaleur Bay area (4T) from 27 May to 28 August. In May water temperatures ranged from 1.9°C at the bottom to 7.1°C at the surface. In July they ranged from -0.15°C at the bottom to 15.4°C at the surface. Finally, at the end of August, the

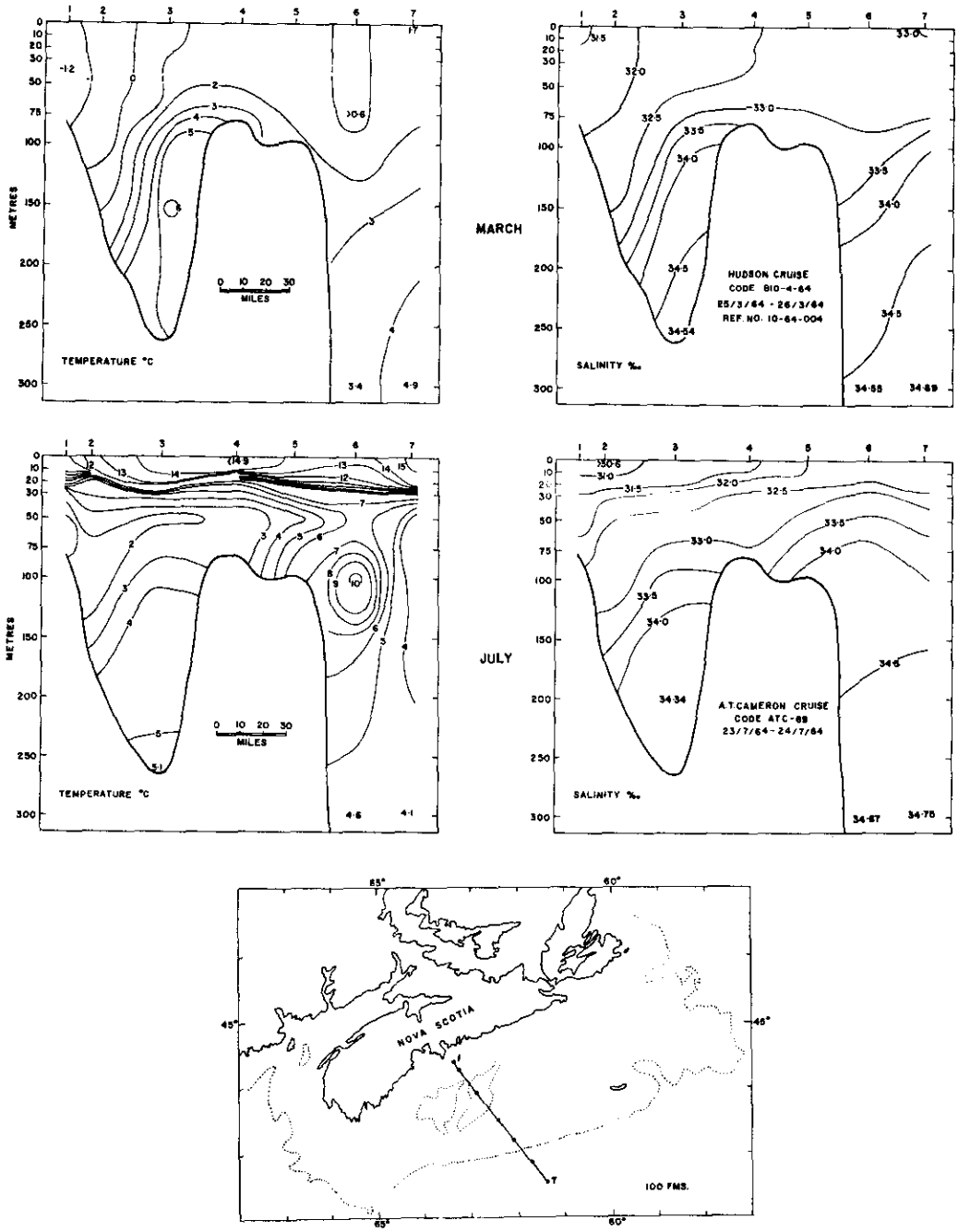


Fig. 8. Hydrographic section off Halifax, March and July 1964.

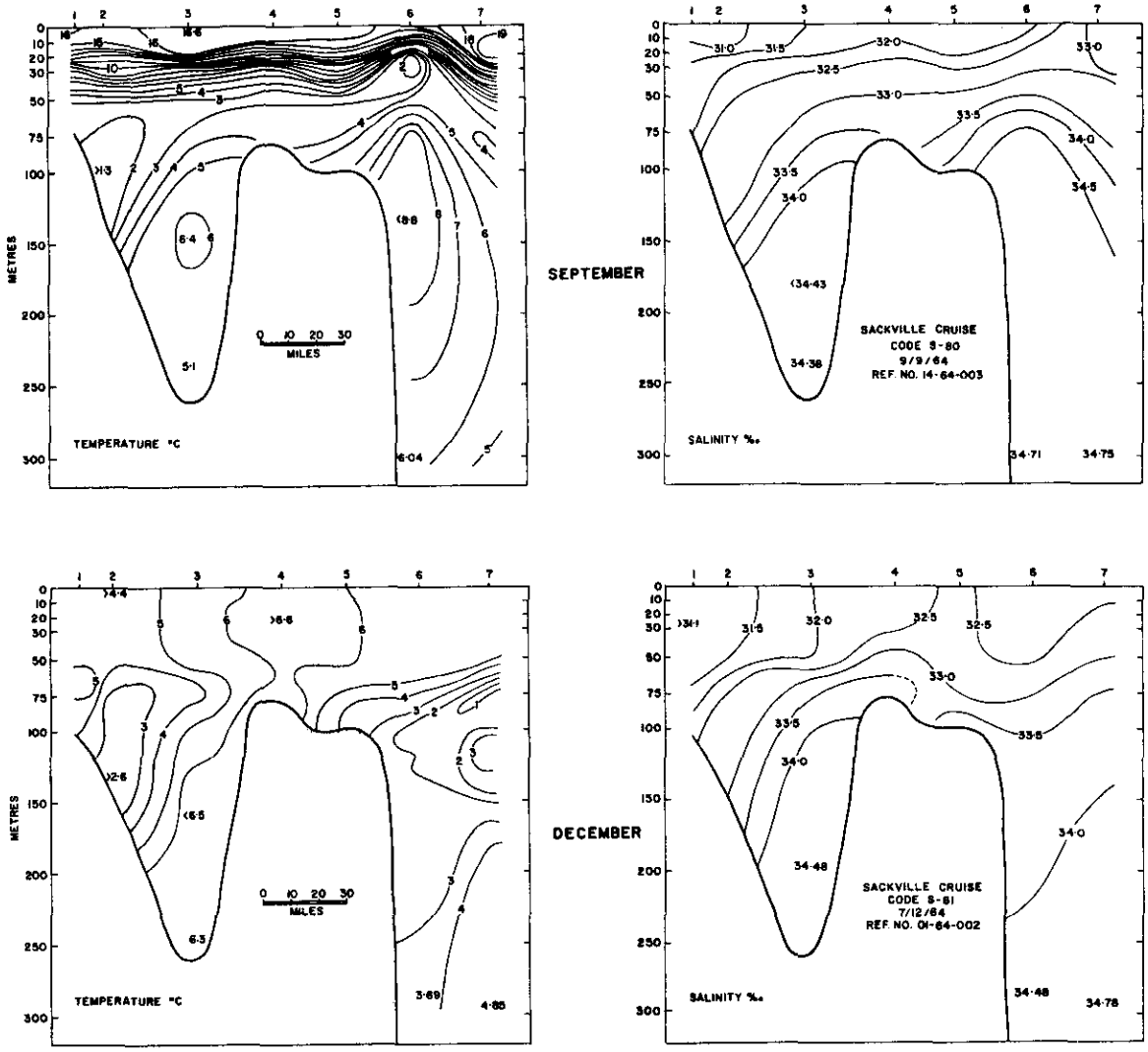


Fig. 9. Hydrographic section off Halifax, September and December 1964.

corresponding figures were 4.9 and 15.6°C.

2. Bottom topography. Detailed charts of Chaleur Bay and Orphan Banks areas were published in 1964. These are intended for fishermen. The fishing grounds west and south of Anticosti Island (4S) were mapped for the same purpose.

3. Benthic studies. The bottom sampling program started in previous years was extended in 1964 to cover most of the Magdalen Shallows (4T) in the Gulf of St. Lawrence. Physical characteristics of the sediments in the same area are under study. Relationships between sediment parameters and abundance of some of the benthic organisms have been pointed out.

4. Plankton. Nine series of observations were made at 5 stations in Chaleur Bay from 13 May to 26 October, 1964. Zooplankton volumes were generally smaller than those of 1963 and 1962. The peak of abundance occurred in July as in previous years.

The study of direct catches of 24 species of pelagic and hyperbenthic macro-invertebrates and fish revealed a well defined pattern of daily vertical migrations or daily changes in behaviour in all but one species. Almost all the migrations were nocturnal, underwent distinct seasonal changes, and ranged in extent from a night bottom phase of pelagic forms to pelagic swarming of benthic forms in a restricted season and at a short distance from the bottom. Mysidacea with functional eyes were clearly the most pelagic of hyperbenthic groups. Variability of catches was greater in the late spring of 1962 than in the summer and fall of 1961.

5. Other environmental studies. An active study is under way to lay the proper foundations of a research program of biological oceanography.

Charts showing the sea surface temperatures in Subarea 4 are broadcast daily by radio-facsimile.

Analyses of time series of accumulated data are carried out.

II. Biological Studies

1. Cod. Surveys on the Gulf of St. Lawrence cod population were carried out in January and in September. The January survey in the Cape Breton area (4Vn) effectively combined echo-sounder records and trawling at selected stations. Using both methods, extensive coverage of the grounds was obtained and cod were found to be continuously distributed from the edge of ice off Sydney Bight to Scatari Bank. Concentrations were related to bottom contours with cod most abundant between 150 and 175 m. Nocturnal migration of cod off bottom as much as 30 m was again recorded. A continuing fall survey in the

Magdalen Shallows region of 4T is designed to provide a long-term series of data on sizes and ages of cod to relate to changes in fishing effort and environment. In the September 1964 survey cod were spread quite evenly over the area, with no apparent relationship to bottom temperatures (0.2 to 11.2°C) or to feeding. Smaller fish predominated in the southern section. Length distributions of cod in small-mesh research-vessel nets had a peak at 34 cm. The numbers of 3-year-old fish (1961 year-class) were above average. This year-class is expected to influence scrod landings from 4T in the summer of 1965.

The regular cod survey was carried out at the end of June in the Orphan Bank-Chaleur Bay area. The average length of all cod caught with a covered codend was 42.6 cm in 1964 compared with 46.3 cm in 1963. The proportion of cod of commercial sizes (38 cm and larger), however, was greater in 1964 than in 1963 (92.5% in 1964 compared with 86.1% in 1963).

Data on maturity stages for 25 cruises in the Gulf of St. Lawrence (4T) from 1959 to 1964 were summarized. Results indicate that cod spawning is spread over the period from May to October, with most activity early in this period. Egg and larval distribution cruises are planned for June and September 1965 to study the problem of recruitment to Gulf stocks.

Stomach contents of about 22,000 cod examined during 1959 to 1964 have been analysed, using IBM computer methods. Cod stomachs examined came from a wide area, but the principal data are for the 4VT cod stock. Part of the analysis shows the relation of food type and volume to size of cod. Small cod (15 to 29 cm) fed mainly on small crustaceans (about 75% by volume), mysids, euphausiids, amphipods, and decapod shrimp. As cod grew, their diet became more varied and increasing numbers of molluscs and echinoderms were found. The crustacean diet gradually decreased with increase in size, and teleosts were taken more frequently. Cod over 70 cm in length contained about 70% fish by volume. The type of fish eaten varied with area.

Seasonal changes in stomach volumes of feeding cod and proportion of empty stomachs are shown in Fig. 10. For small cod there was little seasonal change in volume. Cod of 15 to 29 cm averaged about 4 cc per stomach; those of 30 to 49 cm, about 12 cc. Stomachs of larger cod contained most food in the January-April period. For 50 to 69 cm fish the amount was about double that for the remainder of the year (60 cc compared to 30 cc). Throughout the year the proportion of empty stomachs was never large. Highest percentage of empty stomachs for all sizes was recorded between January and April.

Analysis of the data on cod feeding, as related to their vertical migrations and those of hyperbenthic and pelagic prey, was continued. The study of stomach repletion indices ($R' = W/L^3$, where W is the wet weight of the whole stomach contents, and L is the fish length) showed, in the 3 years 1960 to 1962 and at the same locality (depth: 110 m), a significant and gradual decrease in

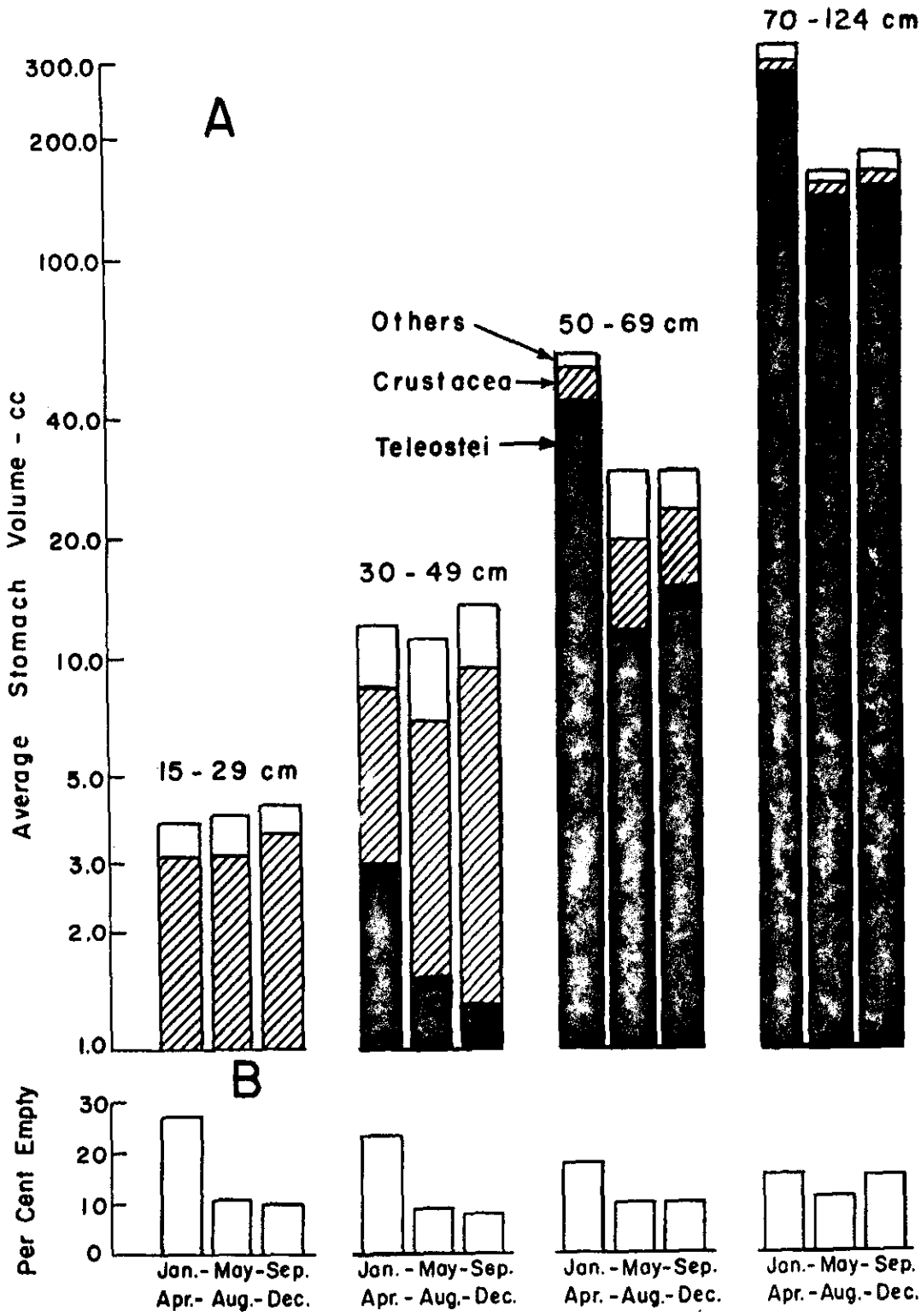


Fig. 10. Food volumes in cod and proportions of empty stomachs.

stomach repletion from May to September, and a slight increase on 12 October, 1961. Indices were significantly larger in trawled than in gillnetted cod, and those of cod longer than 50 cm were significantly more variable, and seldom as low in late summer and fall, than those of smaller cod. They did not differ significantly between the upper and lower trawl half, nor between day (05:-17: hours) and night (21: and 01:-03: hours).

2. Haddock. No survey cruises for haddock were carried out in 1964. Predictions in 1963 that for the Sable Island Bank region (4W) year-classes of 1957 and 1959 were relatively strong and those of 1958 and 1960 weak appear to be confirmed by results from the commercial fishery. Age composition of current commercial landings show the same general pattern of relative year-class strengths.

Analyses of earlier survey cruise data show larger trawl catches of haddock by day than by night. Comparison of size compositions shows that more small haddock (under 40 cm) are taken in daylight tows, while day and night catches of large haddock (over 40 cm) are similar.

Observations on haddock held at the surface after capture in 30-minute otter trawl hauls showed mortalities of about 30%. Haddock surviving did not regain full capacities as measured by blood lactic acid levels for about 4 hr. The results are important in considering tagging mortalities.

3. American plaice. An analysis in 1964 of cod stomach contents for the Magdalen Shallows (4T) provided an opportunity to estimate the effect of cod grazing on mortalities of small American plaice. For the period 1956 to 1961 estimated total instantaneous plaice mortality due to cod predation was reduced from about 0.8 in 1956 to 0.15 in 1961. The decrease in cod grazing on plaice is attributed to a decline in the abundance of large cod which are the main plaice predators.

4. Witch (Greysole). A review of records from commercial vessels fishing witch shows that the most important areas for this species were Sydney Bight (4Vn), St. Georges Bay (4R), Scatari Bank (4Vn), Middle and Canso Banks (4W). Best catches were usually deeper than 200 m. There appears to have been little change in fishing grounds during the last ten years at least.

Examination of witch otoliths used in growth and age composition studies shows, from ring formation, that summer growth occurred from June to October. In the Scatari Bank region (4Vn) witch reached a length of 30 cm (current minimum commercial size) in about 8 years. Up to 10 years of age there was little difference in growth for males and females. Beyond 10 years females grew somewhat faster. In research-vessel catches from 4VN witch of 10 to 15 years predominated in the catch,. although some fish were estimated to be about 20 years old. Preliminary analyses suggest differences in growth

rate and age composition between 4V and 4W witch stocks.

5. Egg and larval studies.

Cod and plaice. Southern Gulf of St. Lawrence (4T). Plankton hauls during groundfish surveys from 1958 to 1962 showed that cod and plaice eggs were widespread in 4T, but particularly numerous over depths of 38 to 120 m. Cod eggs were more abundant than plaice eggs, and both were taken in greatest numbers in May. Both gadoid (mostly cod) and plaice eggs were more numerous in the Gulf (4T) than in the Nova Scotia Banks region (4VW). Few larvae of either species were taken during these surveys.

Eastern Nova Scotia Banks (4W-4V). Plaice eggs were taken over a wide area, as early as the end of February, but peak catches occurred in April. A few plaice larvae were taken in late May. In late March gadoid eggs (mainly haddock) were most abundant across Emerald and Western Banks, toward the edge of the Scotian Shelf (4W). In early March scattered gadoid eggs were taken south of Cape Breton Island (4V).

Other eggs and larvae. Mackerel, snake blenny (Lumpenus lumpretaeformis (Walbaum) and sand launce (Ammodytes americanus DeKay) larvae were taken in fair numbers in the Gulf of St. Lawrence (4T). Redfish, herring, sculpin (Myoxocephalus sp.) and four-bearded rockling (Enchelyopus cimbrius (L.)) larvae were encountered less frequently.

In the Nova Scotia Banks region (4W) sand launce larvae were commonly taken. Other larvae occurring were those of redfish, pollock, sculpin and mackerel.

6. Argentines. During 1964 exploratory fishing for argentines, Argentina silus Ascanius, was carried out on the Scotian Shelf (4VWX) and records from previous surveys were analysed. Argentines were caught in quantity along the edge of the continental shelf from Browns Bank to Banquereau. None were taken in the Bay of Fundy and only occasional specimens were taken along the Laurentian Channel and in the Gulf of St. Lawrence (4T). Largest catches were consistently taken between 175 and 375 m. Most argentines were between 20 and 30 cm in length. In general, size increased with depth of capture. Modal length of female fish (22 to 26 cm) was larger than for the males (19 to 23 cm) and females appear to grow slightly faster than males. During September-October 1964 fish of 2 to 5 years made up the greatest portion of the catch, with 3-year-olds predominating.

7. Silver hake, Merluccius bilinearis (Mitchill). Results from past surveys (1958 to 1963) show that silver hake were mainly found in the areas around Sable Island Bank (4W). They are scarce in the Gulf of St. Lawrence (4T) and eastward of Banquereau (4V). They occurred to the westward around

Browns-LaHave Banks and in the Bay of Fundy (4X), but catches were generally small. The mean size of silver hake caught in the Sable Island region (4W) was around 30 cm in both winter and summer, with most fish between 25 and 35 cm.

During September-October 1964 both males and females had begun to mature at about the same length (24 cm) and all specimens over 35 cm were mature. By mid-September about 45% and by mid-October 90% of the females were spawning and spent. Indications are that silver hake spawning in 4W is virtually completed by November.

Age determination studies were begun and as recommended at the 1964 ICNAF Annual Meeting, exchange of otoliths with the USA and USSR was started.

8. Herring. Routine sampling of herring for size and age composition in the Passamaquoddy region of 4X showed mean lengths varying from 89 to 255 mm and mean ages from 1.0 to 3.4 years. Only 7% of the fish examined were spring spawned. Herring are recruited to the fishery at the end of their first year of life (average length 90 to 100 mm).

In the southwest Nova Scotia region of 4X, age 4 herring which are reaching sexual maturity for the first time are the major contributors to the fishery. The 1960 year-class was especially strong - 55% of the fish sampled in 1964 were of this year-class.

In May and June 1964, 6,112 herring were tagged and released in Passamaquoddy to continue a study of the migrations of "sardine" herring and to evaluate tagging techniques. Recovery was mainly from the tagging area, but there was some movement eastward along the New Brunswick shore and across the Bay of Fundy to Digby. Recovery of spaghetti tags amounted to 10.6% as compared to 1.0% for opercular tags.

Experiments to discover length and weight loss due to storage showed length losses of 1.0 to 3.2% and weight losses of 11.7 to 59.3% for refrigerated storage. For herring preserved in formalin comparable values were 0.5 to 2.2% loss in length and 4.2 to 7.8% loss in weight.

9. Mackerel. Mackerel investigations were concerned mainly with the size and age composition of landings in 4X. Mean lengths decreased from 387 mm in May to 265 mm in July. As the season advances, the older and larger mackerel are replaced by younger and smaller fish.

10. Sea scallops. Studies of the development of sea scallop larvae were continued in 1964 and the major emphasis was placed on culturing larvae through to settlement. Larvae were obtained from eight separate spawnings and two cultures did particularly well. The larvae remained in the top third

of the containers and were very abundant in the top centimetre. When they descended to the bottom they were usually moribund. Changing the cultures daily instead of every second day seemed to improve survival. The use of antibiotics to control bacterial growth was ineffective and one antibiotic apparently killed sea scallop larvae.

11. Species associations studies. Studies were begun on association between demersal fishes in order to assess fishes as factors which influence mortality, recruitment and growth of various groundfish species. Efforts during 1964 involved testing sampling methods, mainly trawling, that might be applicable. Rate of accumulation of species when several tows were made at a station was studied. After four to seven tows few further species were accumulated. Studies on feeding relationships among fishes living together were begun. Early results suggest that, although fishes have a large number of organisms in their stomachs, many species may concentrate their feeding on a few types of food without much overlap between species.

12. Tagging of groundfish. Taggings of cod, halibut and witch were carried out in Subarea 4 during 1964 in a further effort to determine the interrelationships and migrations of stocks. All cod were tagged in the Gulf of St. Lawrence. In May, 1,887 cod were tagged in Div. 4S and 4T; in September-October, 1,536 cod were tagged in Div. 4S; and from September to November, 1,536 cod were tagged in Div. 4R; 1,000 cod were tagged off Grand River (4T) in the autumn of 1964. It is yet too early for results to be significant.

About 1,600 witch were tagged off Cape Breton in Div. 4V and in the eastern part of 4W.

A total of 174 halibut were tagged in Subarea 4, 164 of these between Sable Island Bank and Banquereau (4W-4Vs), and 10 in Div. 4X. Some recaptures have been recorded from those tagged in 4W-4Vs, mostly from the tagging region.

13. Discards of groundfish. Observations on 11 trips from June to September in Div. 4T and 4R showed that, contrary to previous years, all cod, flounders and redfish caught were landed. No discards of these species were reported. Undersized flounders and redfish were landed for fish meal and all cod were processed as fillets or blocks.

14. Harp seals. Research included an aerial photographic survey of the group of adult seals giving birth in Div. 4T and a simultaneous capture-recapture tagging of young born in these same groups. In the latter experiment, some 2,800 young seals or 2.4% of estimated production were tagged from a helicopter and recovery obtained from the fishery which began a few days later. Returns from tagging gave an estimate of 120,000 young seals produced, while photographic survey indicated 95,000 adults in the same group;

the real figures are believed to be intermediate but closer to the tagging estimate. Including other unsurveyed groups, the number of young seals produced in Subarea 4 was estimated at some 150,000 in 1964.

Subarea 5

A. Status of the Fisheries

I. Haddock

The Canadian fleet continued to fish for haddock on Georges Bank (5Z). Statistics of landings are not yet available but landings are likely to be the equivalent of those in 1963 (8,000 tons). Samples of commercial landings for size and age have been forwarded to investigators of the US Fish and Wildlife Service who have taken primary responsibility for analysis.

II. Cod

Substantial quantities of cod were taken along with haddock from 5Z, probably of the same order as in 1963.

III. Herring

There was no Canadian herring fishery in Subarea 5 in 1964. However, intentions to fish for herring on Georges Bank in 1965 have been announced.

IV. Swordfish

About 50% of the Canadian swordfish landings from the ICNAF area are made from Subarea 5. Landings from this subarea in 1964 (3,320 tons round weight) were essentially the same as in the previous year. The distribution of swordfish catches in 1964 is shown in Fig. 11.

V. Bluefin tuna and Skipjack

Canadian tuna and bonito landings in 1964 amounted to 1,315 tons round weight, about double the landings in 1963. Most of the increase was due to two purse-seiners that were in operation for their first full season. Landings from these vessels (992 tons) consisted of bluefin and skipjack in the ratio of approximately 3:2. The catches were made in 5Y, 5Z and the adjacent area southward to Cape Hatteras. The trap and sport fishery for bluefin in Subarea 4 accounted for the balance of the Canadian landings in 1964.

VI. Sea scallops

In 1964, Canadian sea scallop landings from Georges Bank (5Z)

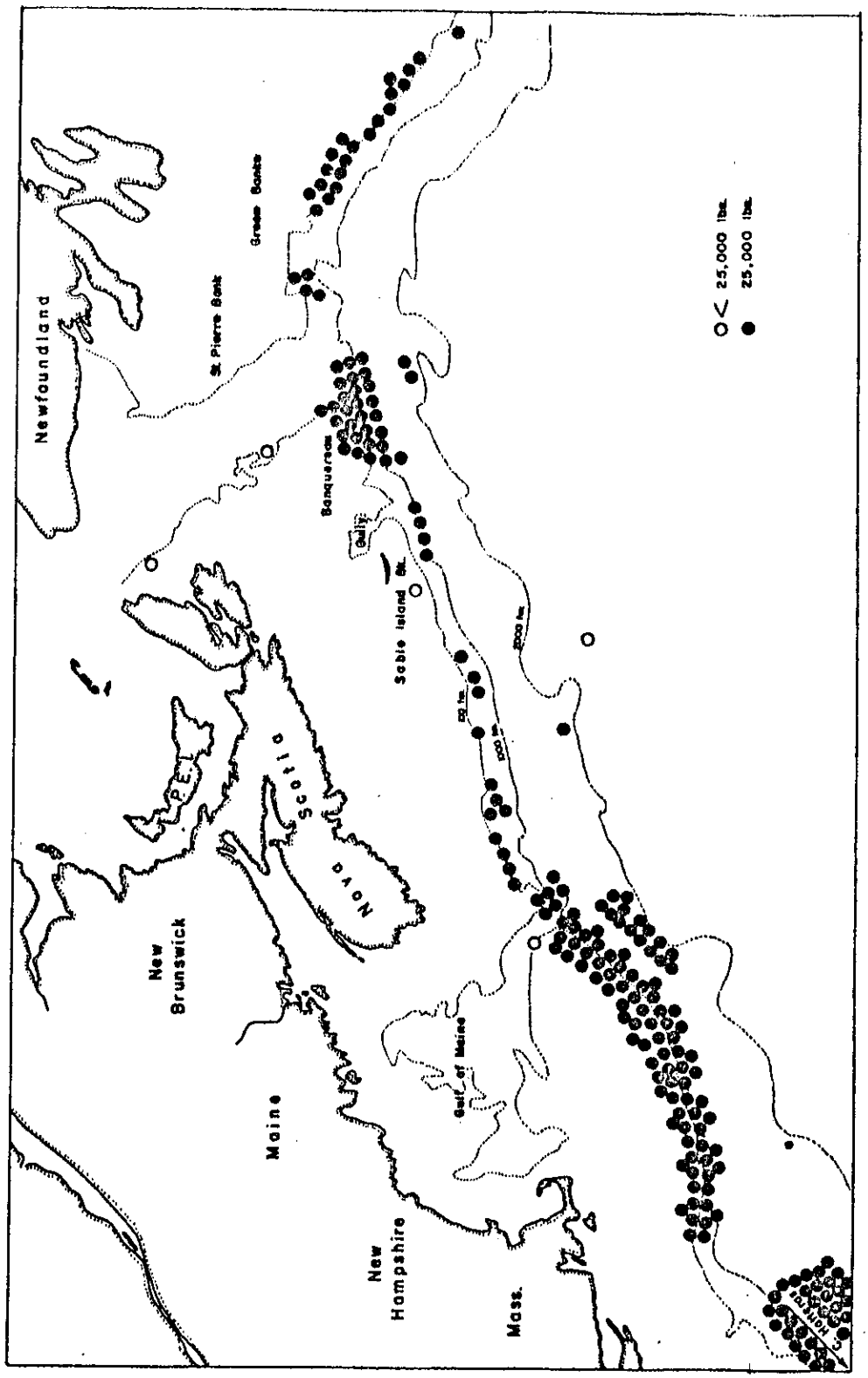


Fig. 11. Distribution of swordfish catches, 1964.

amounted to 5,941 tons of shucked meats (adductor muscles only), 49,310 tons of whole scallops. This was an increase of less than 1% over 1963 landings. The fleet size remained the same as in the previous year (40 boats compared to 39) but the catch per unit effort decreased and days spent fishing increased from 5,905 days in 1963 to 6,723 days in 1964. The Canadian fleet covered a larger portion of the bank than before and even fished in deep water (up to 137 m) off the northeast peak where no previous effort had been expended. Several more boats converted to other less arduous or more lucrative fisheries.

B. Special Research Studies

I. Environmental Studies

Studies of non-tidal drift (5YZ) as inferred from analysis of drift bottle and seabed drifter recoveries were continued. A study of the surface circulation in all of Subarea 5 is included in Folio 7 of Serial Atlas of the Marine Environment as part of a cooperative program.

II. Biological Studies

1. Herring. Samples of herring from Georges Bank taken in 1962, 1963 and 1964 were examined for size and age composition. It was observed that the 1956 and 1957 year-classes which were strong in 1962 were sharply reduced in 1963, but dominated the samples again in 1964. The 1958 and 1959 year-classes were consistently weak in all the samples. The 1960 year-class dominated the samples in 1963 and was strongly represented in 1964.

2. Swordfish. Food studies indicated that swordfish feed chiefly on silver hake, redfish, barracudinas and lanternfish. Cephalopods are also important in the diet. Twenty-eight swordfish were tagged and released during 1964, but so far there have been no recoveries. For longline catches the ratio of females to males is approximately 3:1. Apparently the harpoon fishery took only females. Shore sampling of swordfish for length and weight studies showed a weight range of 7 to 486 pounds (3.2-219 kg) with an overall average for the season of 142 pounds (64 kg). This is in sharp contrast to the 200-pound (90 kg) (average size) swordfish taken with harpoons prior to the 1963 season.

3. Tuna. Tuna studies were concerned chiefly with landings by two new purse-seiners. Bluefin varied from 55 to 170 cm (fork length) and skipjack from 46 to 60 cm. During the year 15 bluefin, 1 yellowfin, 1 bigeye, 4 common bonito and 82 skipjack were tagged and released.

4. Sea scallops. Investigations begun in 1963 to determine scallop distribution and the error involved in sampling were continued in 1964. The data are now being analysed. Further work was undertaken with an underwater camera to study bottom characteristics and also to determine if scallop abundance can be better assessed with this camera than by standard dragging techniques.

II. Danish Research Report, 1964

by Paul M. Hansen and Frede Hermann

Subarea 1

A. Status of the Fisheries

I. Cod

1. The fisheries. The Greenlanders' cod fishery has been limited chiefly to the inshore waters. After having increased gradually from 1942 to 60, landings rose abruptly to 35,164 tons and 36,666 tons in 1961 and 1962 respectively. In 1963, landings dropped to 23,650 tons and, in 1964, dropped further to 17,178 tons which is almost the same as the total catch in 1946.

The decline in the last two years may be due partly to a scarcity of cod in inshore waters, which is probably a consequence of abnormal meteorological conditions and a strong winter cooling of the upper water layers.

The pound net fishery which is a very important branch of the Greenlanders' cod fishery failed, especially in Div. 1BCD. The pound-net catches consisted merely of small cod belonging to the rich 1960 and 1961 year-classes with mean lengths about 36 to 45 cm and 50 cm respectively. Another fact which may have had an influence on the output of the cod fishery is the Greenland fishermen's failing interest in cod fishing and their changeover to more profitable fisheries for prawns and salmon. These two fisheries had their best year in 1964. In the autumn good quantities of cod were reported from different places along the coast in Div. 1C but, at that time, the fishermen were only interested in the salmon fishery.

2. Forecast for the cod fisheries. The year-classes older than 1956 will not be important in the commercial catches. The 1956 year-class will probably decrease further in 1965. In Div. 1F, however, it will still be of importance. In Div. 1DE the two year-classes 1957 and 1958 are still important but the year-class 1960 will predominate in most of the catches in Div. 1BCD and possibly in E. The mean length of this year-class will be about 60 cm and the mean weight about 2 kg. The rich, young 1961 year-class will be abundant in many catches especially in Div. 1BC and possibly in D. The mean length of cod belonging to the 1961 year-class will be about 45-55 cm and the mean weight about 0.8 to 1.5 kg.

The cod fishery in 1965 will be characterized by a high percentage of rather small cod.

II. Other commercial species

A few species, other than cod, are of commercial value in the Greenlanders' fishery. The most important are Greenland halibut, wolffish and salmon. Among crustaceans the only species fished is Pandalus borealis. Redfish which is important in the German and Icelandic fisheries is merely used by the Greenlanders for home consumption. Only small quantities of redfish fillets are produced. The catch of redfish in 1964 was 182 tons. The catches of Greenland halibut and wolffish were 2,704 tons and 2,064 tons respectively.

The output of the salmon fishery increased from 420 tons in 1963 to 1,386.2 tons in 1964. Salmon seemed to occur in larger numbers than in previous years. The higher prices for salmon gave reason for a more intensified fishery and a larger number of fishermen participated in this fishery.

The prawn fishery showed the highest output hitherto obtained, 3,770 tons, mainly because a larger number of prawn trawlers participated in the fishery in 1964 than in 1963, especially in Disko Bay.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. Hydrographic investigations were carried out in the coastal waters off West Greenland throughout the year from M/C Adolf Jensen and M/C Tornaq. In addition observations were made from R/V Dana in Davis Strait in July (Fig. 1-6).

The winter cooling seems to have been relatively strong. Thus negative temperatures were found from surface to bottom (300 m) at the entrance to Godthaab Fjord in February. In May, when the Adolf Jensen worked a section over Fylla Bank, conditions there were about normal, possibly a little above normal over the western slope of the bank. The most outstanding feature in the sections is the high temperatures found in the core of the Irminger Current in the deeper layers off the western slope of the banks. Temperatures over 5°C were found in the core of this current as far north as 65°N. Such high temperatures at this locality are very rare in July. Over the shallow parts of the banks the temperatures were, however, only about normal.

2. Plankton. Collection of plankton with 2 m stramin net and with Hensen net were made on nearly all stations where hydrographic observations were made.

3. Other environmental studies. Measurements of the primary production by means of Carbon 14 were made regularly on a fixed station near

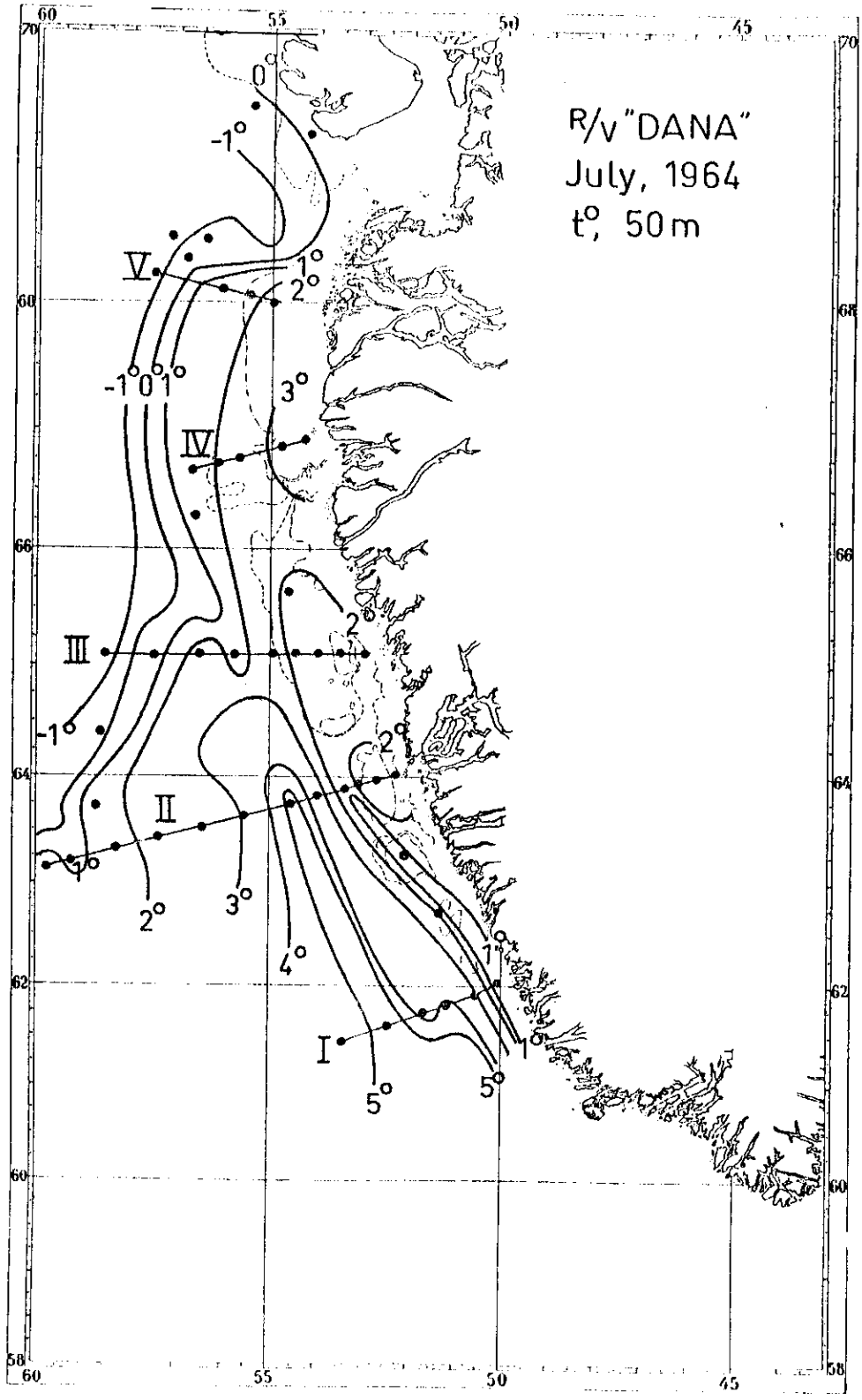


Fig. 1. Temperatures at 50 m off West Greenland

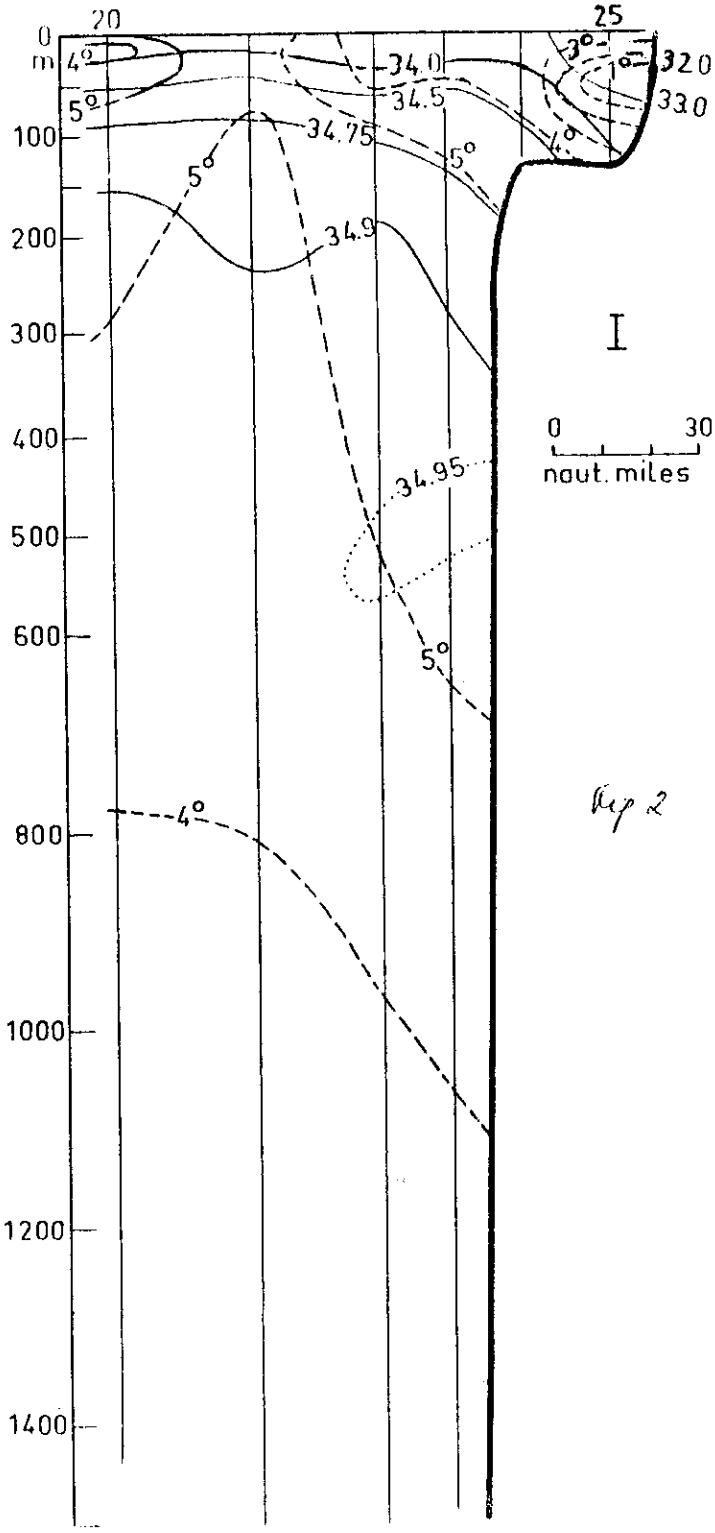


Fig. 2. Temperature and salinity off Frederikshaab (Section I), 8 July 1964.

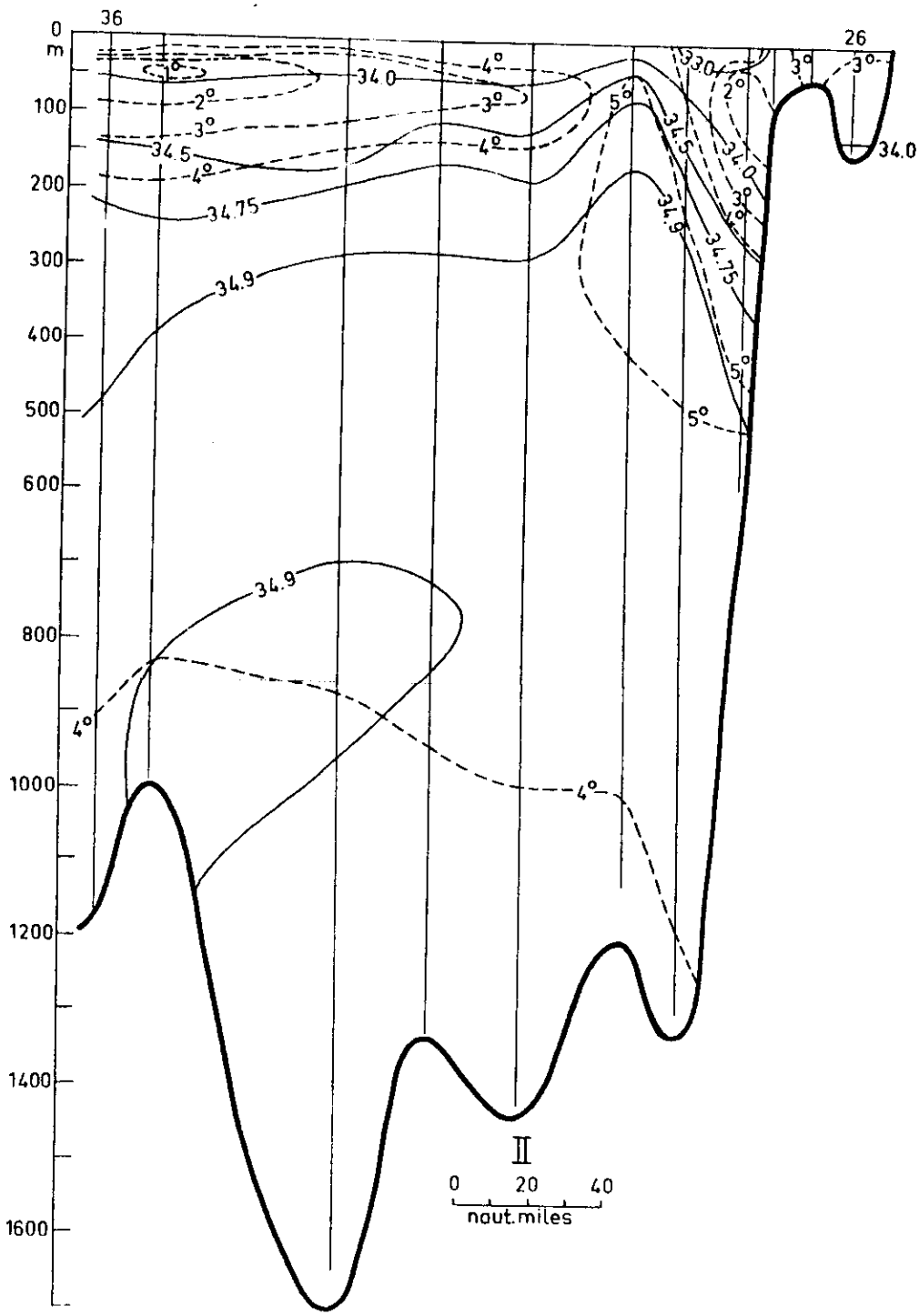


Fig. 3. Temperature and salinity across Fylla Bank (Section II), 13-15 July 1964.

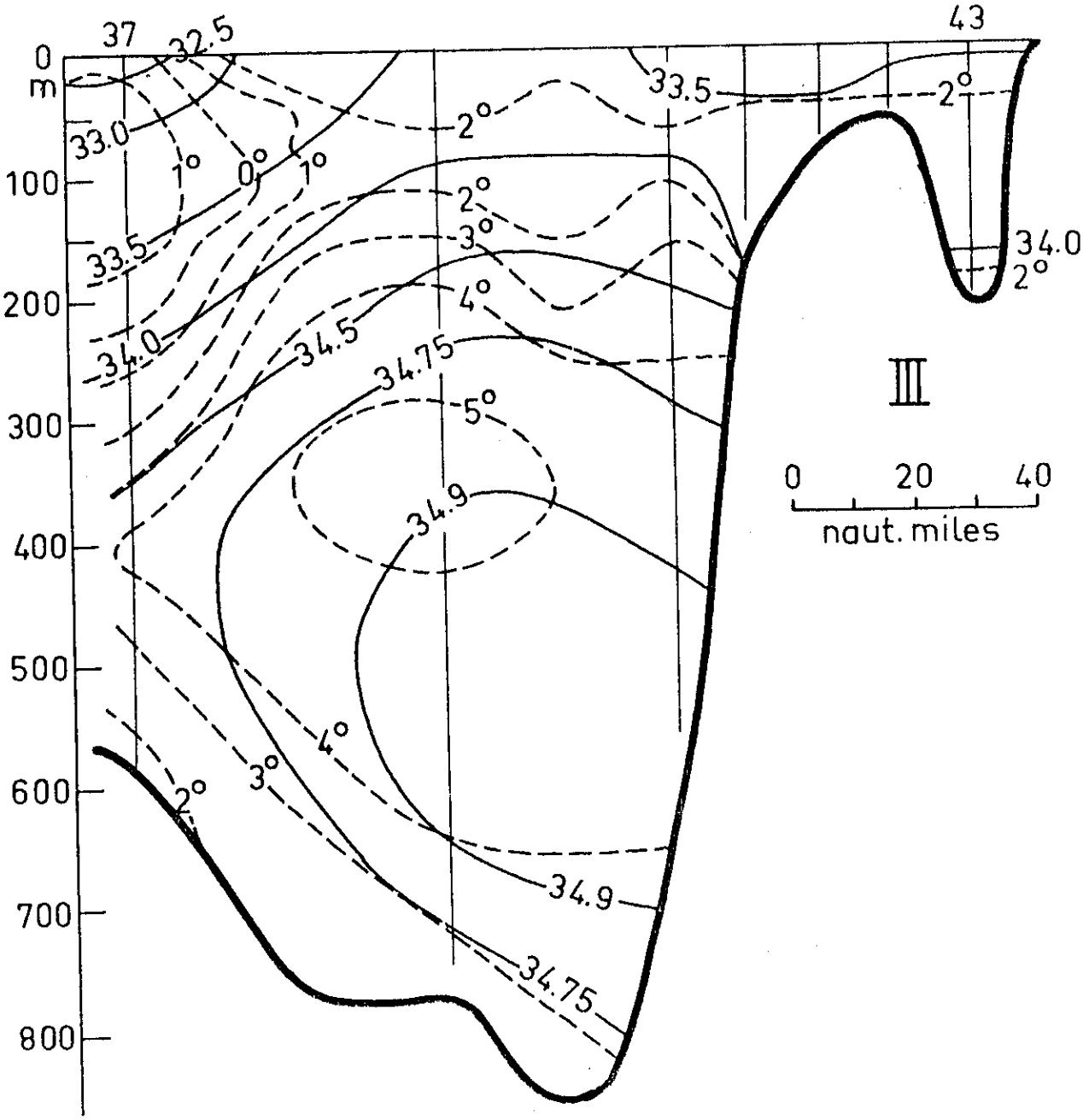


Fig. 4. Temperature and salinity across Lille Hellefiske Bank (Section III) 16-17 July 1964.

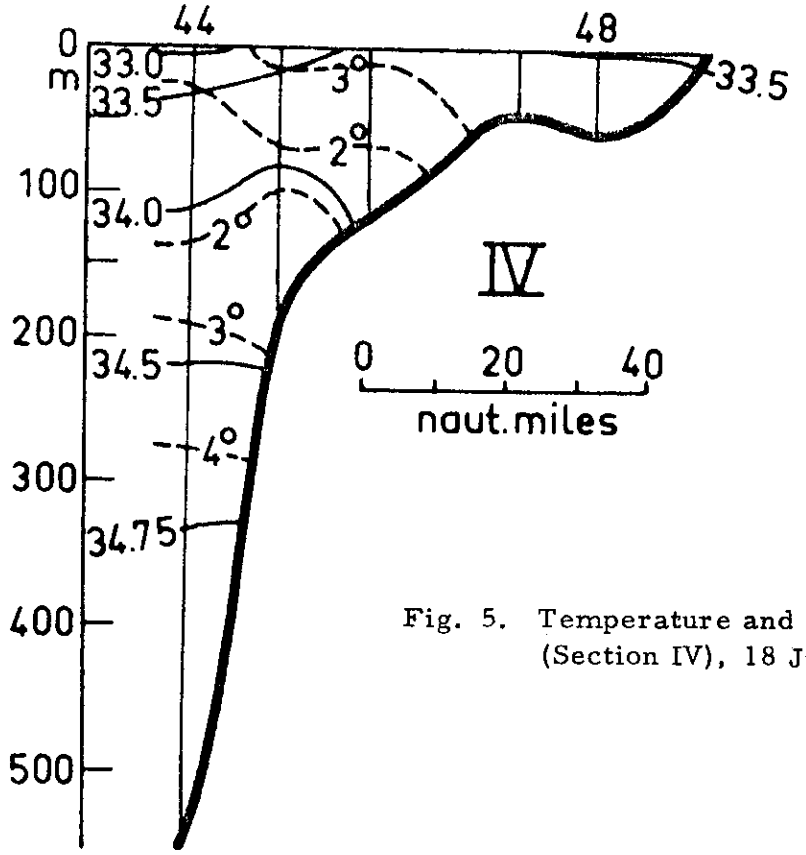


Fig. 5. Temperature and salinity off Holsteinsborg (Section IV), 18 July 1964.

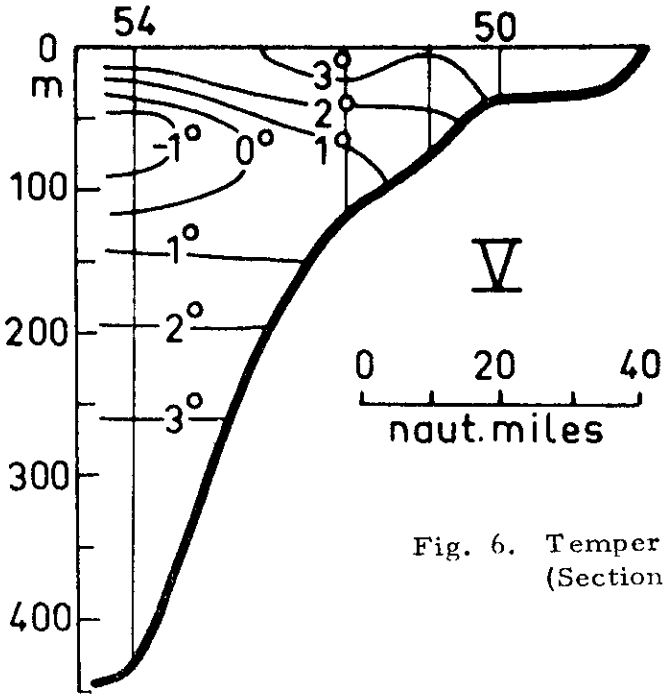


Fig. 6. Temperature and salinity off Egedesminde (Section V), 19-21 July 1964.

Godthaab.

II. Biological Studies of Fish by Species

1. Cod

a. Eggs and larvae (Fig. 7). In Godthaab district and in the Godthaab Fjord hauls with the 1 m stramin net gave better catches of cod eggs and larvae than in previous years. In Davis Strait it was quite different. Very few cod larvae were taken in the 2 m stramin net by R/V Dana in July. The biggest catch was 13 cod larvae caught in the middle of Fylla Bank. A few larvae were caught far east of Fylla Bank between 58° and 60°W. The scarcity of cod fry in 1964 must have been caused by the late warming of the water masses in the Greenland area. Judging from the occurrence of cod larvae in Davis Strait, the 1964 year-class may be expected to be a poor year-class.

b. Occurrence of small cod (age-groups I, II and III). Length distributions of small cod belonging to age-groups I, II and III are given in Fig. 8. Samples 'a', 'b', 'c' and 'd' are from prawn trawl catches while 'e' is from pound net. These samples are from Div. 1D. Samples 'f', 'g', 'h' and 'i' are all from hand seine catches in Div. 1F. The three age-groups are readily distinguished in the graphs by their lengths. Age-group III (1961 year-class) is strong in Div. 1D. In Div. 1F, it is only strong in one sample (h). The distributions of the different age-groups are very different in the different catches in Div. 1F.

c. Age and size of cod in commercial stock. Length measurements and otoliths for age readings have been collected from cod on the banks by the R/V Dana, the M/C Adolf Jensen and the Faroese trawler Skalaberg. Material from inshore waters has been collected by the Adolf Jensen and the M/B Tornaq. Samples have also been taken from the Greenlanders' catches. The distribution of samples is as follows:

	Offshore banks		Inshore waters	
Div.	No. samples	No. specimens	No. samples	No. specimens
1B	2	279	1	214
1C	2	284	1	133
1D	5	809	4	742
1E	2	741	-	-
1F	-	-	7	1,241
Total	11	2,113	13	2,330

The age and length compositions in samples from the banks are given in Fig. 9 and 10. The age compositions in samples from inshore waters are given in Fig. 11. Figure 12 gives a summary of the age compositions of

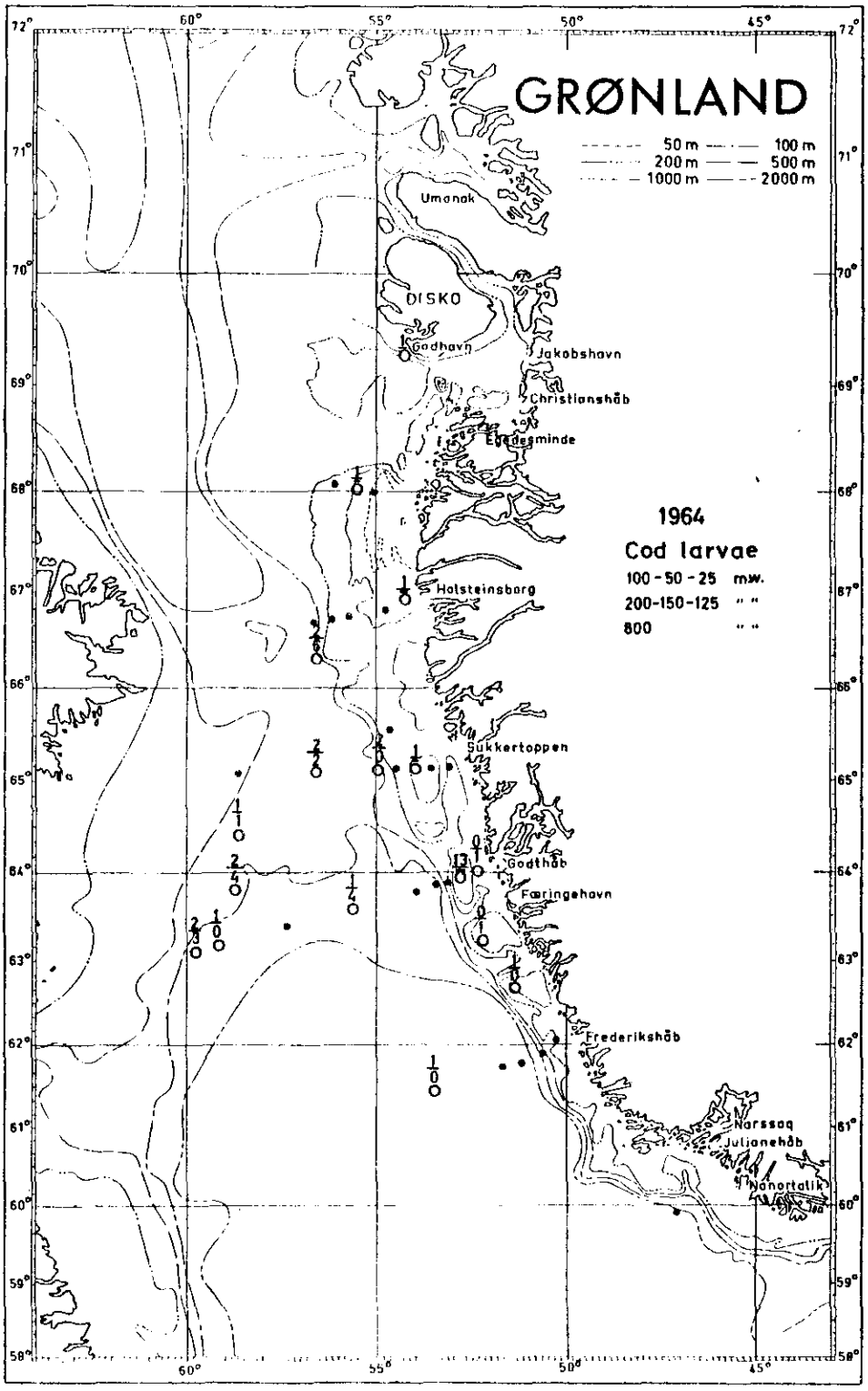


Fig. 7. Cod. West Greenland. Larval distribution, 1964.

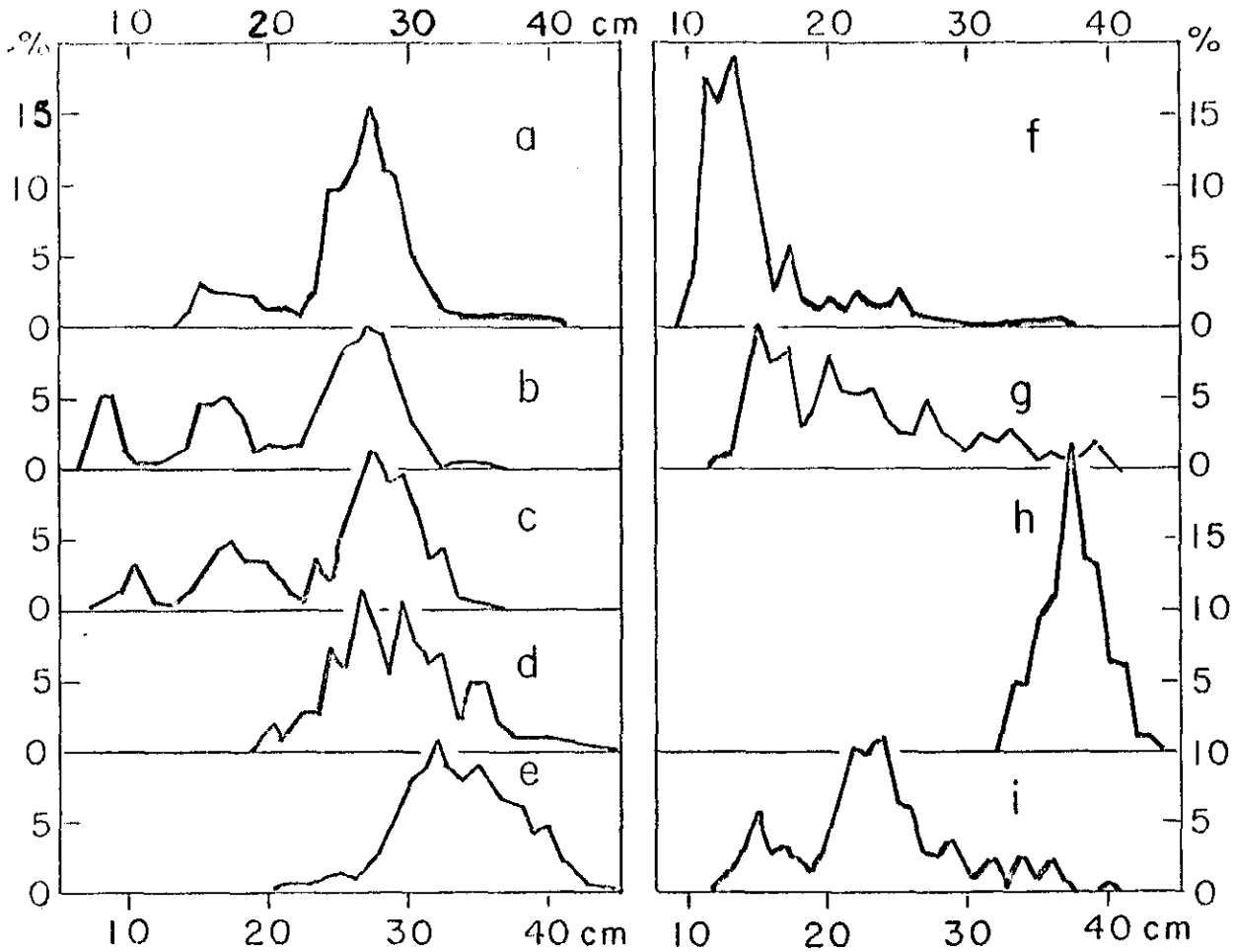


Fig. 8. Cod. West Greenland. Length distribution of age-group I, II and III in inshore waters of Div. 1D and 1F, 1964.

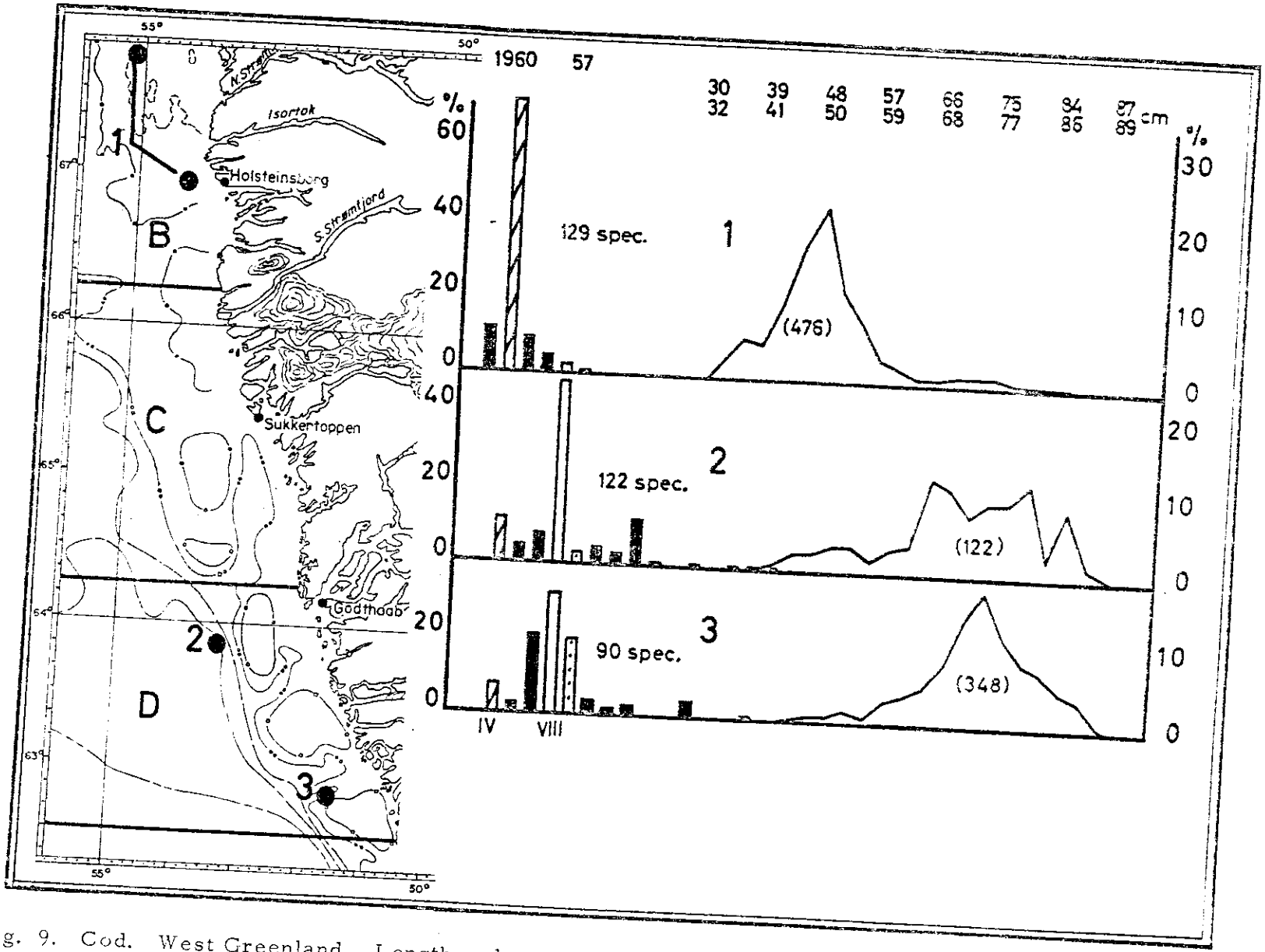


Fig. 9. Cod. West Greenland. Length and age composition in offshore banks in Div. 1B and 1D, 1964.

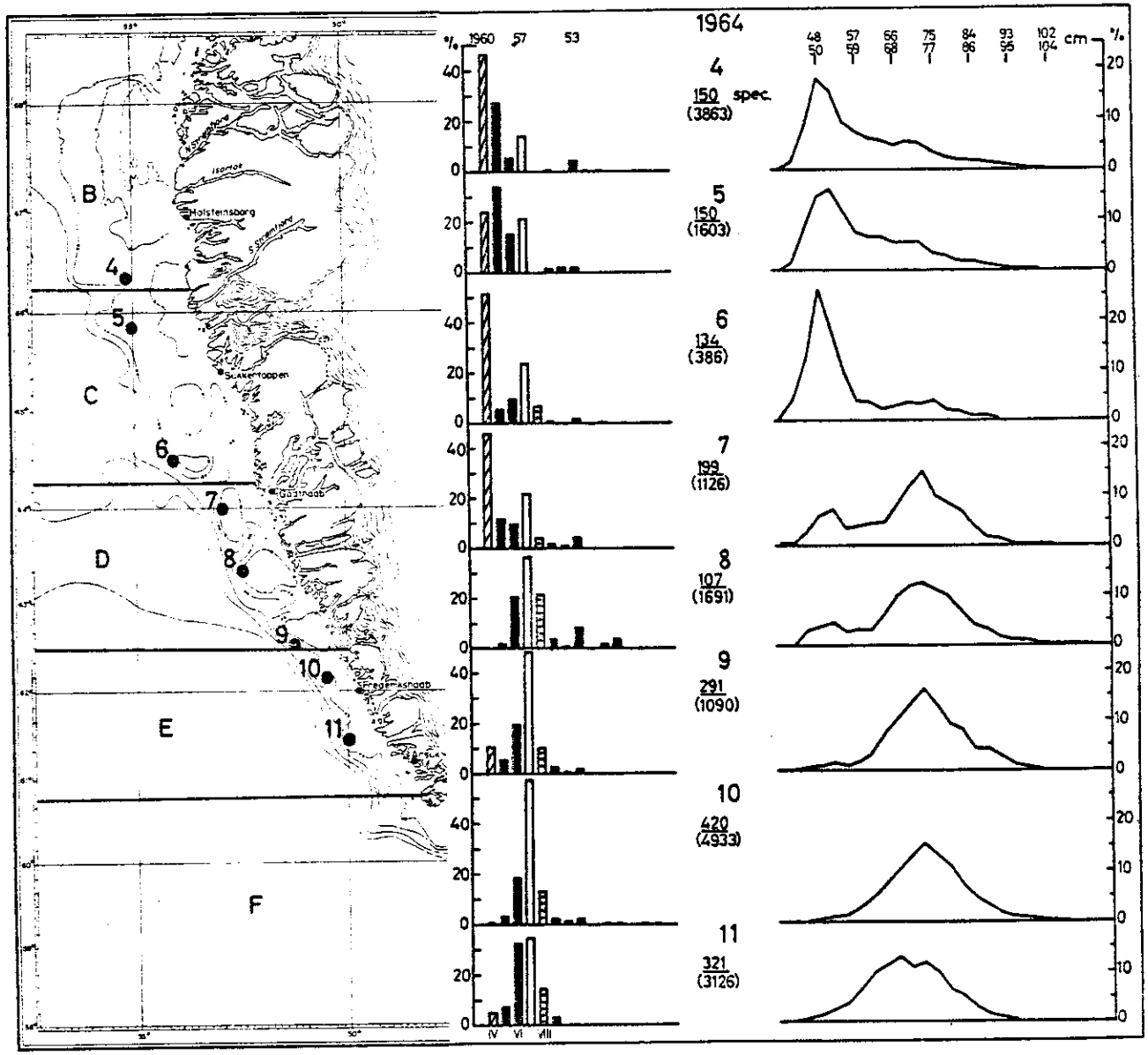


Fig. 10. Cod. West Greenland. Length and age composition on offshore banks in Div. 1B, 1C, 1D and 1E, 1964.

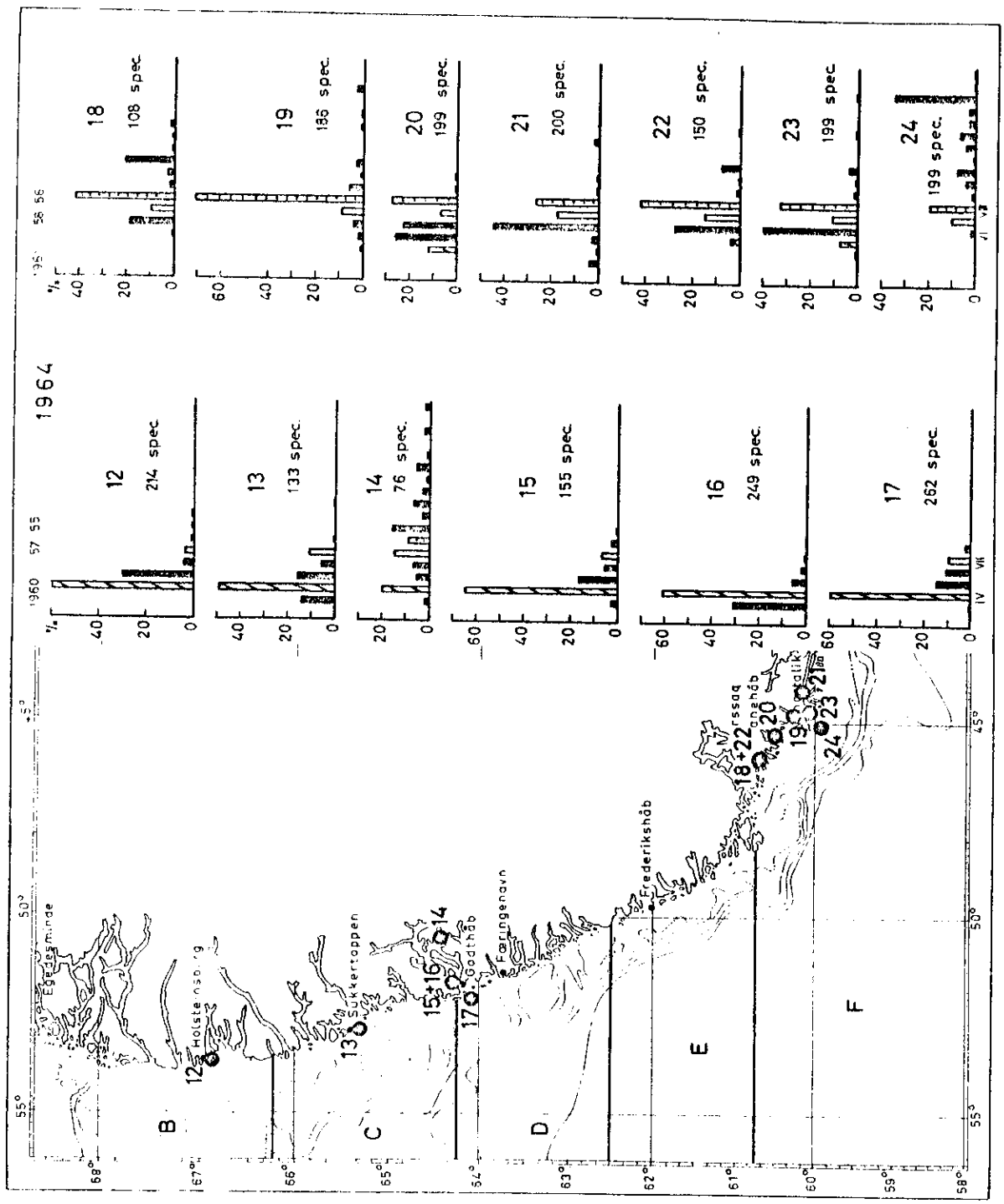


Fig. 11. Cod. West Greenland. Age composition in inshore waters in Div. 1B, 1C, 1D and 1F, 1964.

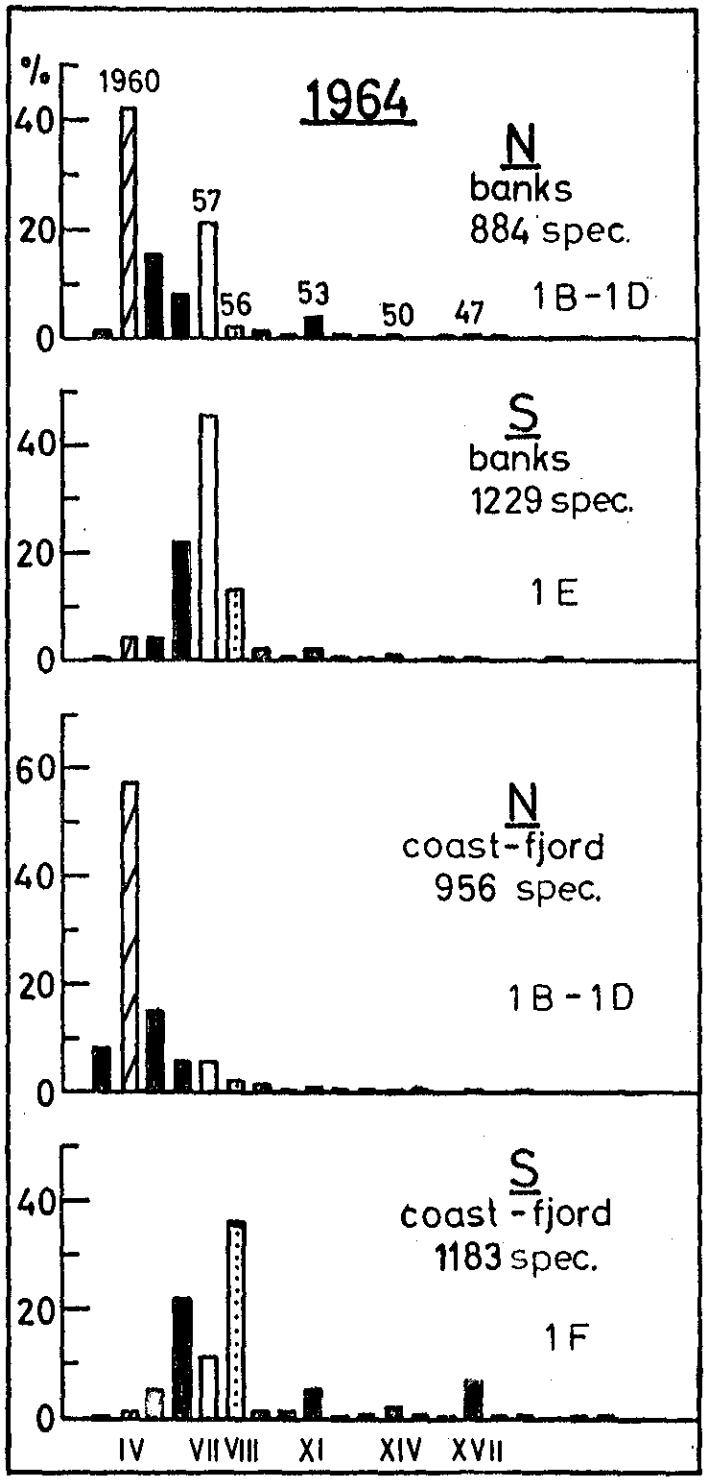


Fig. 12. Cod. West Greenland. Age composition in northern (N) and southern (S) bank and coastal waters, 1964.

all samples from the banks and from inshore waters.

On the northern banks, the dominant 1960 year-class occupies more than 40% of the samples. Also prominent is the 1957 year-class at more than 20%. On the southern banks, the 1957 year-class is the one best represented. In the northern inshore waters, the 1960 year-class is very strong at nearly 60%. In the southern inshore waters, the 1956 year-class predominates at more than 35% while the 1958 year-class is at more than 20%.

It is obvious that small cod belonging to the 1960 year-class (age-group IV) are very common in the northern divisions while bigger cod belonging to the 1956, 1957 and 1958 year-classes are found in the southern divisions. It is not uncommon to find age-group IV predominant in the catches from offshore banks. The 1960 year-class must, therefore, be a very rich year-class.

The rich, old 1953 year-class has almost disappeared from the catches and is of no commercial importance. The same is true for the older and previous rich year-classes. Only in a single sample from Div. 1F was the 1947 year-class (age-group XVII) predominant.

d. Tagging experiments. Cod tagging has been carried out in all divisions except 1A. Taggings by divisions on the offshore banks and inshore waters are given below (numbers in brackets are cod less than 50 cm when tagged).

Division	Offshore banks		Inshore waters	
1B	160	(161)	-	-
1C	88	(23)	-	-
1D	258	-	248	(1410)
1E	-	-	-	(53)
1F	-	-	195	(195)
Total	506	(184)	443	(1976)

A total of 917 recaptures of cod tagged in West and East Greenland waters were reported in 1964. Of this total, 7 cod tagged off East Greenland and 63 tagged off West Greenland were recaptured in Iceland waters. Of the 847 recaptures from Greenland waters, 77 were tagged in 1964 and 770 in previous years.

2. Redfish. Research on the occurrence and growth of small redfish from prawn trawl catches in the inner part of the Godthaab Fjord has been carried out. A total of 5,053 redfish were caught and measured.

A number of redfish (293) caught in pound nets were tagged in May in the Qorqut branch of Godthaab Fjord. Recaptures of 92 redfish from tagging

experiments in previous years were reported. Recaptures, by location and tagging year, are shown below:

Tagging year	1960	1962	1963	1964	Total
Recaptured at Qorqut	11	35	37	3	86
" elsewhere in Godthaab Fjord	-	4	-	-	4
" on offshore banks	-	1	1	-	2
Total	11	40	38	3	92

The 4 recoveries from other places in the Godthaab Fjord were made from 15 to 30 nautical miles from the tagging place.

The 2 recaptures from the offshore banks were both made by Icelandic trawlers. The redfish tagged in 1963 was caught on Fiskenaes Bank on 20 May, 12 months after the tagging. The redfish tagged in 1962 was caught on Frederikshaab Bank on 27 August, 27 months after tagging.

Redfish tagging in the open sea was carried out off Southeast Greenland on the 100 m depth contour. A total of 57 handlined redfish were tagged.

3. Other fish. Tagging experiments have also been carried out with Greenland halibut (82 specimens tagged), spotted wolffish (43 specimens tagged), haddock (12 specimens tagged) and herring (222 specimens tagged).

4. Prawn, Pandalus borealis. Searches for prawn grounds were carried out with success from the Dana and Adolf Jensen. Experiments with different mesh sizes in the trawl fishery for prawn were carried out in Disko Bay. In the same region 3,579 prawns were tagged.

III. German Research Report, 1964

Subarea 1 and East Greenland
by Arno Meyer

A. Status of the Fisheries

1. Cod and Redfish

In 1964 German trawlers again fished off West and East Greenland over the whole year. Since the beginning of the German fishery off Greenland in 1952, the nominal catch has increased steadily to 232,000 tons in 1963. In 1964 the catch dropped for the first time by 17.2% to 192,000 tons. The proportion of cod increased to 67.1% of the total catch, that of redfish decreased to 31.5%, the lowest value to date.

Table 1. German nominal catches (in tons) off Greenland, 1962-1964. Average annual catch per fishing day in brackets.

		Cod	Redfish	Total
West Greenland	1962	126,640 (19.2)	54,900 (8.3)	185,386 (28.2)
(Subarea 1)	1963	139,283 (19.4)	42,292 (5.9)	185,492 (25.9)
	1964	99,614 (17.7)	20,662 (3.7)	122,754 (21.8)
East Greenland	1962	14,246 (8.6)	24,720 (14.9)	40,495 (24.4)
	1963	13,614 (6.2)	30,916 (14.2)	46,646 (21.4)
	1964	29,352 (8.9)	37,294 (11.3)	69,575 (21.2)
Total	1962	140,886 (17.1)	79,619 (9.7)	225,881 (27.4)
Greenland	1963	152,898 (16.3)	73,203 (7.8)	232,146 (24.8)
	1964	128,966 (14.4)	57,956 (6.5)	192,329 (21.5)

Table 1 shows that the decrease in catch in 1964 was caused by a considerable drop of 63,000 tons or 33.9% in the output of the fishery off West Greenland. Never did fishing in Subarea 1 give such poor results as in 1964. Therefore the fishing activity off East Greenland increased. Several factory ships worked off East Greenland for the first time and catches there increased by 49.2% to nearly 70,000 tons. This increase of 23,000 tons in total catch was caused by a big increase in the catch of cod during the spawning period of 116% to 29,350 tons. This is the highest output to date from the cod fishery off East Greenland.

Table 1 and Fig. 1 also show that the poor catches off West Greenland were the result of a further drop in the annual catch of redfish per fishing day.

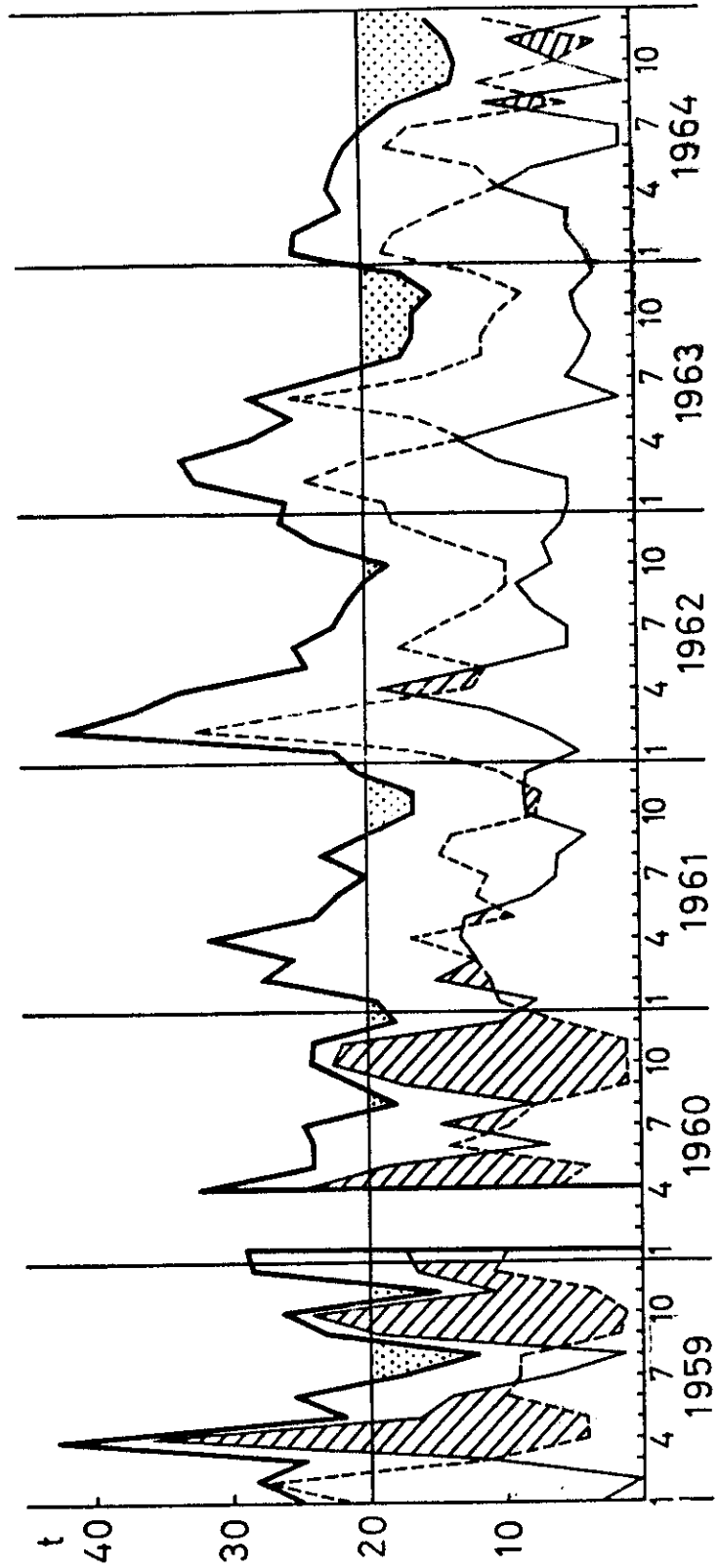


Fig. 1. Average monthly catch per fishing day of German trawlers in Subarea 1 in tons from 1959 to 1964. Thick solid line = total catch; broken line = cod; thin solid line = redfish; hatched section = redfish catches exceeding cod catches; dotted area = monthly catch per fishing day less than 20 tons.

During the last six years the catch per fishing day steadily decreased from 12.5 tons to 3.7 tons. From 1959 to 1964, the proportion of redfish taken in the total catch dropped from 55% to 16%. The stock of redfish off West Greenland has become so reduced that this fish which, up to 1960, was of the greatest commercial importance for the German fishery off West Greenland now is only a by-catch.

The broken line in Fig. 1 shows that, generally, in each year the curve of the monthly catch per fishing day shows two maxima, the first in February to April and the second in June to July. However, in the winter of 1963-64, the monthly catch per fishing day reached its first maximum in January and then it dropped steadily. The expected increase in catch during the spawning period failed to appear. Instead the cod spawning season off Southeast and East Greenland from March to May gave the biggest output of the hitherto existing fishery off East Greenland. The cod fishery off Southeast Greenland has never been so highly productive.

In spite of the increased yield of cod the redfish was the most important fish in the East Greenland fishery. But the proportion of redfish has dropped from 89% of the total catch from the beginning of the fishery in 1955 to 54% in 1964. Because, since 1962, the last possible redfish grounds off Cape Discord and Cape Walloe have been fished, we must assume that in future the redfish catches off East Greenland will continue to decrease. Already the annual catch per fishing day has decreased from 14.9 tons to 11.3 tons from 1962 to 1964. The decrease was, of course, most pronounced on the banks off Southeast Greenland where the catch per fishing day diminished from 23.1 tons in 1962 to 15.0 tons in 1964.

Results of age determinations of fish from commercial catches (Fig. 2) and from research catches made during three trips of the R/Vs Walther Herwig and Anton Dohrn (Fig. 3) throw some light on the special fishery conditions in 1964. In 1964, as in the two preceding years, the two strong year-classes 1957 (of West Greenland origin) and 1956 (of East Greenland origin) were of essential importance for the output of the cod fishery on both sides of Greenland. All older rich year-classes have become very weak. Among the younger year-classes, the 1958 one reached growing importance especially in Div. 1EF. From the southern distribution of this year-class we must assume that these cod were born off East Greenland. This is also true for the rich 1961 year-class (Fig. 3). Since the second half of 1964 the rich, young West Greenland 1960 year-class has entered the fishery. Because of the poor fishing conditions in autumn, this year-class was heavily fished. In November, 46% (by numbers) of the landings from Holsteinsborg Deep consisted of cod of 4 years of age and younger. This does not include all those small cod which were discarded or turned into fishmeal. In the last quarter of 1964, 17% (by weight) of the gross catch of cod in the mentioned area were, according to reports from sea, discards or industrial fish! This intensive fishery on

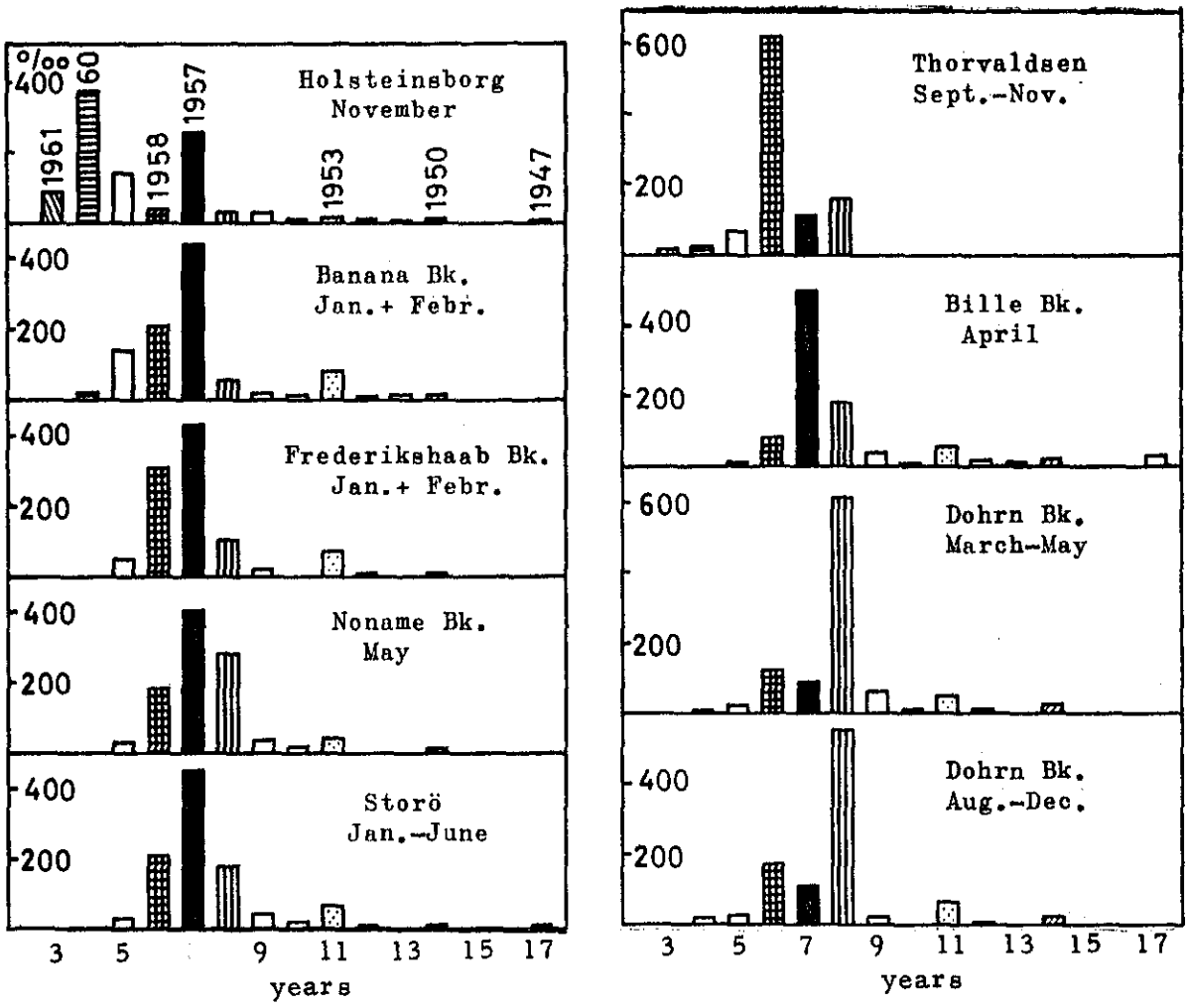


Fig. 2. Cod. Age composition of commercial catches in 1964

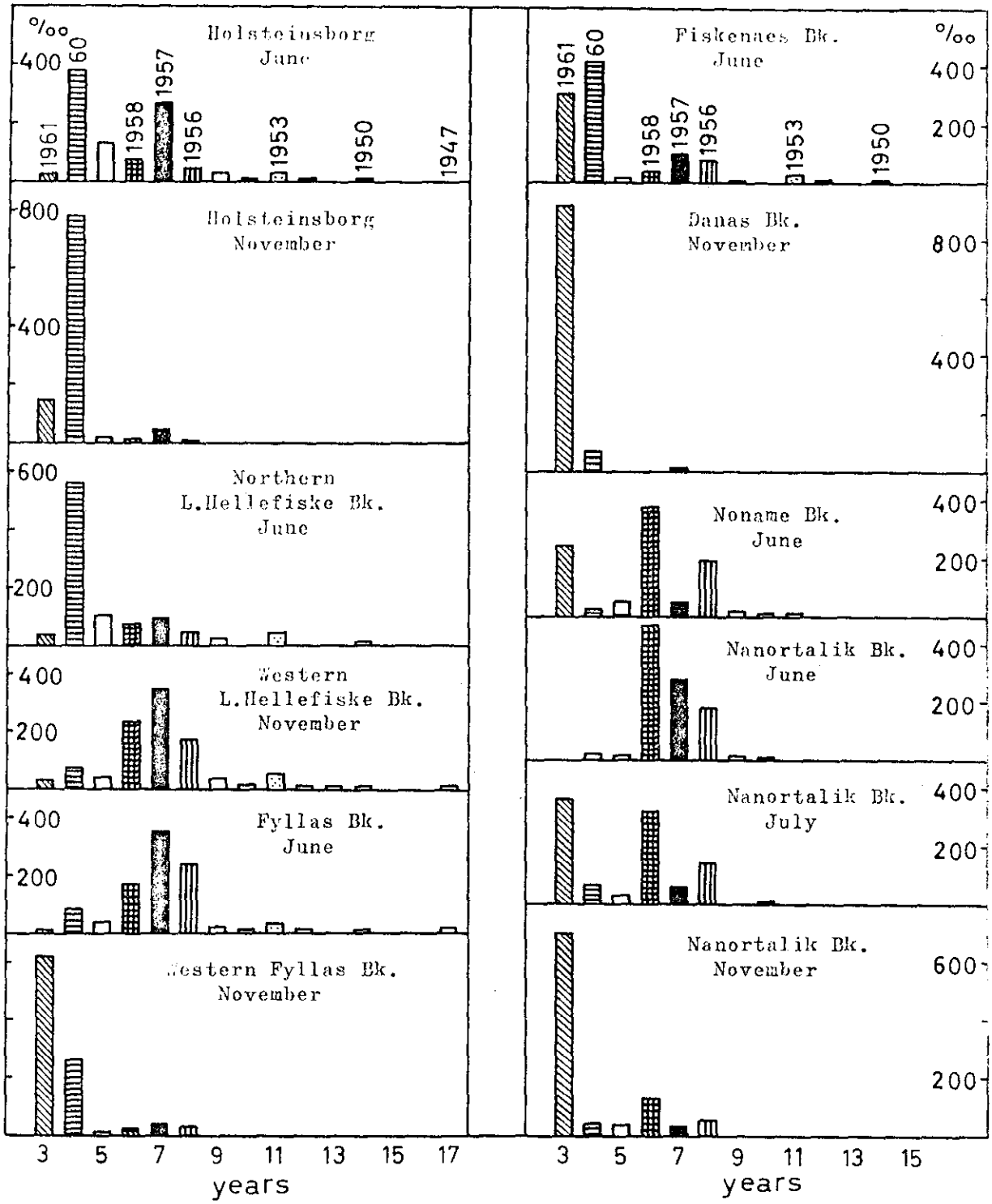


Fig. 3. Cod. Age composition of research catches in 1964

grounds where the young cod are living (fostered by the installation of additional filleting machines for the utilization of small cod on board factory ships and by the equipping of nearly all modern trawlers with fishmeal plants) must have big consequences for the future fishery. This is neither a specific problem of the fishery off West Greenland nor a problem of the German fishery with factory ships but holds good for the whole international fleet of factory ships and trawlers with fishmeal plants in the whole ICNAF area, especially when, in the second half of the year, this international fleet works those areas where the young immature cod are growing up.

It is interesting to trace the spawning migration of the 1957 and 1956 year-classes. We expected that the 1957 year-class would again spawn off Southwest Greenland and that the 1956 year-class, grown up off Southwest Greenland (and as an East Greenland year-class spawning for the first time mostly at 8 years of age) would migrate from Southwest to Southeast and East Greenland to spawn. As seen from the decreasing percentage of the 1956 year-class in the commercial catches off South Greenland from November 1963 to March 1964 (Table 2), the 8-year-old cod left South Greenland for Southeast Greenland. Later they also left Southeast Greenland (Table 3, drop from 55% in January to 12% in April) and their proportion in the catches reached 76% in February off Angmagssalik (35°W) and 54 to 65% on Dohrn Bank (30°W) from the end of February to the beginning of May. While the 8-year-old cod passed the Southeast Greenland area on their way to Angmagssalik, Dohrn Bank and probably Iceland, they were followed by an increasing number of 7-year-old cod (Table 3). When in April on the banks of Southeast Greenland, mainly on Bille and Fylkir Bank, spawning reached its maximum and the monthly catch of cod per fishing day increased to 18.0 tons (the ice and the bad bottom conditions only allow fishing during the short daylight), the 1957 year-class made up more than 60% in these catches.

Table 2. Variation in the percentage of the 1957 and 1956 year-classes in the commercial catches off South Greenland to show emigration of the 1956 year-class and return after spawning.

Date / Year-class	6 Nov. 1963	15 Jan. 1964	26 Feb. 1964	20 Mar. 1964	15 Apr. 1964	21 June 1964
1957	12	34	55	55	42	40
1956	64	34	13	6	16	28

Table 3. Variation in the percentage of the 1957 and 1956 year-classes in the commercial catches off Southeast Greenland to show immigration of the 1957 year-class from South Greenland and emigration of the 1956 year-class to Dohrn Bank and Iceland.

Date / Year-class	23 Sept. 1963	11 Oct. 1963	11 Jan. 1964	5 Mar. 1964	20 Mar. 1964	8 Apr. 1964
1957	16	13	20	38	52	60
1956	40	43	55	31	24	12

From these findings we must conclude that, in 1964, not only the East Greenland 1956 year-class left the Southwest Greenland area but a substantial part of the West Greenland 1957 year-class left also. We may further assume that this emigration of mature cod caused (a) the low first maximum in the 1964 West Greenland yield curve (Fig. 1), (b) the unusual decrease in the monthly catch of cod per fishing day from February to April in Subarea 1; (c) the strong increase in the output of the fishery for spawning cod on the banks of East Greenland and (d) probably a considerable strengthening of the Icelandic stock of spawning cod.

Return of 12 cod tagged off West Greenland and recaptured mainly during the 1964 spawning season off Southeast Greenland (2 cod, born in 1956 and 1957), East Greenland (2 cod, 1 with otolith = 1957 year-class) and Iceland (8 cod, 3 with otoliths = 1956 year-class) endorse these findings.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. The R/V Walther Herwig worked off West, South and Southeast Greenland in June-July and November. The warm Atlantic component of the West Greenland current was very well developed and was lying close to the slope (Fig. 4-7). The temperatures were very high, higher than in the warm year of 1960 and thus probably the highest found to date off West Greenland. On 27 June temperatures over 5°C were found on the western slope of Fyllas Bank from 180 to 340 m with a maximum of 5.2°C at 200 m. On Noname Bank water of more than 5°C covered the slope from 130 to 470 m. Off Holsteinsborg on 23 June temperatures higher than 4°C were found below 320 m with a maximum of 4.66°C at 490 m.

During the first half of November, the temperature close to the slope was more than 7°C!. At the slope, temperatures of more than 6°C were found

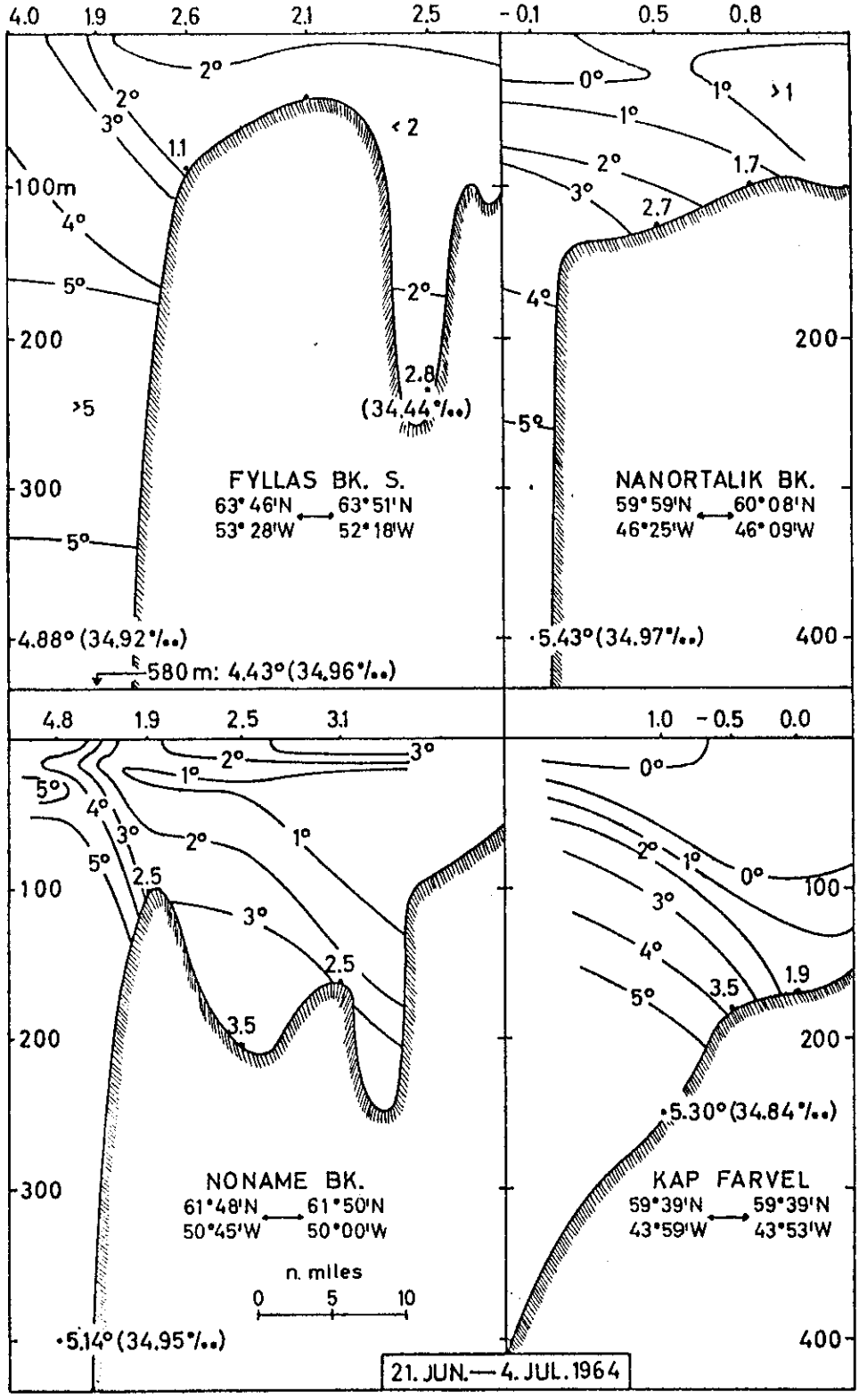


Fig. 4. Hydrographic sections off West Greenland, June-July 1964.

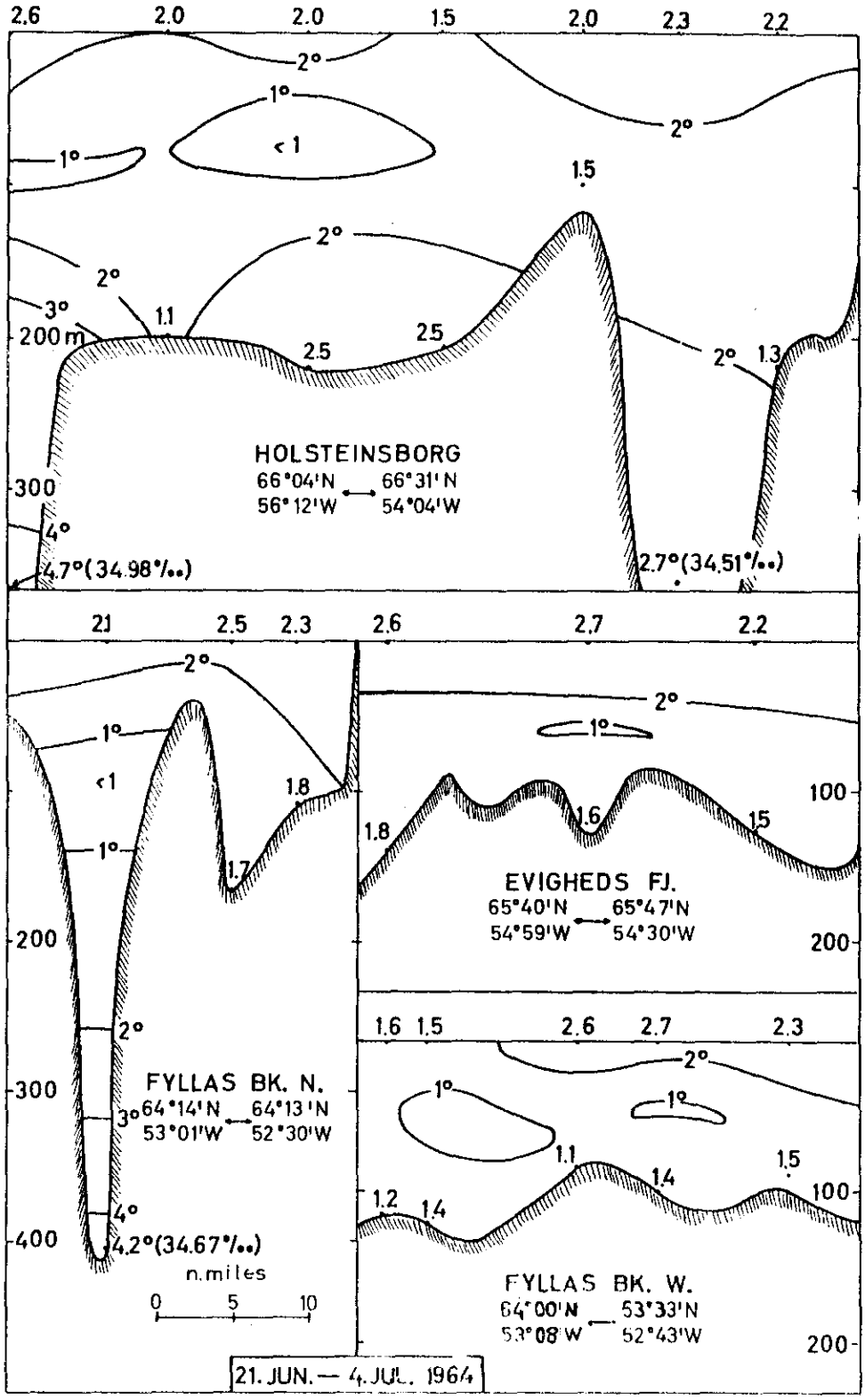


Fig. 5. Hydrographic sections off West Greenland, June-July 1964.

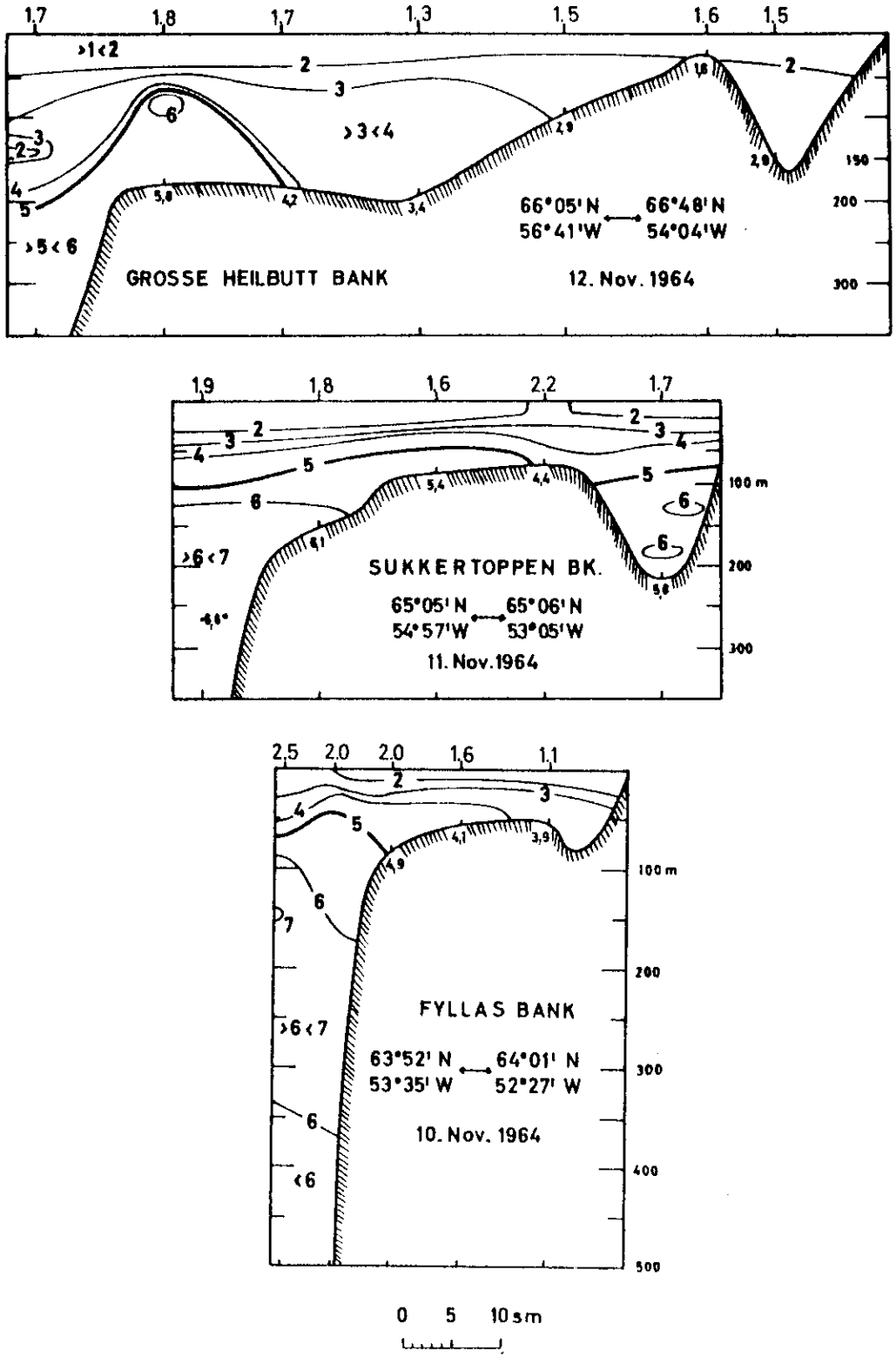


Fig. 6. Hydrographic sections off West Greenland, November 1964.

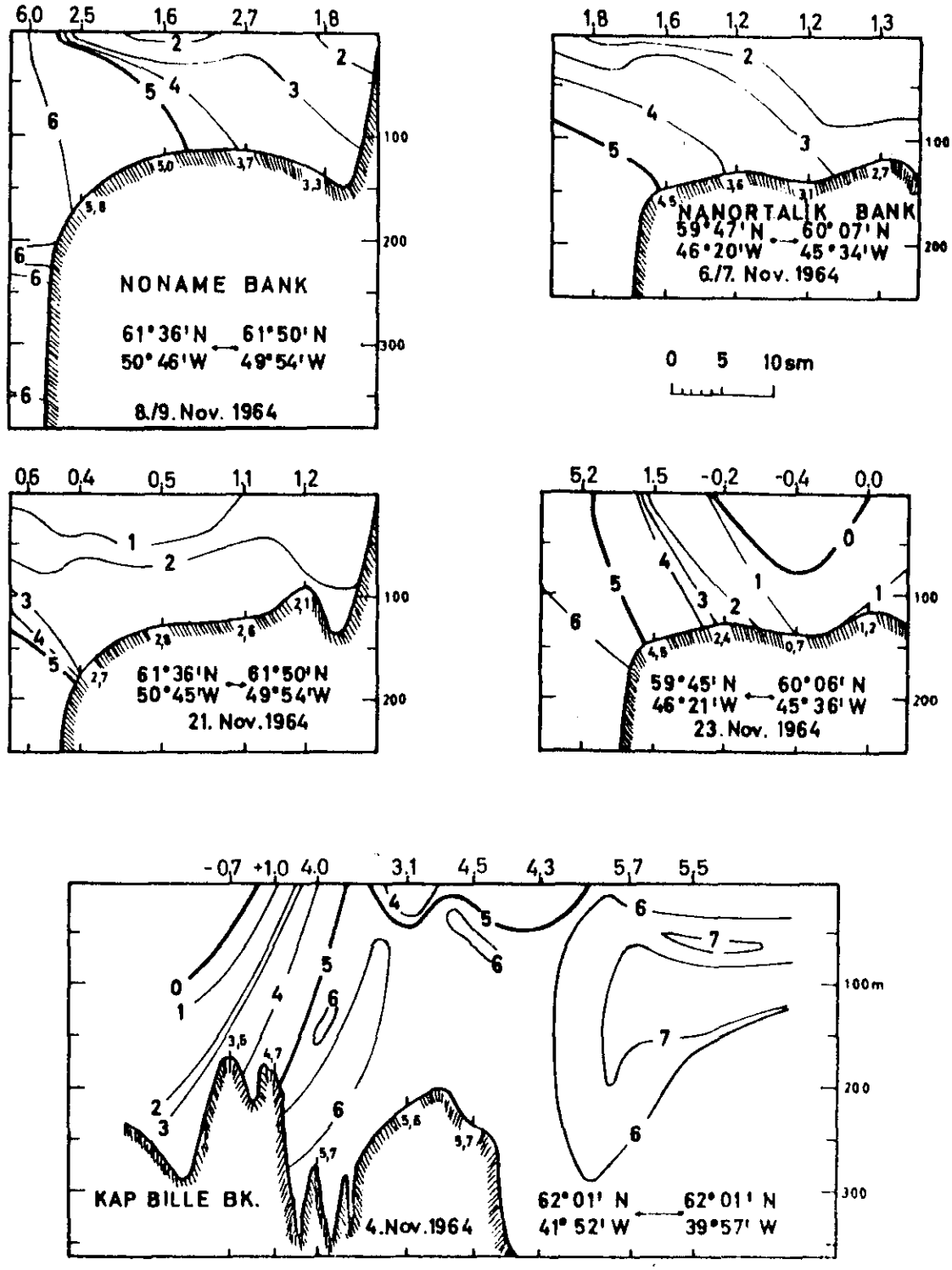


Fig. 7. Hydrographic sections off West and Southeast Greenland, November 1964.

in 170-370 m. The western part and the slope of the southern Great Halibut Bank was covered with water of nearly 6°C. Water of 6°C nearly reached 67°N. Concentrations of mature cod were found on the eastern side of the Sukkertoppen Bank in 250 m in 6.2°C bottom temperature, whilst the young cod concentrated off Holsteinsborg in water of about 5°C.

The cold Arctic component of the West Greenland current was very weak and was found in June-July only over the banks and not on the slope. Minus temperatures down to -0.99°C at 50 m were met only off Cape Farewell. On Noname Bank lowest temperatures were +0.59°C in 24 m. On the bottom of the West Greenland banks temperatures ranged mostly between 1 and 2°C. The surface temperatures over the banks were relatively low at the end of June.

Concentrations of cod were only found off Sermersok (South Greenland) in 2° to 4°C. On the northern banks, cod were scattered and feeding pelagically, mostly on krill, Mallotus and Ammodytes in temperatures of 1.1° to 1.5°C. On the southwestern banks, pelagic traces were found in 3° to 4°C consisting of Mallotus, Ammodytes and squid with some cod and wolffish among them.

In November, the sections over Noname Bank and Nanortalik Bank were worked twice (Fig. 7). At the end of November very cold waters with temperatures down to -0.48°C was advancing northward.

II. Biological Studies

1. Cod. In 1964, 765 cod were tagged off West and East Greenland. From a total of 2,932 taggings from 1959 to 1964, 200 recoveries (6.8%) were reported to March 1965. The recaptures off East Greenland and Iceland were more numerous in 1964 than in the preceding years. To the present, 49 cod were recaptured off East Greenland and Iceland, mostly off Iceland. A special paper of the results of German cod tagging in the Greenland area was prepared for assessment, at the 15th Annual Meeting, of the magnitude of interchange of cod stocks between Subarea 1 and East Greenland and Iceland (1965 Research Document No. 23).

Subarea 2
by J. Messtorff

A. Status of the Fisheries

I. Cod and Redfish

In comparison to the preceding year (1963) an increase in fishing activity and landings of German trawlers was recorded in Subarea 2 in 1964. This was apparently due to the unstable fishing conditions in Greenland waters. But nevertheless, the total landings from Labrador reached only about 6% of

those from Greenland. The landings in metric tons are given below:

MONTH	APR.	JULY		AUG.	SEPT.	OCT.		NOV.			DEC.	1963
DIV.	2J	2J	2H	2J	2J	2J	2H	2J	2H	2G	2J	TOTAL
COD	709	74	81	127	187	1,090	64	55	31	2	39	2,459
REDFISH	28	40	44	676	873	898	714	281	356	19	320	4,249
OTHER FISH	83	14	16	143	214	503	142	66	89	6	102	1,378
TOTAL	820	128	141	946	1,274	2,491	920	402	476	27	461	8,086
TRIPS	1	*	1	2	2	3	2	1	1	*	1	14
FISHING DAYS	39	8	8	57	69	136	62	34	30	6	46	495

* PART OF ONE TRIP TO ANOTHER SUBAREA OR DIVISION

While the quantities of cod and redfish landed in 1963 were almost the same, the increase of the 1964 landings was not equal for both species. Redfish catches amounted to 53% and cod catches to only 30% of the total landings. Most catches were taken from Div. 2J (93% of cod and 73% of redfish landings). Most fishing days (64%) were recorded during August, September and October and also 69% of the total catch was made during this period. The mean catch per fishing day decreased for cod from 10 tons (1963) to about 5 tons (1964) and for redfish from 10 tons to 8.6 tons.

B. Special Research Studies

The entire landings were processed and deep-frozen at sea. Accordingly, no market samples could be taken. Special field work was not carried out in the subarea.

Subarea 3
by J. Messtorff

A. Status of the Fisheries

I. Cod and Redfish

As a result of increased fishing activity in 1964, total landings doubled from the quantity taken in 1963. The landings in metric tons are given below:

MONTH	MAY		JULY		AUG.		SEPT.		OCT.		NOV.	DEC.	1964
DIV.	3K	3L	3K	3L	3K	3M	3K	3M	3K	3L	3K	3K	TOTAL
COD	266	242	23	195	164	240	580	50	60	34	30	6	1,890
REDFISH	137	-	42	4	352	89	1,027	15	213	24	349	80	2,332
OTHER FISH	47	28	5	38	64	35	238	9	39	21	68	20	612
TOTAL	450	270	70	237	580	364	1,845	74	312	79	447	106	4,834
TRIPS	1	*	*	1	1	1	3	*	1	*	1	*	9
FISHING DAYS	20	7	7	9	39	14	106	3	27	4	36	10	282

* PART OF ONE TRIP TO ANOTHER SUBAREA OR DIVISION

On the whole, however, fishing of German trawlers was comparatively unimportant. Only 9 trips which were distributed over 7 months were made to

Subarea 3. The trawlers fished mostly in Div. 3K, where they spent 87% of the fishing days and caught 79% of the total landings of the subarea (60% of cod - and 95% of redfish landings). The composition of the total German landings from Subarea 3 was 39% cod and 48% redfish in 1964 against 59% cod and 27% redfish in 1963. The mean catch per fishing day decreased for cod from 13 tons (1963) to 7 tons (1964) and increased for redfish from 6 tons to 8 tons.

B. Special Research Studies

None were carried out for the same reasons mentioned for Subarea 2.

Subareas 4 and 5
by J. Messtorff

A. Status of the Fisheries

I. Haddock

Fishing, mainly for haddock, was carried out off Nova Scotia during 4 trips. The landings in metric tons are given below:

Month	Apr.	May	Oct.	1964
Div.	4W(+4V,4X,5Z)	4W	4X(+4W,4V)	Total
Haddock	607	953	110	1,670
Cod	230	278	241	749
Pollock	55	229	70	354
Redfish	-	-	52	52
Other fish	99	160	70	329
Total	991	1,620	543	3,154
Trips	1	2	1	4
Fishing days	53	94	31	178

On the first trip in April, fishing operations were extended over several divisions (including northeastern edge of Georges Bank, 5Z) but the main catches were taken from 4W. The proportion of haddock in the landings was 62% (cod 22%, pollock 6%). The haddock catch per fishing day was 11.5 tons against 16 tons in April 1963.

Two trips in May were restricted to Div. 4W and the landings consisted of 69% haddock, 17% cod and 14% pollock. The haddock catch per fishing day amounted to 10 tons which was the same as in May 1963. On the last trip in October 1964 fishing conditions were unsatisfactory for haddock. The catch per fishing day was only 3.5 tons and only 22% of the total catch consisted of haddock (cod 44%, pollock 13%, redfish 10%).

B. Special Research Studies

None was carried out for the same reasons mentioned for Subarea 2.

IV. Icelandic Research Report, 1964

by Jón Jónsson

Subareas 2, 3 and East Greenland

The M/T Thorsteinn Thorskabitur was chartered for work in the Newfoundland area from 5-25 July. During the period 15-26 June and 1-16 September, it worked in the East Greenland area. From the Newfoundland area, otoliths were collected from 617 redfish and the size and maturity of 2,139 redfish were recorded. From the East Greenland area, 1,043 redfish otoliths were collected and 2,600 redfish examined for sexual maturity. From the Newfoundland area, 586 cod otoliths were collected. In the East Greenland area, 1,074 cod otoliths were collected and 202 cod were tagged. Some hydrographic and plankton work was also carried out in the expeditions mentioned.

A. Status of the Fisheries

In 1964, the total number of hours fished by Icelandic trawlers in the ICNAF area was 4,580 compared to 4,480 in 1963. The fishing effort and the catch of cod and redfish in the various ICNAF divisions is listed in Table 1.

Table 1. Fishing effort and catch of cod and redfish by Icelandic trawlers in the ICNAF area in 1964.

	Hours fished	Redfish		Cod	
		Catch	(tons/100 hr)	Catch	(tons/100 hr)
Subarea 1					
Div. 1B	109	194	178	7	6
" 1D	1,038	1,015	98	1,563	151
" 1E	747	613	82	1,144	153
" 1F	420	134	32	377	90
Total	2,314	1,954	84	3,091	134
Subarea 2					
Div. 2J	111	379	341	114	103
Subarea 3					
Div. 3K	954	1,993	209	348	36
" 3L	114	3	3	40	35
" 3M	50	2	4	15	30
" 3P	591	-	-	484	82
Total	1,709	1,999	117	887	52
Subarea 4					
Div. 4W	337	9	3	171	51
" 4X	109	-	-	11	100
Total	446	9	2	182	41
Total ICNAF area	4,580	4,341	95	4,274	93

I. Redfish

The total catch of redfish amounted to 4,341 tons compared to 6,633 tons in 1963. The main redfish fishery, as in previous years, was carried out in Div. 3K where there was a slight decline in catch per unit effort as compared to 1963. The second most important division is 1D; here, too, a drop in the catch per unit effort occurred. For the ICNAF area as a whole, there was a drop from 148 tons per 100 hours fishing in 1963 to 95 tons per 100 hours in 1964.

II. Cod

The main cod fishery was carried out in Subarea 1 and especially in Div. 1DE. The catch/100 hours in both divisions was rather similar but there was a marked drop in 1E compared to the previous year.

Unfortunately no samples could be secured from West Greenland but 10 samples were taken from the East Greenland area in June and September. The June samples which were from Dohrn Bank and the Angmagssalik area show a clear dominance of the 1956, 1957 and 1958 year-classes which were also abundant in the Icelandic spawning stock the same year. The September samples showed more or less the same year-classes but the 1961 year-class is also found in quantities in some of them. This year-class also seems to be dominant in the Icelandic stock of cod; it has been found in research vessel catches and also in the Danish seine fishery in 1964. Two samples of cod were taken from Div. 3K in July and are mostly composed of 5-, 6-, 7- and 8-year-old fish. Another two samples were taken in Div. 2J in the same month and they show a rather similar picture.

V. Norwegian Research Report, 1964

by Erling Bratberg

Subarea 1

A. Status of the Fisheries

I. Cod

From 11 April-6 May 1964, fishing experiments were carried out by the Norwegian R/V Johan Hjort off West Greenland and on the northern part of the Noname Bank-Banan Bank area (Fig. 1). Both trawl and bottom longline were used. Cod were present on all the banks in the investigated area but pelagic shoals were not recorded.

The mean length of the cod varied considerably in the catches and from one bank to another. On bottom longline both the smallest and largest cod were taken on Noname Bank. In three catches the mean lengths were 62.6, 70.6 and 79.4 cm respectively. Fish of 79.4 cm mean length were taken by halibut longline, using hooks No. 2 and 4, the others by cod bottom longline, using hook No. 6; the variation in mean length may be due partly to the different selection of the hook sizes. In two bottom longline catches on Dana Bank, the mean length was 73.6 cm, in one catch on Fiskenaes Bank 68.8 cm. In four catches on Fylla Bank, the mean lengths were 65.5, 66.2, 67.2 and 70.2 cm respectively. In trawl catches on Banan Bank the mean length was 56.4 cm, on Fylla Bank 65.7 cm. In trawl catches (Fig. 2), the overall mean length was 63.6 cm; compared with 1963 (62.6 cm), a slight increase has taken place. In the bottom longline catches (Fig. 3), the overall mean length is 69.5 cm, a marked increase as compared with 1963 (66.4 cm).

In the total bottom longline catch (Fig. 4), the 1957 year-class still dominates, but decreased in importance from about 45% in 1963 to 32.2% in 1964. The 1956 and the 1953 year-classes are also of some importance, together constituting 12.9% of the total catch. The proportion of cod 7 or more years old increased considerably in the total bottom longline catch, from about 29% in 1963 to 54.7% in 1964.

In the total trawl catch (Fig. 5), the 1957 year-class diminished from 50.2% in 1963 to 16.6% in 1964; but fish 7 years or older increased from about 16% in 1963 to 30.6% in 1964.

If the age data are representative of the West Greenland cod population, a further decrease of the 1957 year-class is to be expected. The 1958 year-class will probably also decrease in importance as this year-class increased only slightly in the total bottom longline catch from 1963 to 1964 and decreased in the total trawl catch. The year-classes 1959, and especially 1960, seem

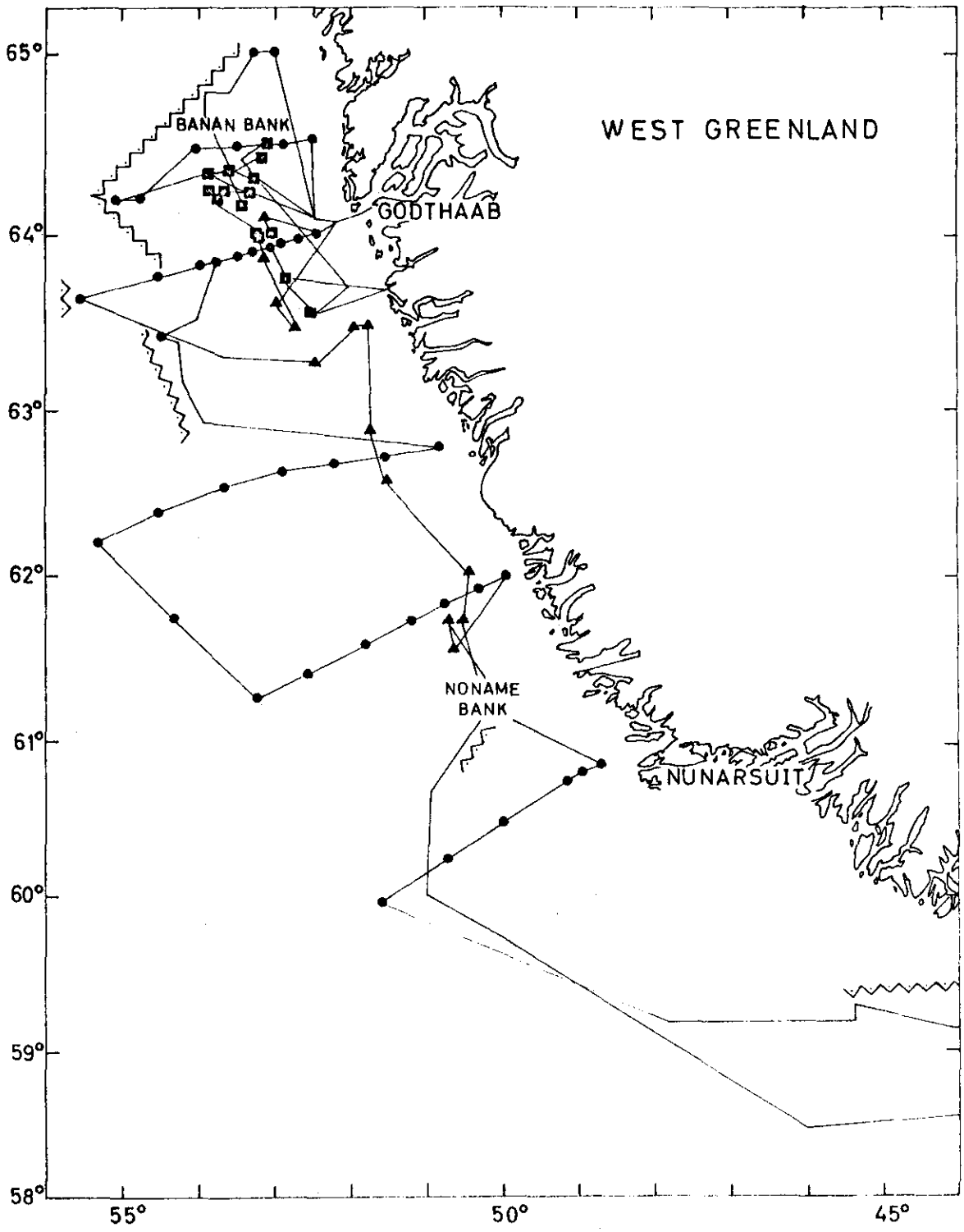


Fig. 1. R/V Johan Hjort, West Greenland, April-May 1964. Route and ne of stations. ● : hydrographical station; ▲ : bottom longline station; ■ : trawl station; ^^^ : drift ice.

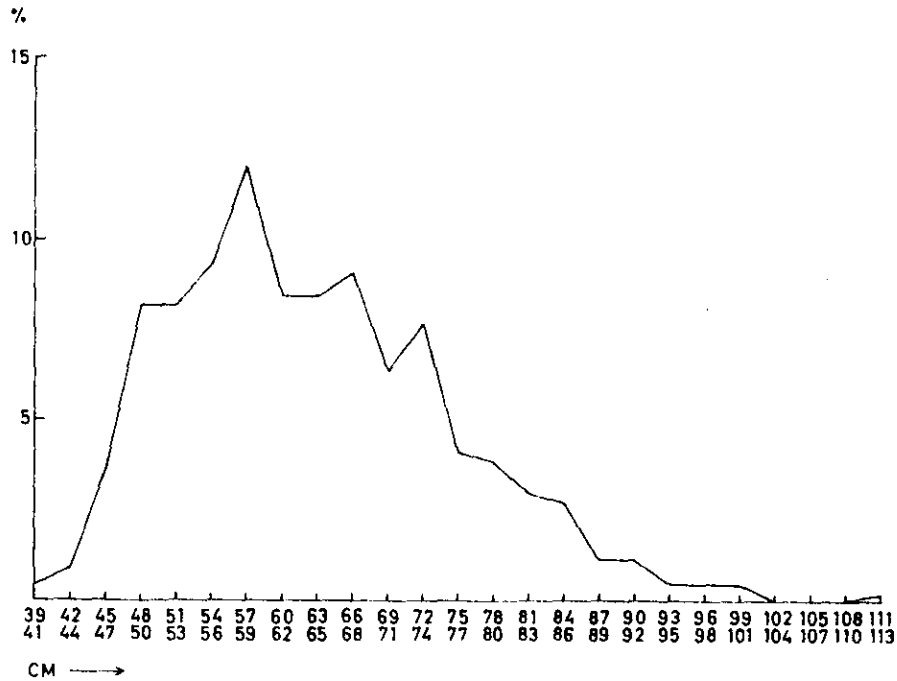


Fig. 2. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Length distribution. Total trawl catch.

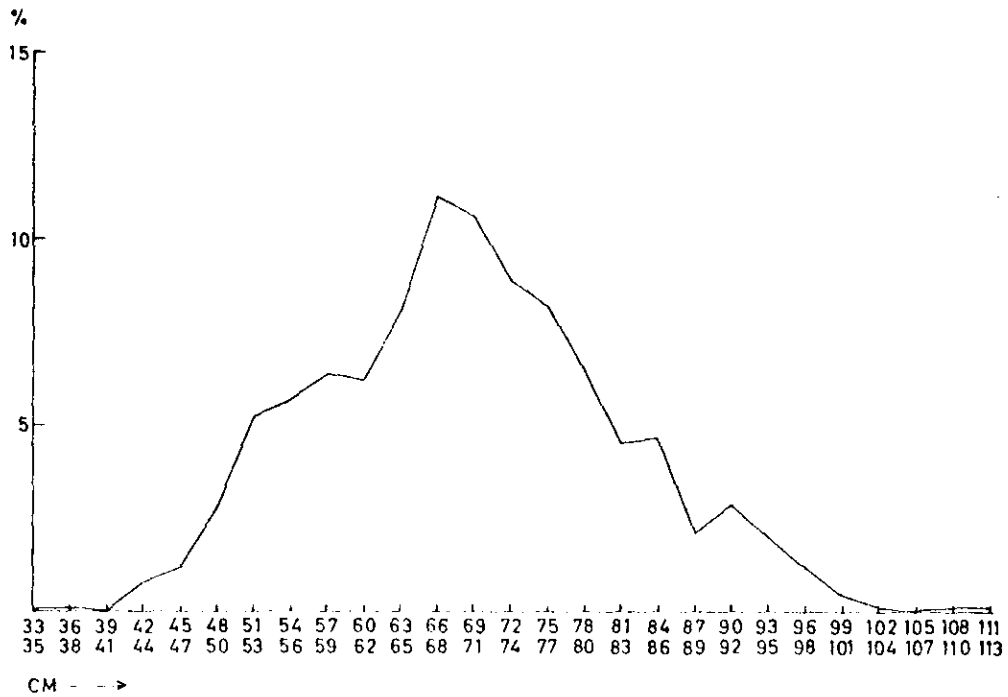


Fig. 3. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Length distribution. Total bottom longline catch.

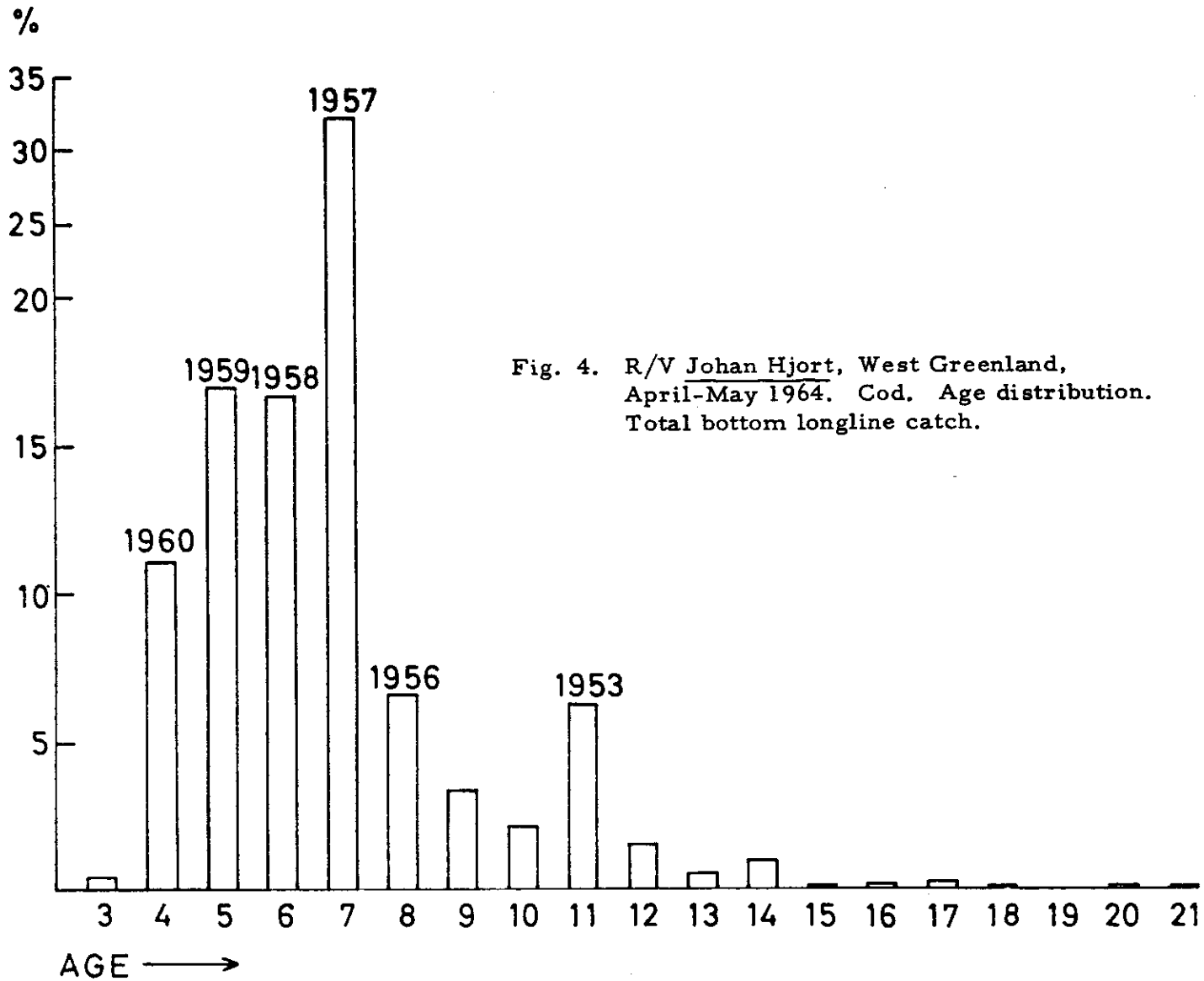


Fig. 4. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Age distribution. Total bottom longline catch.

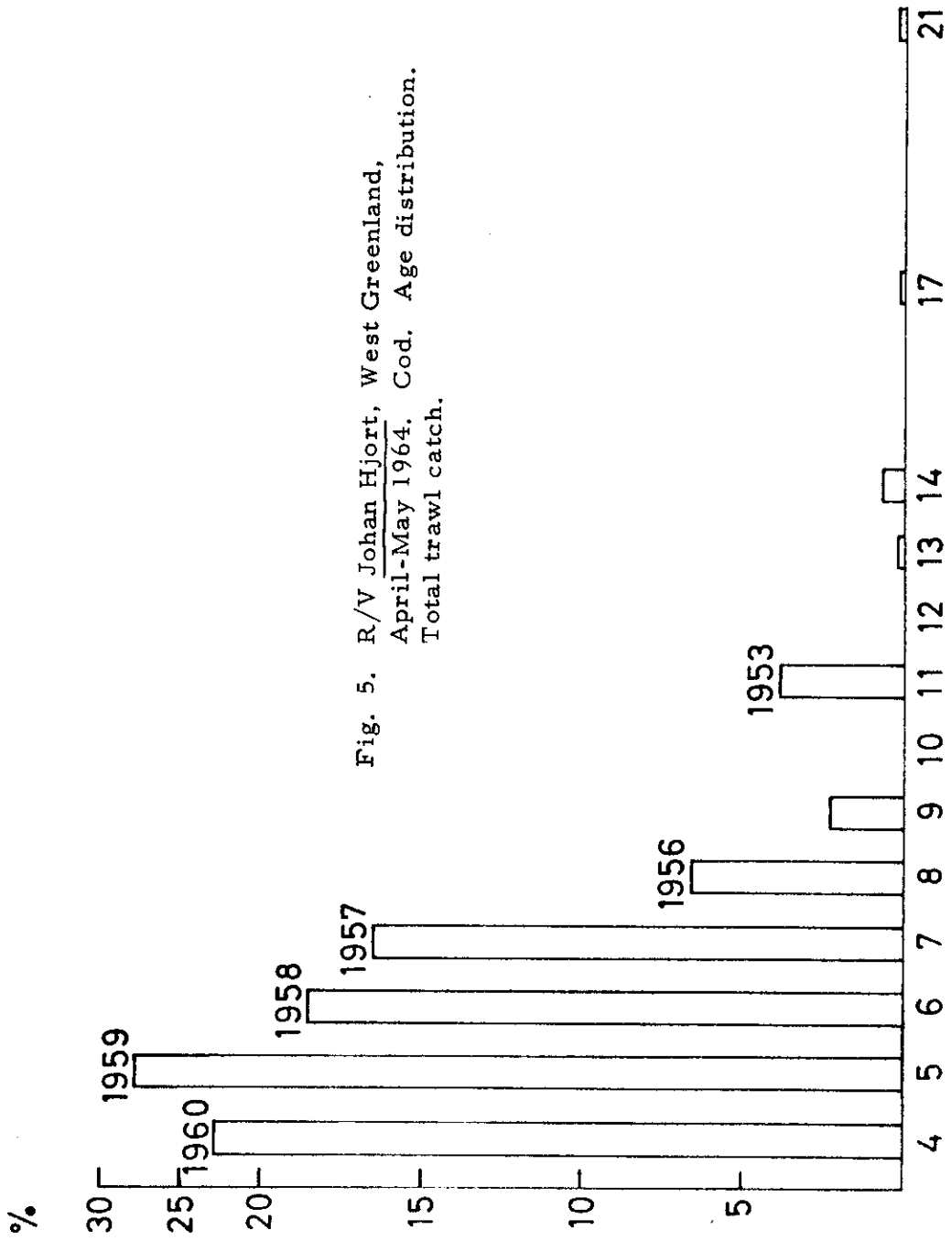


Fig. 5. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Age distribution. Total trawl catch.

to be promising. The latter increased from about 2% in 1963 to 11.1% in 1964 in the bottom longline catch and from about 2 to 22.9% in the total trawl catch.

In 1965 the mean length of the cod in the trawl catches will probably be much the same as in 1964. A slight increase in the mean length of the cod in the bottom longline catches may be expected in 1965. However, this increase in mean length will, of course, depend upon the availability of the 1960 and 1957 year-classes.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. In 1964 the same hydrographical program was planned as that carried out during the Norwegian part of NORWESTLANT I in 1963; due to difficult ice conditions, many hydrographical stations had to be omitted. Off Cape Farewell heavy drift ice concentrations were observed on 7 and 8 April about 50 nautical miles from the coast. In mid-April, a drift ice concentration was followed from 63°12'N, 54°00'W to 63°43'N, 54°48'W. At the same time brash covered wide areas of Banan Bank and some parts of Fylla Bank. At 65°00'N, the pack ice was met with west of 53°30'W. In the beginning of May, the ice border off Fylla Bank had moved about 40 nautical miles westward. Later on, drift ice was observed in position 61°10'N, 50°10'W and this ice border was followed 25 nautical miles southwestward.

During the cruise, 42 hydrographical stations were worked. In connection with the fishing experiments, sea temperature was measured with bathythermograph on 21 localities. The hydrographical sections were situated as follows:

1. 60°48'N, 48°43'W to 59°58'N, 51°37'W
2. 62°00'N, 50°00'W to 61°15'N, 53°15'W
3. 62°46'N, 50°50'W to 62°22'N, 54°32'W
4. 64°00'N, 52°30'W to 63°38'N, 55°35'W
5. 64°32'N, 52°33'W to 64°28'N, 54°04'W

Section 4, across Fylla Bank, was worked both 15 April and 2-3 May.

In April 1964, the temperature in the surface layers seemed to be unusually low as compared with previous years (Fig. 6-11). In the southwestern part of the area investigated, the temperature in the surface layers was between 0°C and 1.5°C on the banks, and in the northern area between -1.7°C and 0°C. Water as cold as -1.2°C penetrated down to the top of the Fylla Bank in April but when the Fylla Bank section was repeated in May warmer water with temperatures between 0.1°C and 1.0°C covered the bank. As usual, the western slopes of the banks, below about 200 m, were covered by water warmer

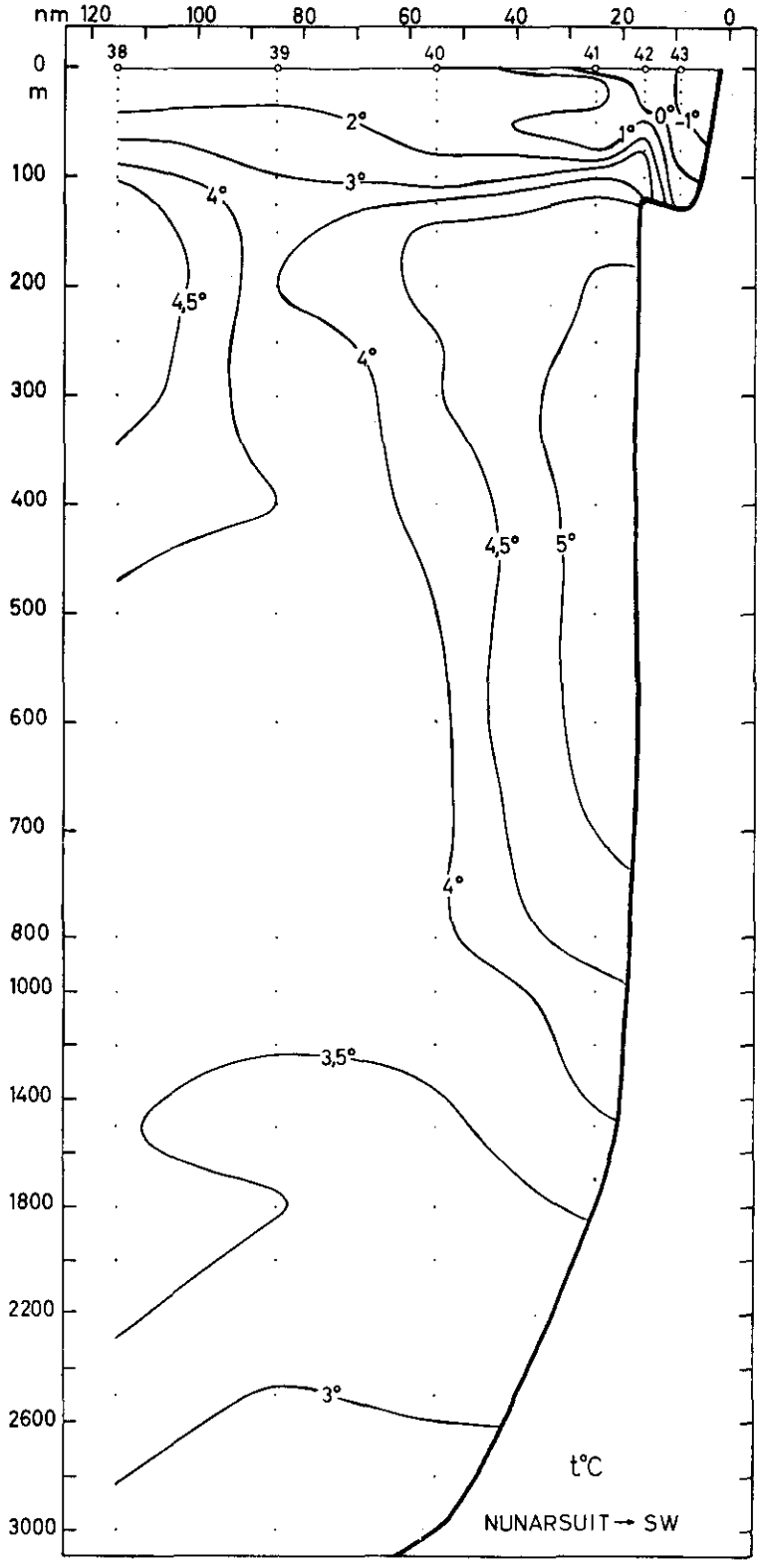


Fig. 6. R/V Johan Hjort, West Greenland, 9-10 April 1964. Section I. Vertical distribution of temperature (°C).

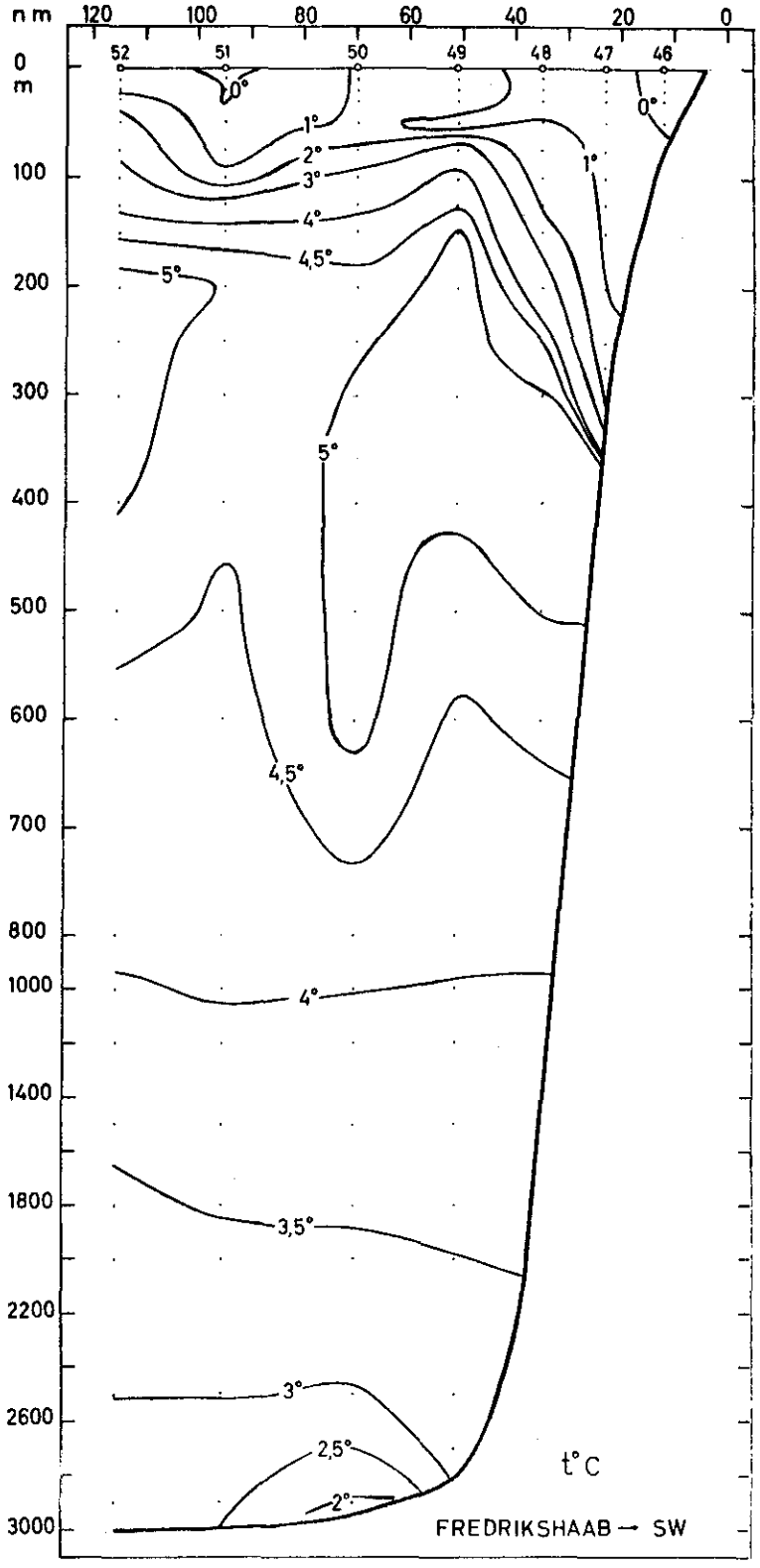


Fig. 7. R/V Johan Hjort, West Greenland, 12-13 April 1964. Section 2. Vertical distribution of temperature (°C).

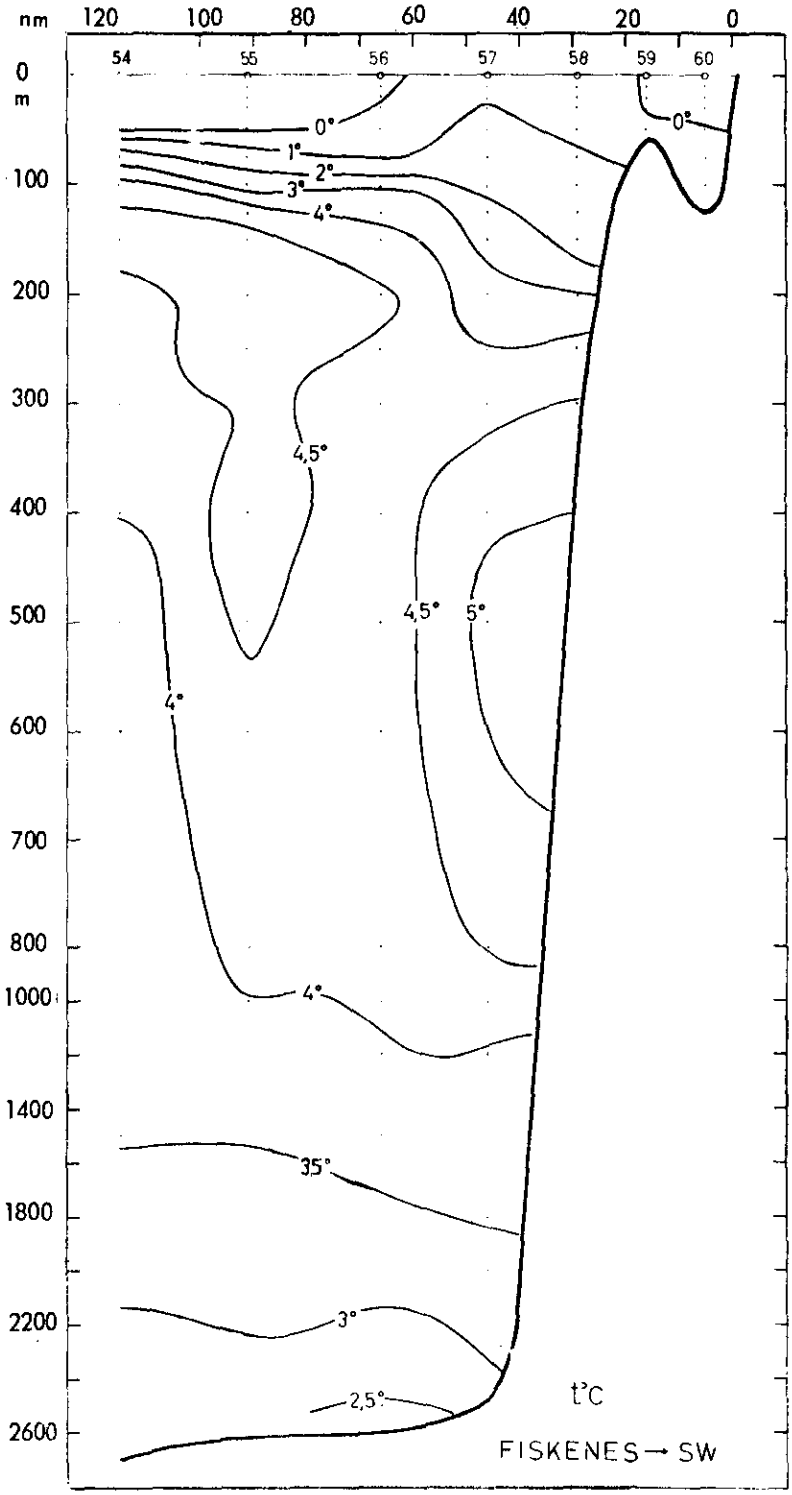
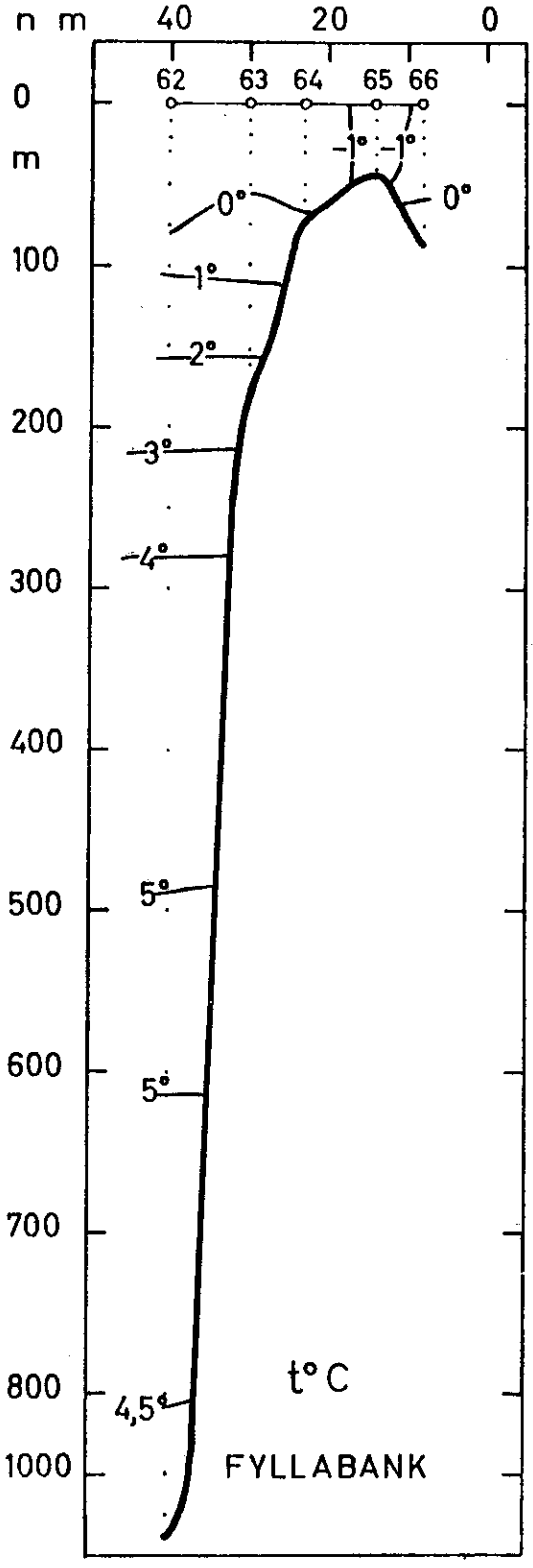


Fig. 8. R/V Johan Hjort, West Greenland, 14-15 April 1964. Section 3. Vertical distribution of temperature (°C).



than 2°C; in the deeper water layers the temperatures seemed also to be normal with regard to the time of the year.

The low temperatures in the surface layers were probably not caused by a heavier influx of polar water. It seemed more reasonable to connect the strong cooling of the surface layers with the hard ice conditions and the extraordinary low air temperatures which were predominant during the winter 1963-64.

II. Biological Studies

1. Cod eggs. Cod eggs were sampled at all the hydrographical and on some of the fishing stations. A total of 55 stations were worked. A standard Hensen net was used in vertical hauls 100-0 m, in shallower areas, from bottom to surface.

Very few cod eggs were found (Fig. 12). The total number was about the same as in 1963 but compared with 1961 when the same number of stations was worked with a 1-m egg net, the total number of sampled cod eggs was extraordinary low. The highest number of eggs was found south of 63°N. Most of the cod investigated were spent and the small numbers of eggs in the samples may therefore indicate that the spawning had failed. The reason may be that the low surface temperature in the area destroyed the eggs.

Fig. 9. R/V Johan Hjort, West Greenland, 15 April 1964. Section 4. Vertical distribution of temperature (°C).

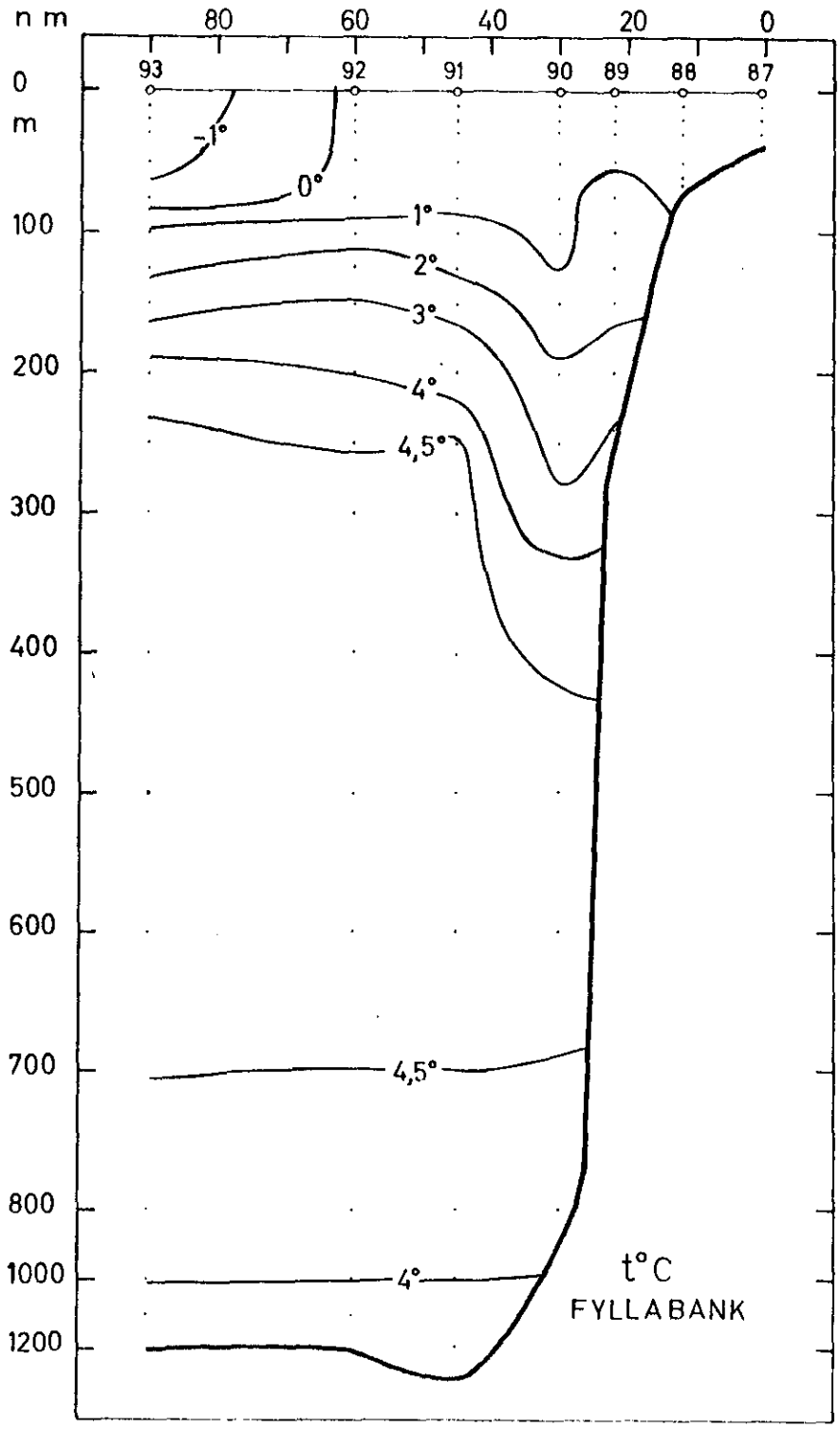


Fig. 10. R/V Johan Hjort, West Greenland, 2-3 May 1964. Section 4. Vertical distribution of temperature (°C).

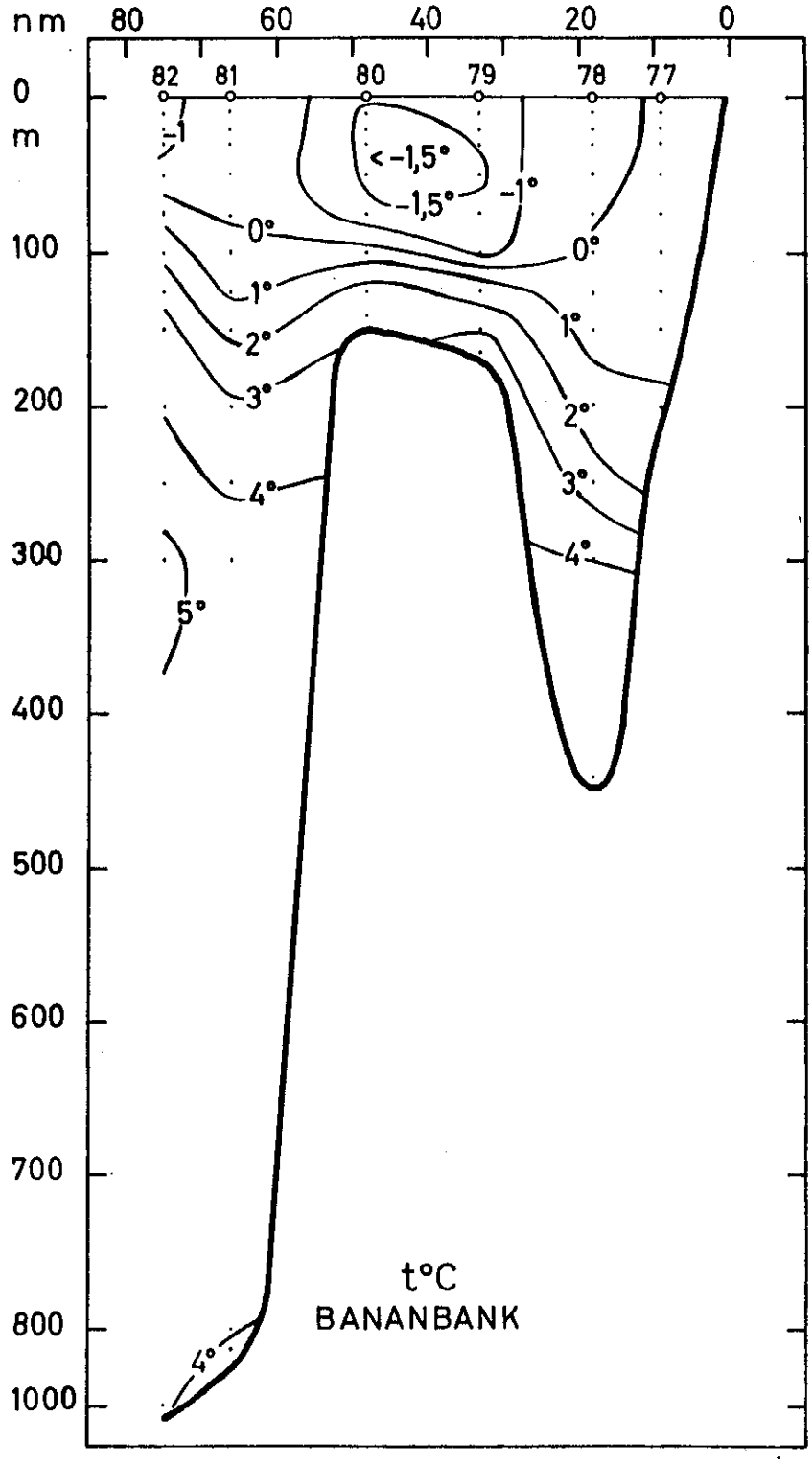


Fig. 11. R/V Johan Hjort, West Greenland, 23-24 April 1964. Section 5. Vertical distribution of temperature (°C).

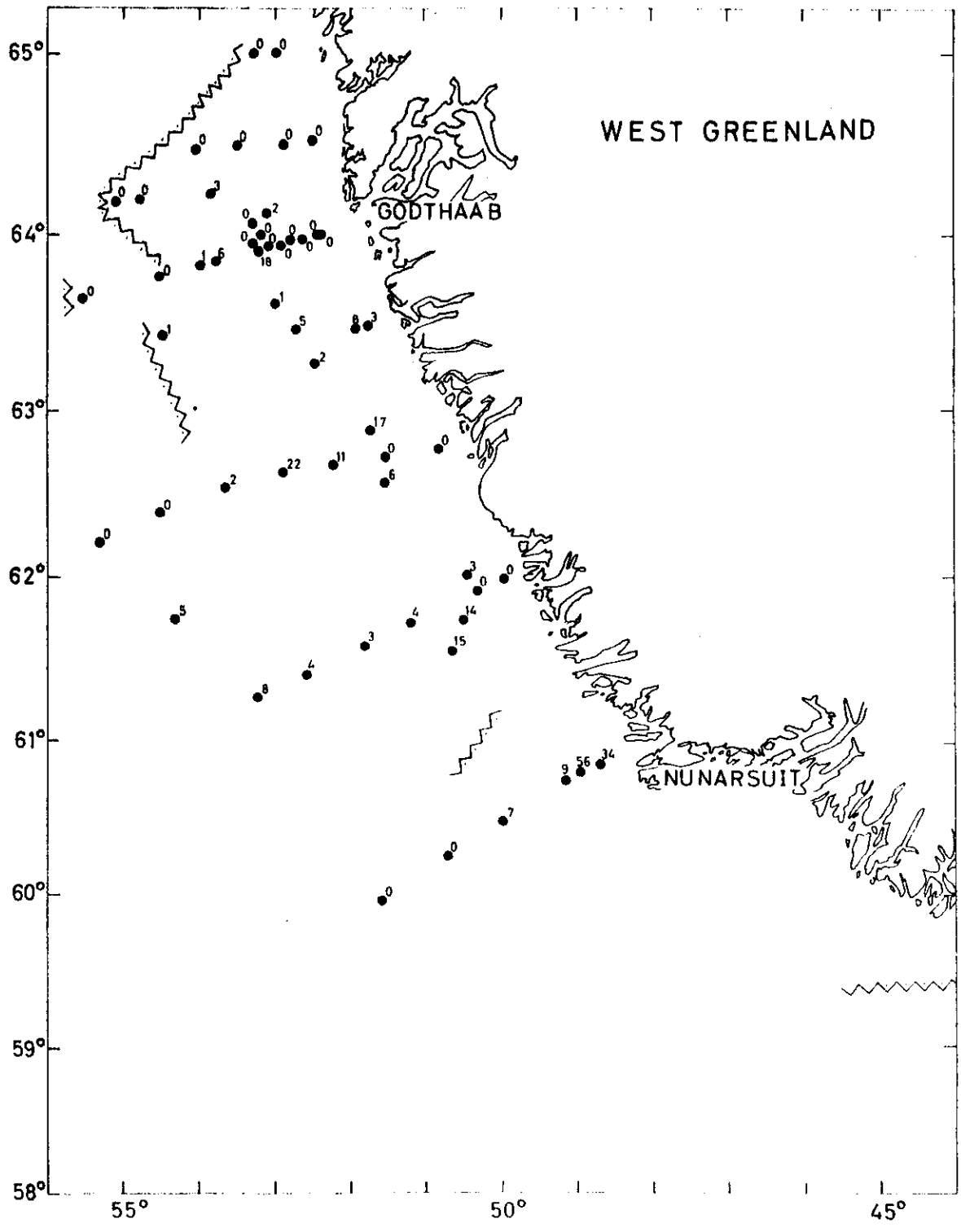


Fig. 12. R/V Johan Hjort, West Greenland, April-May 1964. Distribution of cod eggs. Numbers in vertical hauls with Hensen net.

III. Mesh Selection Experiments

1. Cod Selection. From 21 to 30 April trawling was carried out between the northwestern part of Fylla Bank and Banan Bank. A Hamburg 140' trawl was used. In two hauls codends of double manila were used, in four hauls courlene, and in seven hauls ulstron. The meshes were measured with a standard ICES gauge and the covered codend method was used. The following table lists the results of the experiments; the selection curves are shown in Fig. 13-15.

Material	Mean mesh size	Hauls	50% length	Selection factor	25%-75% sel. range	Total of hauls No. of fish in 25%-75% selection range	
						Codend	Cover
	mm	no.	cm		cm		
Double Manila	133.5	2	45.0	3.4	10.5	734	806
Ulstron	141.5	7	46.0	3.3	12.0	1,420	1,394
Courlene	134.9	4	42.5	3.2	11.5	461	386

The selection experiments will be continued in 1965.

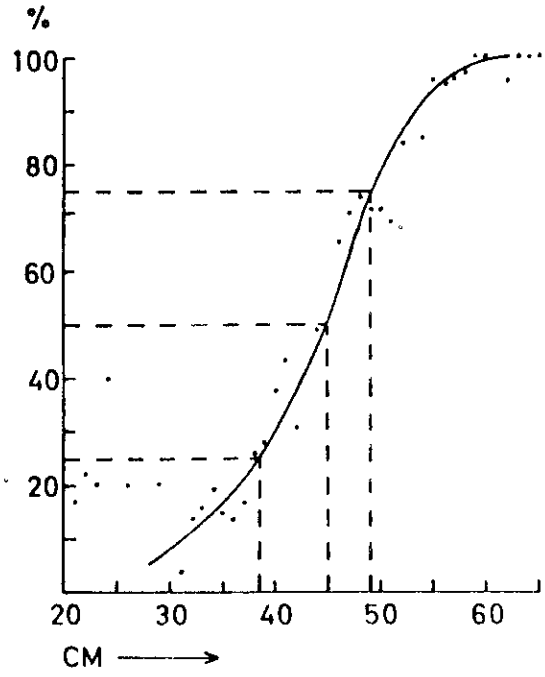


Fig. 13. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Selection curve. Double manila.

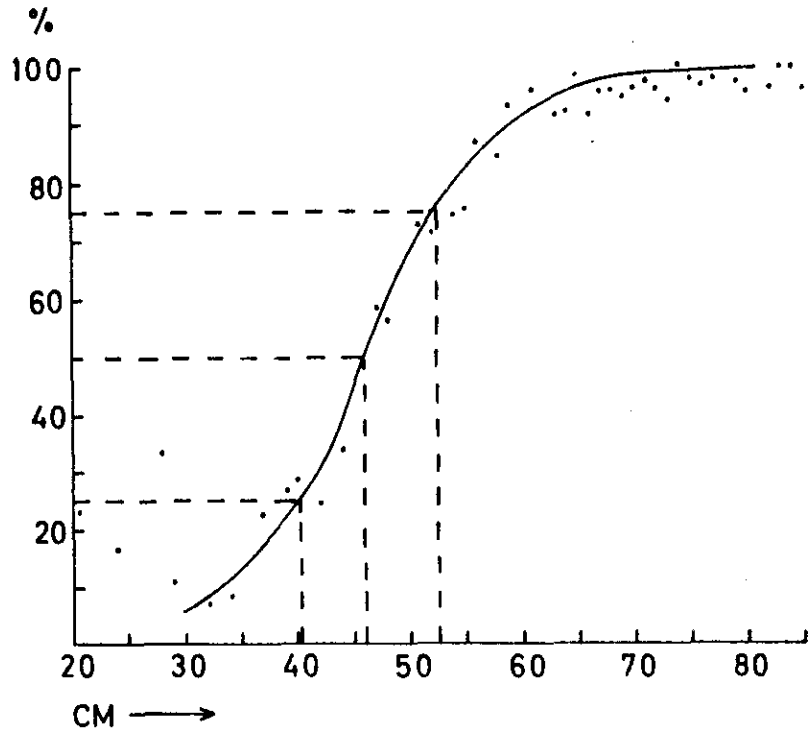


Fig. 14. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Selection curve. Ulstron.

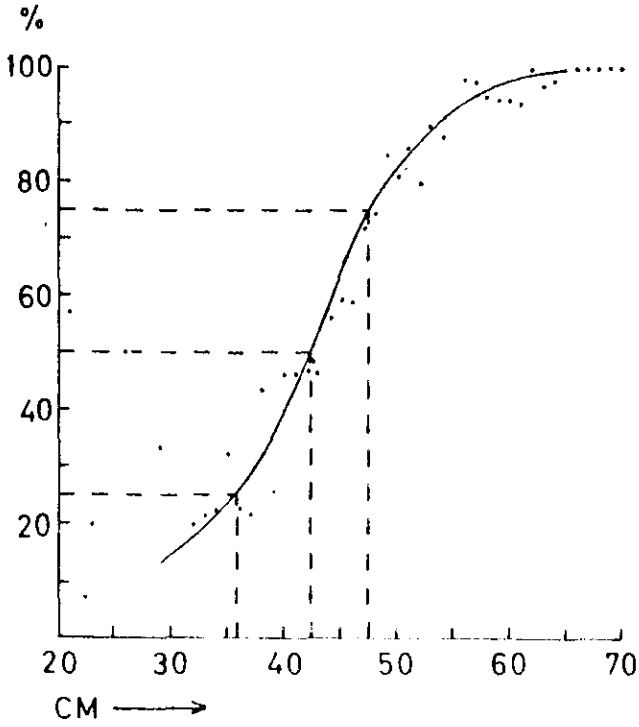


Fig. 15. R/V Johan Hjort, West Greenland, April-May 1964. Cod. Selection curve. Courlene.

East Greenland

A. Status of the Fisheries

I. Cod

The Norwegian bottom longline fishery off East Greenland started very early in 1964; the first vessels began fishing in the area between Cape Tordenskjold and Skjoldungen in the middle of February. At the beginning only a few vessels participated in this fishery, but in July-August, 10 Norwegian vessels fished between Cape Farewell and Cape Dan. At this time three of the vessels used both bottom longline and handline, while the others used handline only. During the winter and in spring the fishery was comparatively good. From late June the catches were decreasing; from the middle of August the catches were no longer profitable and most of the Norwegian vessels left the area.

R/V Johan Hjort visited the area off East Greenland between 18 August and 10 September. Pelagic concentrations of cod were not recorded on the banks or in the fjords where the cod is usually found at this time of the year. The fishing experiments were unsuccessful. Small numbers of cod were present in Angmagssalik Fjord where the Greenlanders reported some catches. The cod arrived in Angmagssalik Fjord later than usual and the catches were considerably smaller than normal.

The sampled material is probably not representative for the East Greenland cod population, but the length and age distributions obtained may give some hints (Fig. 16-17). To some extent the age distributions in 1964 and 1963 agree. Also in 1964 the year-classes 1947, 1950 and 1953, together, seem to play an important part, as they constitute 29.5% of the catch. All together about 55% of the cod are more than 8 years old. The 1956 and 1957 year-classes seem to be important, but, from this material, it is difficult to predict their part in the cod fisheries off East Greenland in 1965.

The mean length of the cod increased considerably, from 77.0 cm in 1963 to 86.0 cm in 1964. This great increase in the overall mean length is hardly representative for the whole East Greenland cod population, but probably some increase in the mean length has taken place.

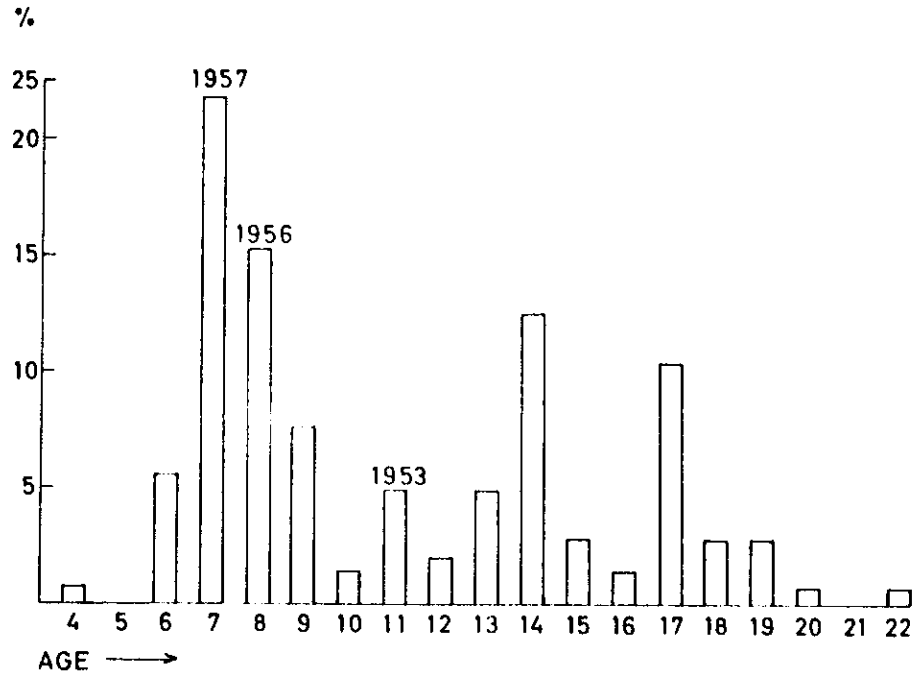


Fig. 16. R/V Johan Hjort, East Greenland, August-September 1964. Cod. Age distribution. Total bottom longline catch.

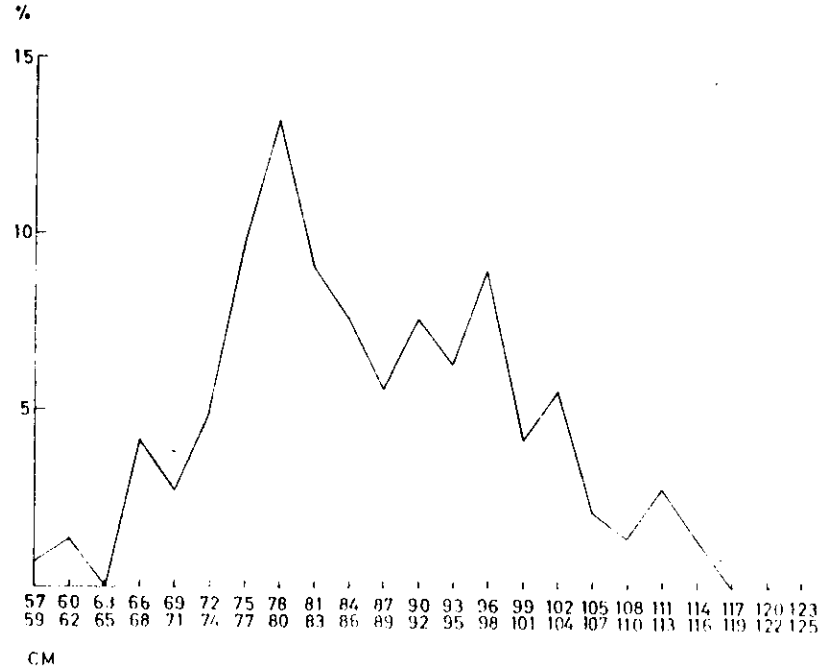


Fig. 17. R/V Johan Hjort, East Greenland, August-September 1964. Cod. Length distribution. Total bottom longline catch.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. During the cruise the weather conditions were very good and the ice conditions were also favourable. Only in the Skjoldungen area was some rough but scattered drift ice found. The number of icebergs seemed to be greater than on previous cruises. Due to the favourable conditions the hydrographical program could be worked as planned. The grid of hydrographical stations was the same as in 1963. In all, 57 stations were worked in connection with the sections. In addition, the temperature was registered on all the fishing stations. The hydrographical sections were:

1. From Prins Christian Sund and eastwards:
   60°03'N, 42°55'W - 60°03'N, 38°50'W

2. From Cape Tordenskjold to Ocean Weather Station ALPHA:
   61°24'N, 42°10'W - 62°00'N, 33°00'W

3. From Cape Møsting and southeastwards:
   63°35'N, 39°58'W - 62°44'N, 36°45'W

4. From Cape Dan and southeastwards:
   65°26'N, 36°50'W - 64°19'N, 34°00'W

5. From Cape E. Holm in East Greenland to Bjargtangar in Iceland:
   67°45'N, 31°49'W - 65°33'N, 24°41'W

Fig. 18 shows the net of stations and Fig. 19-23 show the temperature in the sections.

Compared with the investigations during the previous years, it seemed that in 1964 the temperatures were normal for the time of the year. The amount of cold polar water along the coast was near the average for the previous years. Farther off from the coast, the surface temperatures were higher than in previous years. These high temperatures were probably caused by great radiation of heat from the air as the summer of 1964 had been comparatively warm in these areas. At most of the fishing stations, the bottom temperatures were between 2° and 4°C. On Cape Dan Bank the bottom temperature was 1°C, and at two fishing stations on the slope of the Heimlandsryggen, 500 m deep, about 6°C.

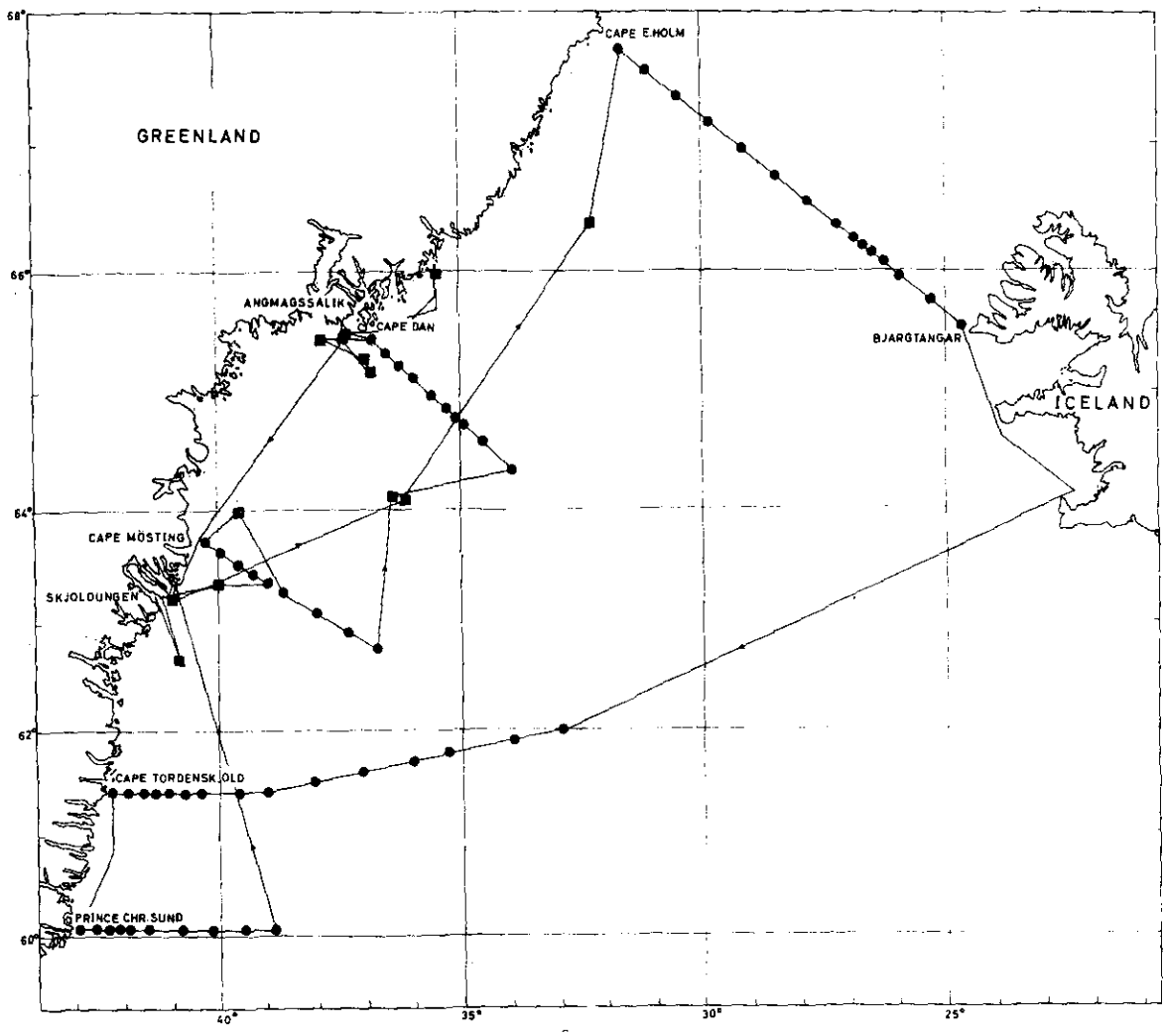


Fig. 18. R/V Johan Hjort, East Greenland, August-September 1964. Route and net of stations. ● : hydrographical station. ■ : bottom longline station.

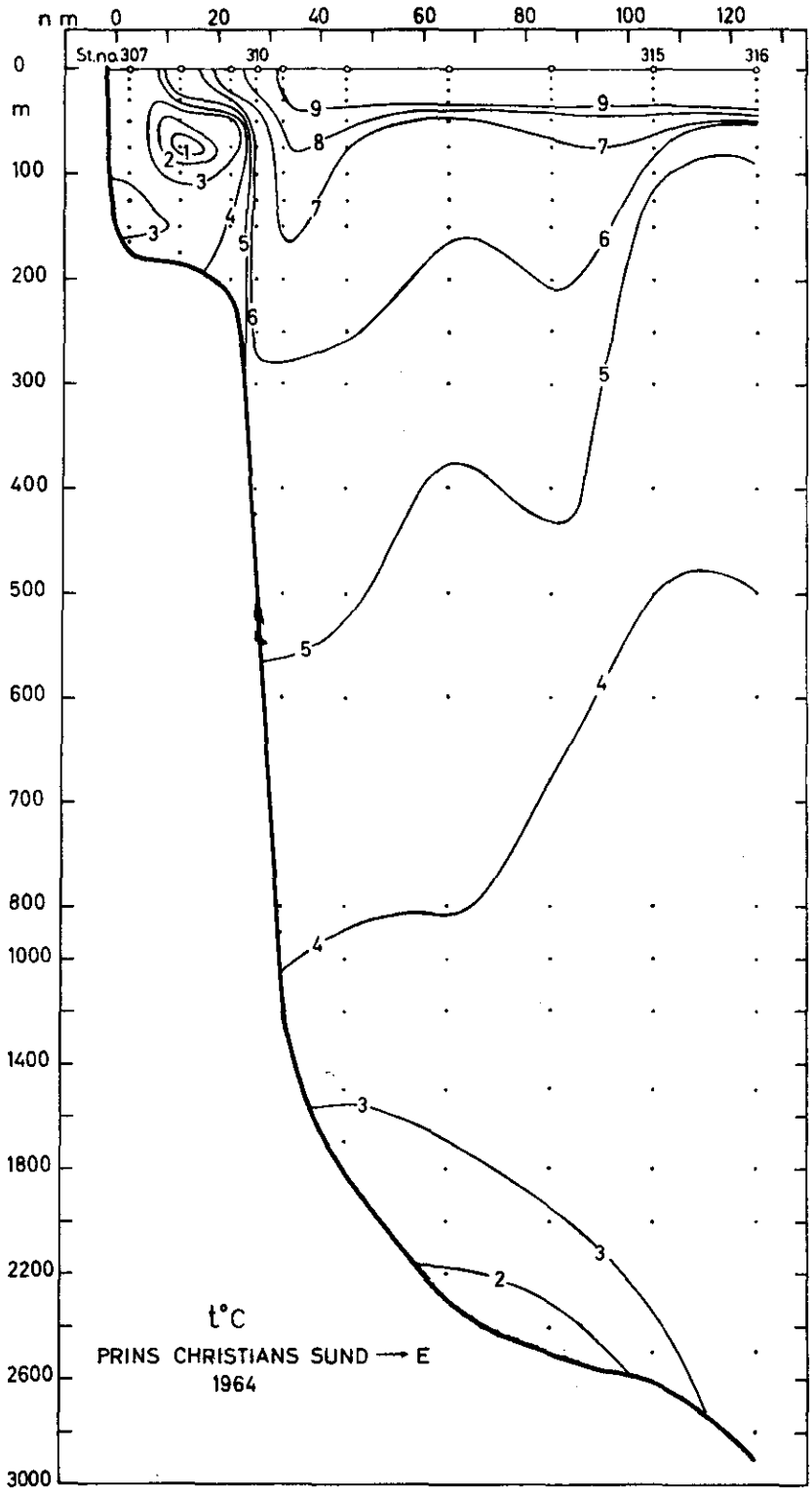


Fig. 19. R/V Johan Hjort, East Greenland, August-September 1964. Section 1. Vertical distribution of temperature (°C).

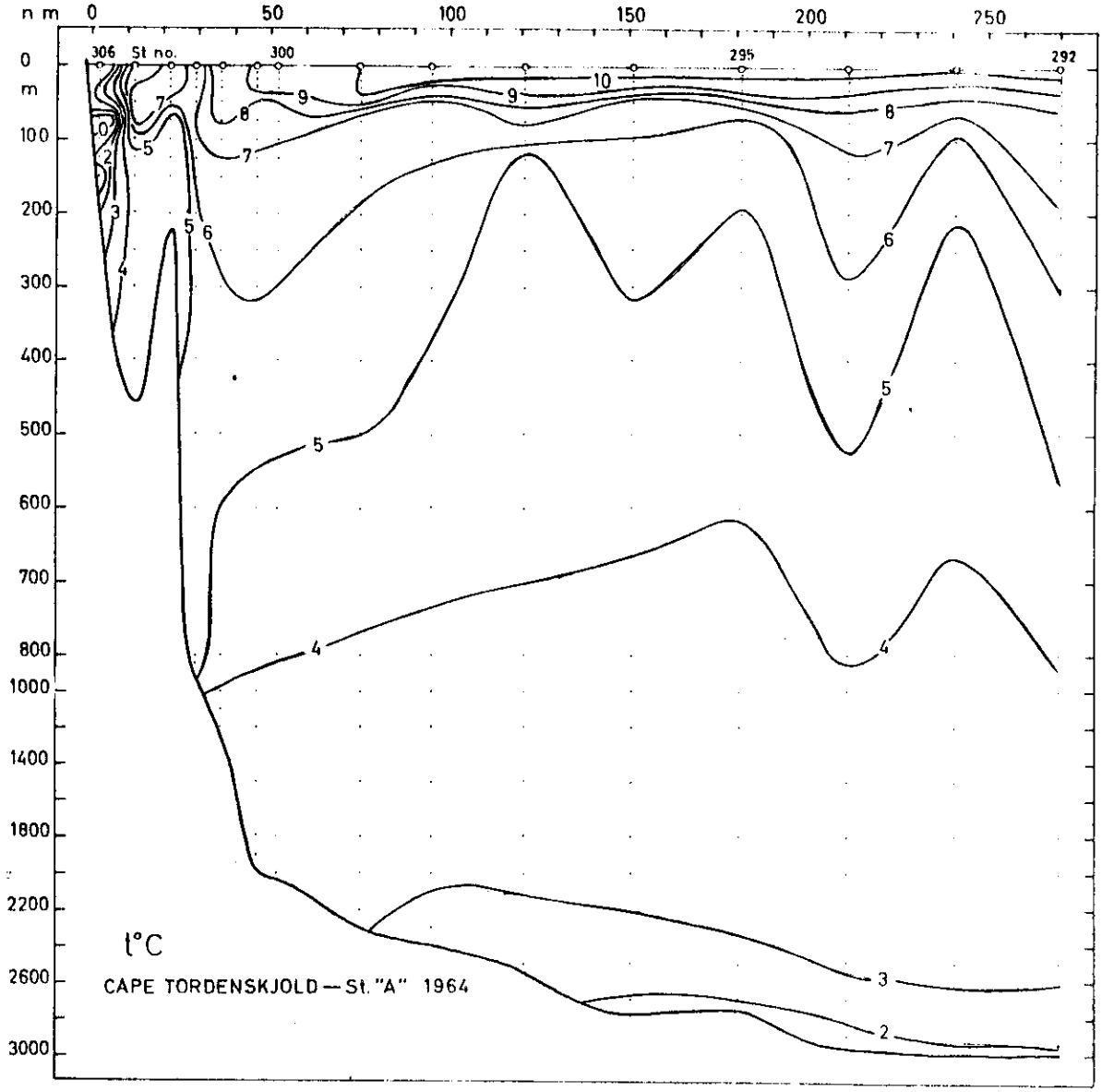


Fig. 20. R/V Johan Hjort, East Greenland, August-September 1964. Section 2. Vertical distribution of temperature (°C).

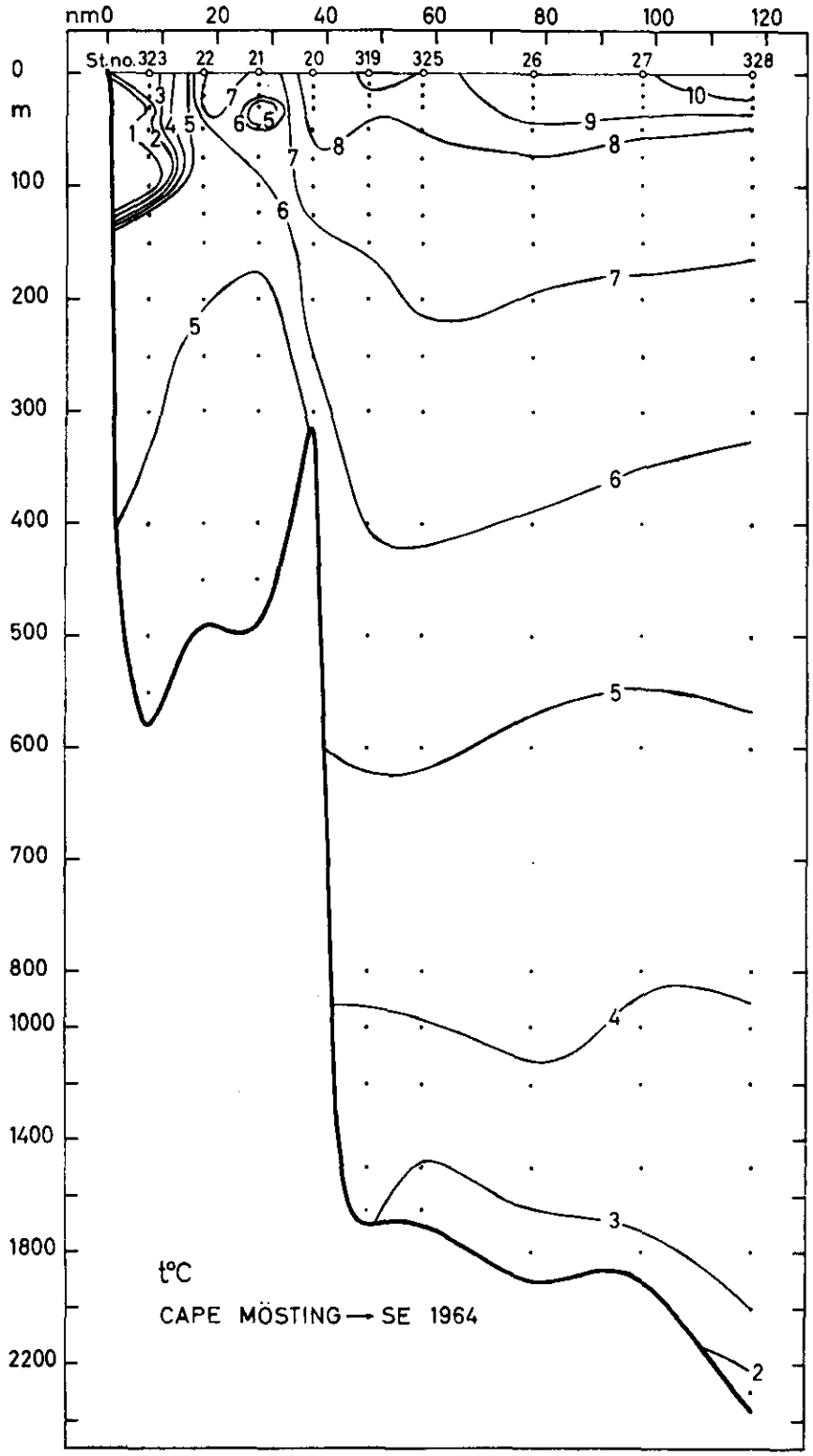


Fig. 21. R/V Johan Hjort, East Greenland, August-September 1964. Section 3. Vertical distribution of temperature (°C).

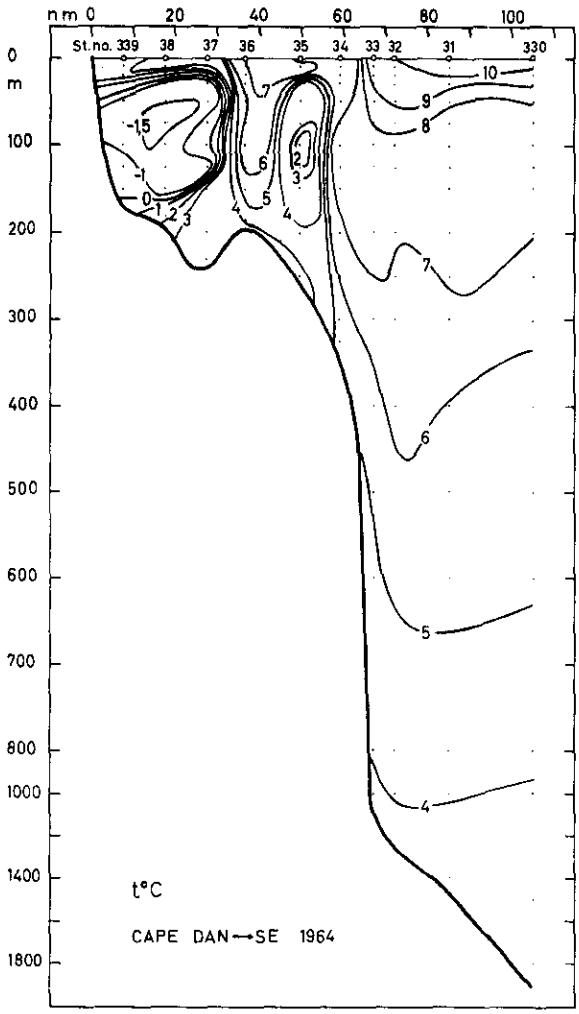
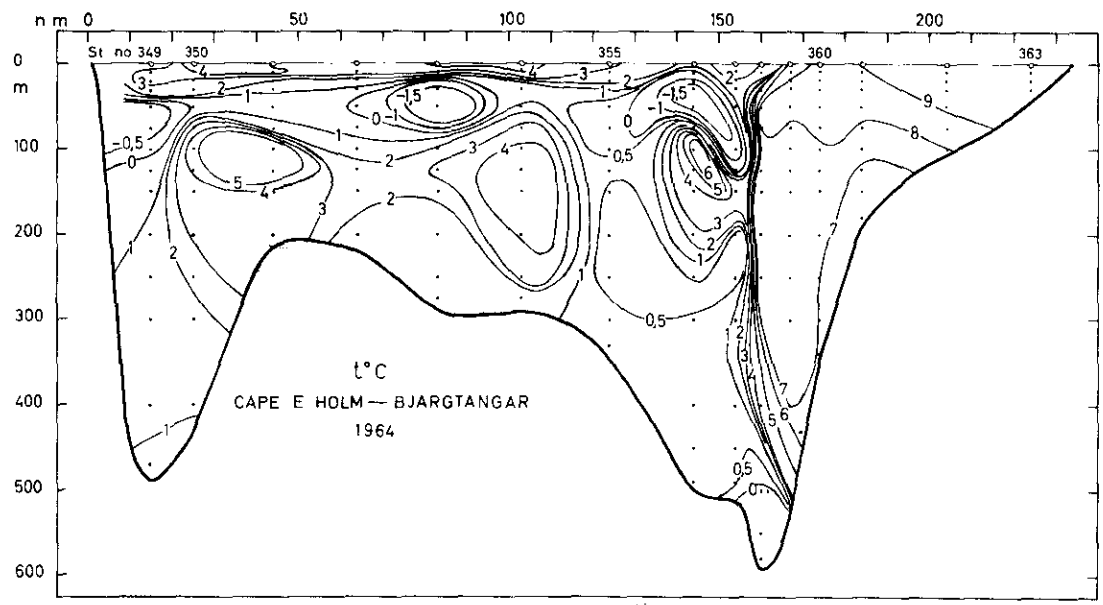


Fig. 22 (left).
R/V Johan Hjort, East Greenland, August-September 1964. Vertical distribution of temperature (°C).

Fig. 23 (below).
R/V Johan Hjort, East Greenland, August-September 1964. Section 5. Vertical distribution of temperature (°C).



VI. Polish Research Report, 1964

by F. Chrzan

Subareas 1-5

A. Status of the Fisheries

In 1964, 10 Polish factory trawlers fished mainly for redfish and less for cod in Subareas 2 and 3. They made 21 trips to the ICNAF area compared with 15 in 1963. Total catches amounted to 37,843 tons, an increase from the 23,248 tons taken in 1963. Catches by major species in 1964 and 1963 are shown in Table 1.

Table 1. Catches by Polish factory trawlers in the ICNAF area in 1964 and 1963.

	1964		1963	
	tons	%	tons	%
Redfish	21,414	(56.6)	12,975	(55.8)
Cod	10,865	(28.7)	7,736	(33.3)
Flatfish	4,888	(12.9)	2,193	(9.4)
Other groundfish	641	(1.7)	93	(0.4)
Herring	35	(0.1)	251	(1.1)
Total	37,843		23,248	

The above percentage data show relative increase of landings of redfish, flatfish and other groundfish. The tonnage of cod caught was greater in 1964 but the percentage of cod caught was lower than in 1963.

The catch distribution and total fishing effort in 1964 is shown in Table 2.

Table 2. Total catch and effort by the Polish fishing fleet in ICNAF divisions.

ICNAF Div.	Catch (tons)	No. hours fishing	No. hauls	No. days fished
1C	81	32	30	3
1D	14	10	7	1
2J	6,935	4,123	1,735	266
3K	27,558	13,839	7,809	1,024
3L	1,678	1,284	696	94
3M	855	467	244	38
5Z	723	566	312	34

There was one trip only to Subarea 1. Because of very low fishing yield, the trawler left the Greenland fishing grounds for fishing grounds in

Subarea 2. The data given in Table 2 indicate that the main Polish catches took place in Div. 2J and 3K, where yield per fishing unit remained high throughout the fishing period. The yield per day fishing in these two divisions in 1964 was 26.1 and 26.9 tons respectively. In other divisions fished, the yield per day ranged from 17.8 to 22.5 tons.

The development of Polish catches in the ICNAF area and changes in yield per day fished and yield per hour trawling are given in Table 3.

Table 3. Polish landings and yield per fishing unit, 1961-64 inclusive

Year	Total catch (tons)	No. days fished	No. hours fished	Yield per day (tons)	Yield per hour (tons)
1961	3,923	236	2,488	16.6	1.58
1962	8,667	409	5,243	21.1	1.65
1963	23,248	850	10,733	27.0	2.15
1964	37,843	1,460	20,321	25.9	1.86

Increase in catch is quite obvious, but the yield per unit effort in 1964 was less than in 1963. It should be mentioned, however, that the yield in the last two years was higher than in previous years.

I. Redfish

Table 4 shows that the most important fishing grounds for redfish were in Div. 3K, where the catch per 100 hours trawling was 118 tons for this species in 1964. The second most important grounds were in Div. 2J, where pure catches of redfish per 100 hours amounted to 101 tons.

Table 4. Total catch of redfish and cod by Polish vessels in the ICNAF area in 1964.

ICNAF Div.	Redfish (tons)	Cod (tons)
1C	3	81
1D	-	11
2J	4,180	2,058
3K	16,399	7,710
3L	704	240
3M	128	717
5Z	-	48

II. Cod

Table 4 shows that cod were found in greatest abundance in Div. 3K and 2J. In Div. 2J, the average catch per 100 hours trawling was 50 tons and in Div. 3K, 56 tons.

B. Special Research Studies

I. Hydrography

Hydrographic studies were carried out in June and July by the R/T Wieczno in the Hamilton Inlet Bank, Ritu Bank, Flemish Cap, Great Bank of Newfoundland, Browns Bank and Georges Bank areas. Plankton samples were collected at some stations.

II. Biological Studies

1. Sampling. Between 18 June and 29 July 1964, catches made by the R/T Wieczno were sampled in Div. 2J, 3KLMO, 4WX and 5Z. The results will be presented in the Sampling Yearbook Vol. 9 for 1964. The total number of samples are shown in Table 5.

Table 5. Samples taken in ICNAF area in 1964

Species	No. measured	No. of pairs of otoliths
Redfish (mentella)	7,629	891
Redfish (marinus)	1,382	435
Cod	9,029	2,247
Haddock	3,882	833
Silver hake	4,529	707
Red hake	689	159
Pollock	60	60
American plaice	4,718	435
Witch flounder	121	121
Yellowtail	989	101
Greenland halibut	187	187
Halibut	1	1
Herring	5,794	374
Argentine	2,399	272
Alewife	119	119
Blueback	549	115

2. Cod. Some observations have been made on the biology and identity of cod stocks on the Labrador and Newfoundland fishing grounds. Length measurements show that cod caught in June on Hamilton Inlet Bank were 20-70 cm

long (mean length, 44.7 cm). On Sundall Ground the cod were 19-86 cm long (mean length, 46.3 cm). Remarkable differences in length were observed on Ritu Bank, where, in the 135-150 m water layer, cod of 16 to 82 cm (mean length, 48.9 cm) were taken, while from the 145-250 m layer the cod were 16-91 cm long (mean length, 41.2 cm). The largest cod were taken on Woolfall Bank, and had a length from 16-125 cm (mean length, 63.6 cm). The smallest cod were taken in Div. 3M and had a mean length of 38.6 cm.

3. Redfish, Sebastes marinus, caught in June in Div. 3K had a length of 20-63 cm (mean 47.3 cm), while in Div. 3M the length was 20-52 cm (mean 38.4 cm).

Polish trawlers exploited the concentrations of Sebastes mentella appearing in June and July in Div. 3KM. Measurements of these species on board the research vessel have shown that the largest redfish (mentella) (mean length 36.8 cm) were taken on Ritu Bank. Here, the fish ranged in length from 15 to 51 cm.

Observations on the length of redfish (mentella) have shown that the fish become smaller to the southward. The smallest redfish (mentella) (12-37 cm, mean 24.8 cm) appeared in July on Sable Island Bank.

4. Haddock. In July, remarkable concentrations of haddock were found over the southwest slopes of the Great Bank of Newfoundland and on Emerald Bank, Browns Bank and Georges Bank. The highest yield, about 150 kg per one hour trawling, was obtained on Browns Bank. But here the haddock was small (mean length, 18.6 cm). The largest haddock were taken on Georges Bank, where despite the considerable amounts of smaller fish, mean length was 58.9 cm.

5. Other species. Data concerning other species have been presented to the Fifteenth Annual Meeting in the following documents: Research Document No. 33, J. Netzel and E. Stanek "Some biological characteristics of Blueback (Pomolobus aestivalis Mitch.) and Alewife (Pomolobus pseudoharengus Wils.), based on sampling material taken on Georges Bank (July and October, 1964); Research Document No. 34, J. Netzel, E. Stanek and C. Zukowski "The size and sexual maturity of herring (Clupea harengus L.) on the fishing grounds of Nova Scotia and Georges Bank in July 1964"; Research Document No. 35, F. Chrzan and C. Zukowski "Some characteristics of Argentine (Argentina silus Asc.) occurring in the region of Nova Scotia".

VII. Portuguese Research Report, 1964

by Manuel Lima Dias

During 1964 the Portuguese fleet caught 211,300 tons of cod from Subareas 1, 2, 3 and 4. This amount represents a decrease from 1963 of almost 19,200 tons for the same species.

The present report is based on observations made on board commercial trawlers by two members of the Research Unit of the Portuguese Advisory Commission for the Northwest Atlantic Fisheries in Subareas 2 and 3. The samples were taken at random, after discards, for data on length and age composition, stage of maturity and age at first maturity.

For the age-length keys we have used stratified subsamples, obtained from the initial random samples by choosing, in each 3-cm length class, a number of otoliths which show mean age similar to that given by the total readings of the random samples ("t" test; level, 0.05). This procedure is the first attempt at stratified sampling on commercial vessels, where biological observations cannot be made as easily as on research vessels.

Details of length and age compositions will be published in ICNAF Sampling Yearbook Vol. 9 for 1964.

Subarea 2

A. Status of the Fisheries

I. Cod

Landings from Subarea 2 decreased from 73,300 tons in 1963 to 41,150 tons in 1964. All landings were made by trawlers.

Samples were obtained in Div. 2J between 13 March and 30 October as follows:

Sample Group for Div. 2J	Sample Nos.	Date	Depths (m)	No. lengths	No. aged
A	1,3-8,10	13-31 Mar.	256-420	925	525
B	11-21,23-24	4-30 Apr.	256-439	1,716	924
C	26-34	2-19 May	196-366	1,624	574
D	36-42	18-31 Aug.	210-300	950	300
E	43-45	1-28 Sept.	240-300	550	150
F	46-47,49-55 58-64	1-30 Oct.	180-345	2,225	775
				7,990	3,248

a. Lengths (Fig. 1) ranged from 37 to 94 cm classes. The mean lengths are: A-56.4 cm; B-53.5 cm; C-53.8 cm; D-54.0 cm; E-53.9 cm; F-54.3 cm.

b. Ages (Fig. 1). In all cases age-group VII (1957 year-class) is dominant, followed by the VI and VIII age-groups (1958 and 1956 year-classes) for March, April, May and October, and by the V and VIII age-groups (1959 and 1956 year-classes) for August and September.

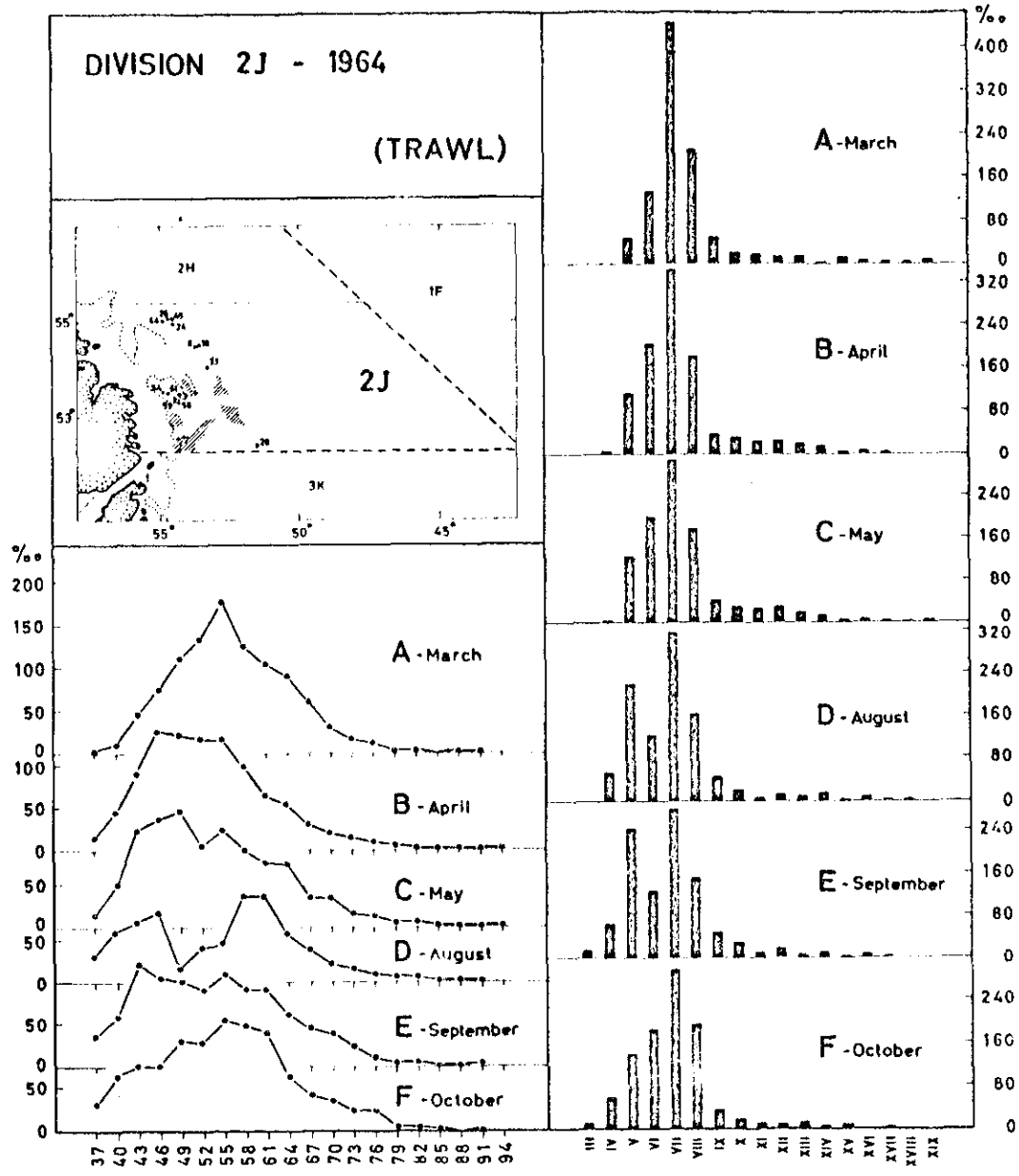


Fig. 1.. Cod. Div. 2J. Length and age composition, March-October 1964.

Age-group III (1961 year-class) appeared for the first time in September. Mean ages of the various sample groups are: A-7.7 years; B-7.5 years; C-7.6 years; D-6.8 years; E-6.8 years; F-6.9 years.

c. Growth is shown in the following table of average lengths (figures in brackets are numbers of fish):

Age-group	1st quarter Mar.	2nd quarter Apr.-May	3rd quarter Aug.-Sept.	4th quarter Oct.
III	-	-	37.0 (3)	36.7 (3)
IV	46.0 (1)	41.3 (14)	40.4 (9)	40.7 (10)
V	44.4 (34)	42.8 (154)	44.7 (27)	42.6 (21)
VI	51.1 (99)	49.0 (256)	49.7 (12)	48.6 (20)
VII	54.3 (232)	52.3 (552)	58.9 (34)	57.3 (31)
VIII	57.7 (95)	56.8 (268)	63.8 (24)	63.2 (25)
IX	60.9 (24)	61.9 (65)	66.4 (9)	70.3 (11)
X	65.3 (10)	63.1 (34)	70.0 (5)	72.3 (7)
XI	68.7 (7)	65.6 (32)	74.0 (5)	76.5 (8)
XII	61.3 (4)	67.0 (32)	78.7 (3)	76.3 (4)
XIII	71.0 (4)	67.4 (26)	66.0 (1)	74.3 (4)
XIV	71.0 (2)	70.0 (21)	72.7 (3)	81.5 (2)
XV	71.5 (2)	75.4 (8)	75.0 (1)	71.0 (1)
XVI	70.8 (5)	79.2 (9)	72.0 (2)	118.0 (1)
XVII	77.0 (1)	77.1 (10)	124.0 (1)	76.0 (2)
XVIII	74.3 (3)	80.2 (6)	78.0 (1)	-
XIX	81.0 (2)	83.8 (5)	-	-
XX	-	87.5 (2)	-	-
XXI	-	76.0 (1)	135.0 (1)	-
XXII	-	-	-	-
XXIII	-	98.0 (3)	-	-

d. Stage of maturity (Fig. 2). Spawning decreases gradually from March to May. At the same time the number of cod with gonads in the developing and resting or recovering stage is more frequent. During August and through to October, there is little spawning. After October spawning again increases.

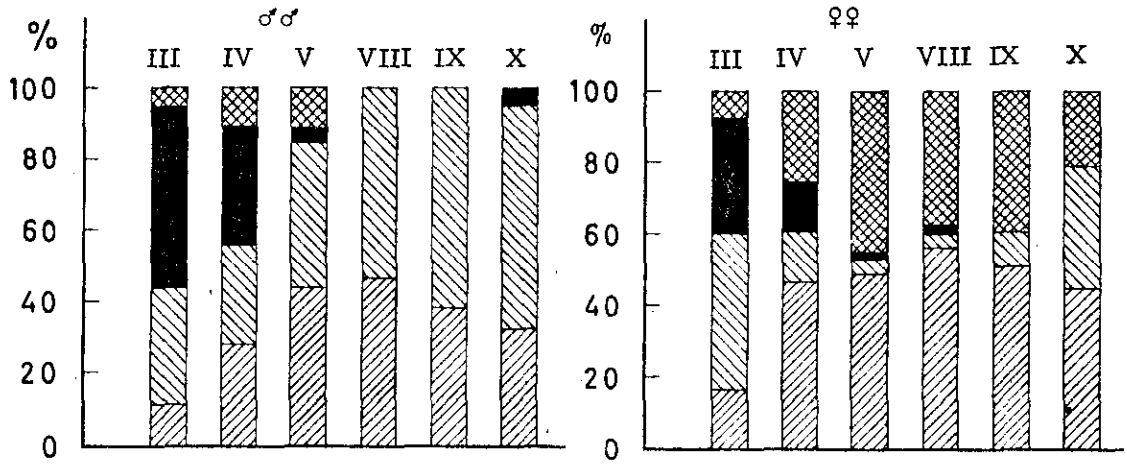


Fig. 2. Cod. Div. 2J. Stages of maturity, 1964. ▩ Post-spawning; ■ spawning; ▧ developing; ▨ resting or recovering.

e. Age at first maturity

DIV.2J

1ST SPAWN. / AGE-GROUP	♂♂ VI	VII	VIII	IX	X	XI	XII	XV	♀	?	TOTAL	♀♀ VI	VII	VIII	IX	X	XI	XII	XIII	♀	?	TOTAL
III									1		1									1		1
IV									11		11									8		8
V									121		121									126		126
VI	1								217	4	222	5								159	1	165
VII	9	-	39	-	-	-	-	-	326	7	381	18	60							373	15	466
VIII	9	19	12	-	-	-	-	-	129	2	171	4	32	20						174	11	241
IX		8	8	-	-	-	-	-	25	2	43	4	10	5	3					37	7	66
X		1	10	-	-	-	-	-	10	1	22		5	4	4					18	3	34
XI		2	5	6	3	-	-	-	7	-	23			5	5	2				15	2	29
XII		1	-	3	-	-	-	-	5	-	9		2	3	9	2	1			13	3	33
XIII		2	1	2	-	1	-	-	7	2	15		1	4	2	2	1			7	3	20
XIV			1	-	-	-	-	-	3	1	5		3	6	6	1	1	1		2	3	23
XV				1	1	-	-	-	1	-	3			3	2	2				2		9
XVI			1	1	3	-	-	-	1	-	6		2	2	1	2				3	1	11
XVII			1	1	1	-	-	-	2	-	5		1	5	1	1			1			9
XVIII						1	1	1	1	1	5			1	2	1					1	5
XIX					1	1	-	-	-	-	2			1	1	1	2					5
XX															1		1					2
XXI							1	-	-	-	1			1								1
XXIII																2						2
No. OF OBSERV.	19	33	78	14	9	3	2	1	867	20	1,046	31	116	60	37	16	6	1	1	938	50	1,256

Subarea 3

A. Status of the Fisheries

I. Cod

From 1963 to 1964, landings increased 22,000 tons and amounted to 102,600 tons (72,900 for trawlers and 29,700 for dory vessels).

Samples were taken from the landings from 10 March to 24 September in Div. 3K, and from 18 April to 4 July in Div. 3L, as follows:

Sample Group	Sample Nos.	Date	Depths (m)	No. lengths	No. aged
for Div. 3K					
A	2-4	10-24 Mar.	329-402	250	250
B	7-19	13-31 May	284-375	1,675	875
C	20-23	1-4 June	256-338	675	275
D	49, 51-55	10-29 Aug.	220-400	1,100	300
E	56-69	2-24 Sept.	210-300	1,973	849
				5,673	2,549
for Div. 3L					
A	5-6	18-19 Apr.	274-280	200	200
B	24-35, 37-43	8-30 June	83-238	3,136	1,125
C	44, 46-47	1-4 July	192-237	786	0
				4,122	1,325

a. Lengths. In Div. 3K (Fig. 3), lengths ranged from 37 to 91 cm classes with a relatively small variation between months. Mean lengths were A - 53.1 cm; B - 57.7 cm; C - 55.4 cm; D - 54.7 cm; E - 54.4 cm.

In Div. 3L (Fig. 4), the lengths ranged from 40 to 91 cm classes with mean values of: A - 64.8 cm; B - 59.8 cm; C - 57.9 cm.

b. Ages. In Div. 3K (Fig. 3), as in Div. 2J, age-group VII (1957 year-class) is dominant, followed by age-groups V, VI and VIII (1959, 1958 and 1956 year-classes). Age-groups IV and III (1960 and 1961 year-classes) appeared, for the first time, during May and August respectively.

Mean ages of the sample groups are: A - 6.9; B - 8.1; C - 7.6; D - 6.5; E - 6.5.

Div. 3L (Fig. 4), in both April and June, age-groups VI and VII (1958 and 1957 year-classes) are dominant. The mean ages are: A - 7.9; B - 7.2.

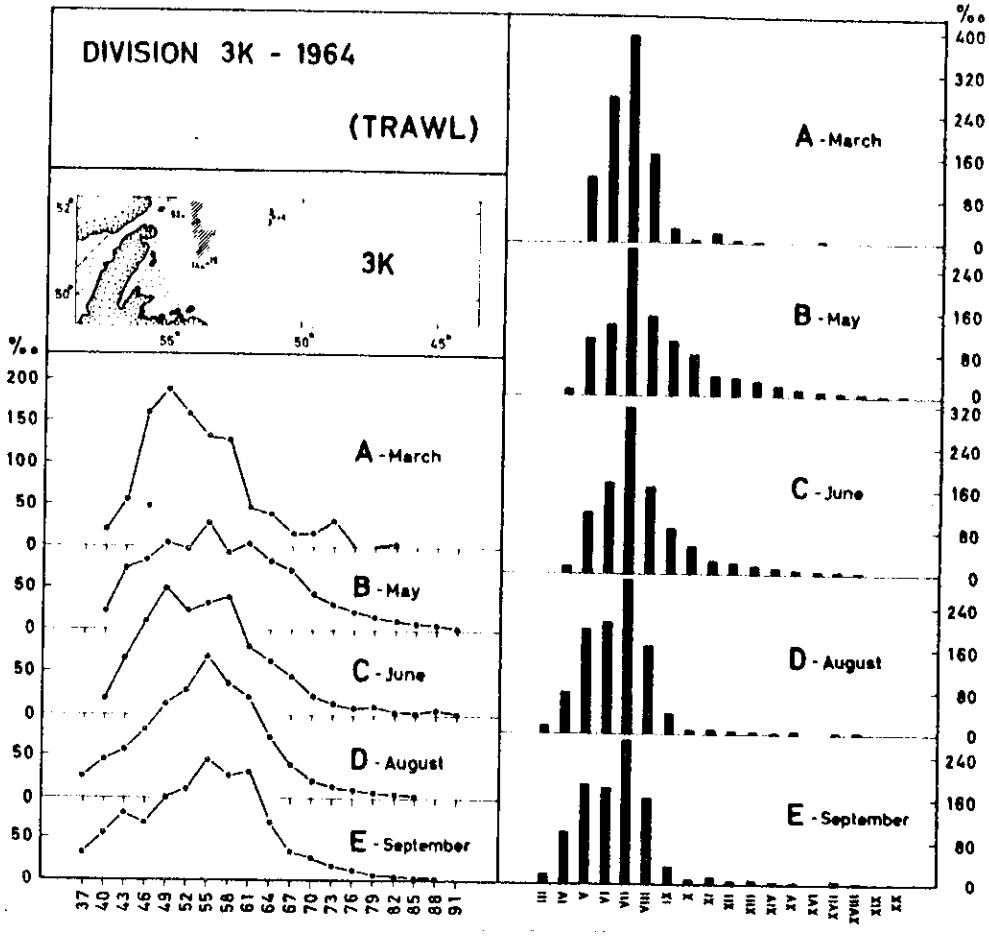


Fig. 3. Cod. Div. 3K. Length and age composition, March-September 1964.

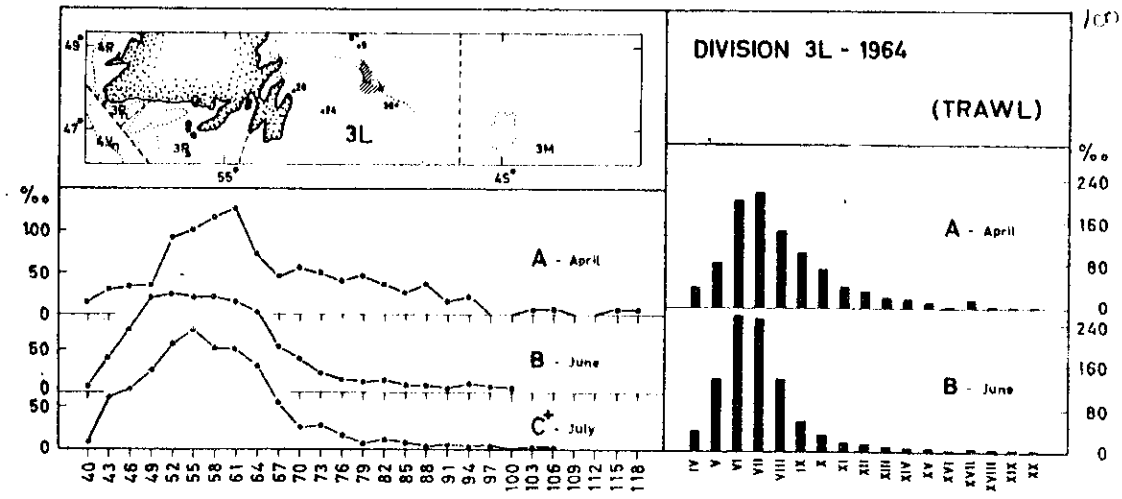


Fig. 4. Cod. Div. 3L. Length and age composition, April-July 1964.

c. Growth (figures in brackets are numbers of fish):

Division	3K			3L
Age group	1st Quarter Mar.	2nd Quarter May-June	3rd Quarter Aug.-Sept.	2nd Quarter Apr.-June
III	-	-	37.0 (5)	-
IV	48.0 (1)	43.3 (4)	39.9 (18)	44.0 (15)
V	45.4 (36)	46.1 (46)	46.1 (24)	48.7 (34)
VI	50.6 (68)	49.6 (54)	55.3 (18)	54.2 (70)
VII	53.6 (95)	54.4 (113)	60.2 (28)	59.2 (69)
VIII	57.4 (35)	58.1 (71)	64.9 (22)	66.4 (51)
IX	70.1 (7)	63.1 (36)	71.5 (12)	75.0 (44)
X	69.0 (1)	71.1 (31)	71.0 (3)	79.8 (35)
XI	68.3 (4)	67.2 (15)	77.4 (7)	83.4 (21)
XII	82.0 (1)	73.6 (21)	78.5 (4)	91.0 (26)
XIII	-	77.2 (13)	73.5 (2)	93.8 (19)
XIV	-	79.5 (11)	71.0 (1)	99.4 (19)
XV	-	79.8 (8)	87.5 (2)	99.6 (10)
XVI	-	89.9 (9)	-	100.3 (3)
XVII	-	90.4 (5)	-	104.7 (11)
XVIII	-	87.3 (4)	-	101.8 (5)
XIX	-	88.5 (2)	-	-
XX	-	-	-	107.0 (2)

d. Stage of maturity. In Div. 3K (Fig. 5), in both males and females, spawning is more intense from March to June, while in Div. 3L (Fig. 6), with data from May and June only, spawning occurs mainly during June.

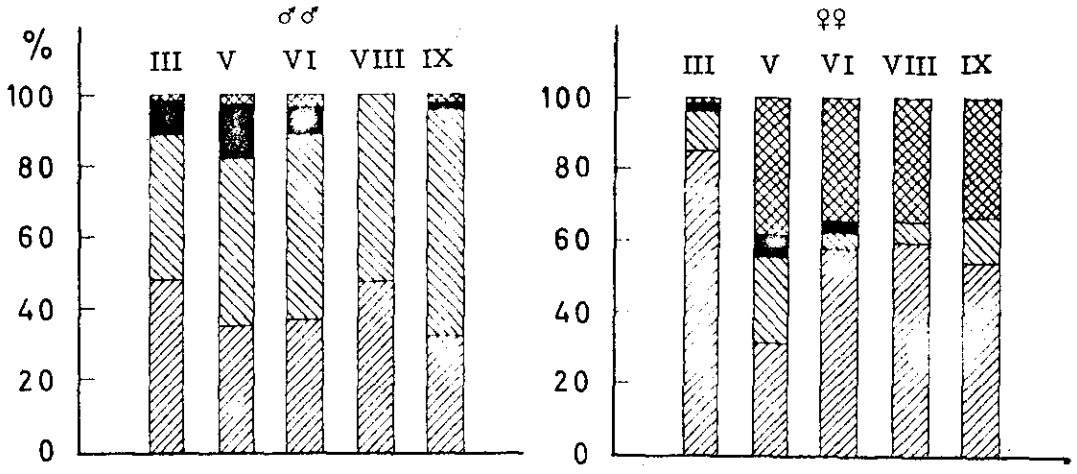


Fig. 5. Cod. Div. 3K. Stages of maturity, 1964. Post-spawning
Spawning Developing Resting or recovering

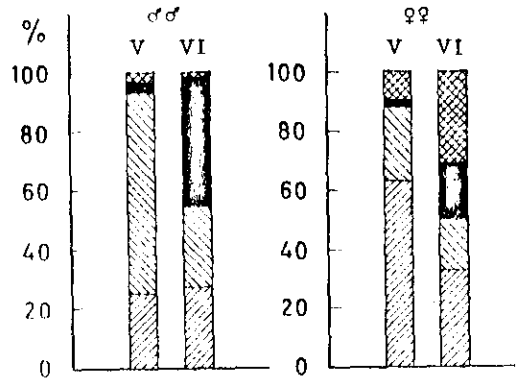


Fig. 6. Cod. Div. 3L. Stages of maturity, 1964.

- Post-spawning
- Spawning
- Developing
- Resting or recovering

e. Age at first maturity:

Div. 3K

1st Spawn. / Age Group	♂♂ VI	VII	VIII	IX	X	XI	XII	XIV	θ	?	Total	♀♀ VI	VII	VIII	IX	X	XI	θ	?	Total
III									2		2							3		3
IV									13		13							10		10
V									46		46							60		60
VI	2								58		60	4						75		79
VII	7	6							76	1	90	4	14					122	5	145
VIII		4	6						40	2	52	1	17	4				51	3	76
IX	1	3	2	1					15	1	23	1	3	3	4			18	2	31
X			5	1					8	1	15		4	4	3			9		20
XI		1		1	1				5	1	9		1	7	2			6	1	17
XII		3	2						2		7		4	1	1	3		9	1	19
XIII		2							3		5			1	3	2	1	3	1	11
XIV			1	1	1	1	1		3		8		1	1	1	2		2		7
XV				2					4	1	7				3	1	1			5
XVI				2					1		3		2	1	1	3		2		9
XVII					1				1		2			1	1			2	1	5
XVIII				1							1				1	1		1	1	4
XIX																1		1		2
XX								1			1									
No. observ.	10	19	16	9	3	1	1	1	277	7	344	10	46	23	20	13	2	374	15	503

Div. 3L

1st Spawn. / Age Group	♂♂ VI	VII	VIII	IX	X	XII	XIV	XVI	θ	?	Total	♀♀ VI	VII	VIII	IX	X	XI	XIII	θ	?	Total
IV									5		5								10		10
V									17		17								17		17
VI									29		29		2						39		41
VII	2	2							30		34		4						31		35
VIII	1	1	2						16		20	1	1	1					27		30
IX	3	6	3	1					13	1	27	1	1	2					12	1	17
X			4	3					7		14		2	2	2				13	2	21
XI			2						7	1	10		1	2	1		1		4	2	11
XII		2		1					11	3	17	1	1	1	1	1			4		9
XIII			2		1				5	1	9		1	1	1	1			6		10
XIV		2	1	1	1	1			2	3	11			3		1			4		8
XV			2	3							5		1		1				2		4
XVI			1								1			1	1						2
XVII			1	1					1	2	5			2	1			1	2		6
XVIII				1				1			2					1		2			3
XIX							1				1										
XX				1					1		2										
No. observ.	6	13	18	12	2	1	1	1	144	11	209	3	14	15	8	4	1	3	171	5	224

VIII. Spanish Research Report, 1964

by J. L. Arambarri, O. Cendrero and A. Figueras

Spanish otter trawlers and pair trawlers caught a total of 230,501 tons of fish in Subareas 1, 2, 3, 4 and 5 in 1964. The two types of fishing vessels landed almost equal amounts of, mainly, cod. However, otter trawlers were active in Subareas 2, 3 and 4, while the operation of the pair trawlers was confined almost entirely to Subareas 3 and 4. Table 1 shows the landings by species, type of fishing vessel and subarea for 1964.

TABLE 1. SPANISH OTTER TRAWL AND PAIR TRAWL LANDINGS (METRIC TONS) IN SUBAREAS, 1964.

	Otter Trawl				Pair Trawl				Grand
Subarea	Cod	Haddock	Various	Totals	Cod	Haddock	Various	Totals	Totals
1	743	-	-	743	-	-	-	-	743
2	45,285	3	73	45,361	-	-	-	-	45,361
3	51,184	318	629	52,131	66,060	1,587	451	68,098	120,229
4	16,628	35	188	16,891	38,633	4,974	3,689	47,296	64,187
5	-	-	-	-	18	2	2	22	22
Totals	113,840	356	890	115,086	104,711	6,562	4,142	115,415	230,501

Investigations on the biology, particularly the age and growth of cod, were carried out by O. Cendrero of the Laboratorio del Instituto Espanol de Oceanografia, Santander, from the commercial trawler Virazon during June, July and August in Subarea 3. The results of this research are to be found in 1965 Research Document No. 22 "Some aspects of the biology of cod from the Newfoundland fishing grounds in 1964".

Investigations on cod biology were also carried out by A. Figueras of the Instituto de Investigaciones Pesqueras, Vigo, from the trawler Aquilon of the PYSBE company from February to October in Subareas 2, 3 and 4. The results of this research are presented in 1965 Research Document No. 24 "Age and growth of cod caught by the Spanish trawler Aquilon in Subareas 2-4 in 1964".

In addition, J. Arambarri of the PYSBE company in St. John's, Newfoundland, has provided a "Summary of the 1964 Spanish fishing season" (1965 Research Document No. 38).

Subarea 2

A. Status of the Fisheries

I. Cod

Fishing was carried out mainly in Div. 2J in 1964. The bulk of the fleet arrived in the spring. Ice hampered fishing. Catches were good in the spring,

generally poor in the summer and improved in the late fall.

Cod sampled in Div. 2J averaged 59.8 cm in length with a dominant length-group of 54-56 cm. The 1958 year-class (6 years old) was dominant in the samples which had a mean age of 6.8 years. Age at first maturity averaged 6.1 years. Average length and age of cod showed a slight increase from 1960, 1961 and 1962.

Subarea 3

A. Status of the Fisheries

I. Cod

The main fishery was carried out in Div. 3L by otter trawlers and Div. 3K by pair trawlers. The dominant year-class in most samples in the divisions is the 1958 one. The 1957 year-class is still strong in the fishery. In Div. 3L the 1958 and 1959 year-classes make up more than one-half of the stock. The average length and age of the cod in the subarea has increased slightly from previous years. Cendrero (1965 Research Document No. 22) presents data on the cod length-girth relationship and feeding. Small cod feed on small copepods and amphipods and both small and large cod feed on sand-eels or capelin. Character of the otoliths of cod in the subarea and growth rates in each of Div. 3KLN have been studied by Figueras (1965 Research Document No. 24).

Subarea 4

A. Status of the Fisheries

I. Cod

Fishing by the pair trawlers and otter trawlers started in the subarea early in February. Samples taken in Div. 4R had the 1958 year-class dominant with an average age of 6.3 years and average length of 57.5 cm. In Div. 4Vn, cod sampled had a bimodal length frequency and average length of 48.9 cm. Again the 1958 year-class was dominant and cod averaged 5.9 years of age. In Div. 4Vs, the cod were large, averaging 65.7 cm in length, and averaged 6.2 years of age. In contrast to the cod in Div. 4R and 4Vn, the 1959 year-class is dominant.

IX. USSR Research Report, 1964

by A. S. Bogdanov, K. G. Konstantinov and A. S. Noskov

The total catch obtained by the USSR fleet in the ICNAF area in 1964 was 617,313 tons.

Table 1 shows the 1963 and 1964 catches of the main commercial species.

Table 1. Species composition of USSR catches in the Convention Area, 1963-64.

Species	1963		1964	
	Tons	%	Tons	%
Cod	81,658	16.6	129,053	20.9
Haddock	6,504	1.3	12,925	2.1
Silver hake	230,380	46.9	248,455	40.2
Other gadoids	5,528	1.1	11,830	1.9
Redfish	37,535	7.6	44,079	7.1
Scups	6,578	1.3	1,494	0.2
Herring	100,036	20.4	133,195	21.6
Argentine	12,337	2.5	17,773	2.9
Flatfish	3,282	0.7	4,904	0.8
Other fish	7,808	1.6	13,605	2.3
Total	491,446	100.0	617,313	100.0

The catches of all species, particularly cod and herring, have increased. On the other hand, the catch of scups has remained steady.

Table 2 shows the species composition of USSR catches in ICNAF subareas for 1963-64. In 1964 Subarea 1 was not fished by the USSR fishing vessels; research and exploratory vessels alone operated and fished in this subarea. The increase in catches in Subareas 2 and 3 may be attributed largely to an increase in the catches of cod and redfish. The catch in Subarea 4 decreased due to a drop in silver hake and redfish catches. The increase in the total catch from Subarea 5 resulted from an increase in herring and silver hake catches.

Table 3 gives the distribution of the total catch by subareas.

Table 3. Distribution of the USSR catch by subareas, 1963-64.

Subarea	1963		1964	
	Tons	%	Tons	%
1	6,302	1.3	-	-
2	25,116	5.1	69,294	11.2
3	63,756	13.0	96,923	15.7
4	165,440	33.6	115,166	18.7
5	230,832	47.0	335,930	54.4
Total	491,446	100.0	617,313	100.0

Table 2. Species composition of USSR catches (in metric tons) by subareas for 1963-64.

	1		2		3		4		5		TOTAL	
	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964	1963	1964
COD	5,053	-	20,833	57,097	40,201	56,464	10,221	10,064	5,350	5,428	81,658	129,053
HADDOCK	62	-	8	-	372	1,943	3,701	5,499	2,361	5,483	6,504	12,925
SILVER HAKE	-	-	-	-	-	-	123,023	81,147	107,357	167,308	230,380	248,455
OTHER GADOIDS	-	-	-	-	108	1,272	1,443	5,000	3,977	5,558	5,528	11,830
REDFISH	868	-	3,808	8,636	19,485	31,339	12,288	3,659	1,086	445	37,535	44,079
SCUPS	-	-	-	-	-	-	1,946	-	4,632	1,494	6,578	1,494
HERRING	-	-	-	-	-	-	2,707	2,472	97,329	130,723	100,036	133,195
ARGENTINE	-	-	-	-	-	-	8,127	4,943	4,210	12,830	12,337	17,773
FLATFISH	35	-	251	1,268	2,056	3,431	631	146	309	59	3,282	4,904
OTHER FISH	284	-	216	2,293	1,534	2,474	1,353	2,236	4,221	6,602	7,608	13,605
TOTAL	6,302	-	25,116	69,294	63,756	96,923	165,440	115,166	230,832	335,930	491,446	617,313

Subarea 1

A. Status of the Fisheries

In 1964 no regular fishing was conducted by the USSR fishing vessels off West Greenland. The area was visited by exploratory and research vessels which caught only 760 tons of fish for research purposes. Severe ice conditions complicated the operations of these vessels during the spring months.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. Altogether four exploratory and research vessels conducted routine hydrological studies and worked 32 standard sections in Davis Strait and on the West Greenland Shelf.

In January 1964, the temperature of the 0-50 m layer along the West Greenland coast was found to be below zero. Compared with 1963 conditions, the cold water brought by the West Greenland Current was more extensive. Very severe ice conditions were observed in May 1964 along the southwestern coast of Greenland. The temperature of water in the 0-50 m layer was 0.6-1.2°C lower than in May 1961. However, in the 200-500 m layer the water temperature was higher in 1964 than in 1961.

In July-September 1964, a rapid and intense warming of water was observed. The distribution pattern of the warm water of the West Greenland Current was similar to that observed in previous years. Similar to 1961-63 a stream of relatively cold water with a temperature of 1-2°C and salinity of 34.5‰ was observed at 500-650 m in the area of the Canada-Greenland Ridge between 58° and 59°E.

In September 1964, the stream of the West Greenland Current was very distinct as usual, but the water temperature increased rapidly during the second half of the year and in November was 1.3°C higher than in the same month in 1963.

2. Plankton. Plankton sampling was done by vessels that conducted hydrological studies. Plankton samples taken from mid-water off West Greenland in September 1964 were characterized by the abundance of Aglantha digitale and small Copepoda. Mature Calanoida were in the near-bottom layers only.

Distribution of Euphausiidae along the coast of West Greenland was studied in January and May. The abundance of Euphausiidae was mainly neritic species such as Thysanoessa inermis and Thysanoessa raschii which were

most abundant on Lille Hellefiske Bank, Banan and Fyllas Banks. On Fiskenaes, Danas and Frederikshaab Banks, these species were scarce or absent.

Stable concentrations of Th. raschii were observed on Store Hellefiske Bank.

II. Biological Studies

1. Cod. The 3-year-old cod belonging to the rich 1961 year-class, which were 36 to 38 cm long in the first half of the year, were most abundant on Frederikshaab Bank and, in some instances, formed as much as 15% of the number of cod in the catch. On Fyllas, Banan and Lille Hellefiske Banks, they were less abundant and formed about 4-11% of the catch. In the second half of the year, the 3-year-old cod reached a length of 50 cm and occurred more often in catches on Fyllas and Banan Banks making up as much as 25-30% of the catch.

The 4-year-old cod belonging to the highly abundant 1960 year-class, which ranked first in catches, kept to more northern areas and were most abundant on Fiskenaes, Fyllas, Banan and Lille Hellefiske Banks. These cod made up 33-85% of the catch by number. Mean length of these cod was 46-48 cm in the first half of the year and 58 cm in the second half of the year.

The 5-year-old cod belonging to the 1959 year-class (mean length 57 to 61 cm in the first half and 65 cm in the second half of the year) occurred in catches in relatively small numbers, in some cases making up 20% in Div. 1C and 1D. On the average the share of this year-class in catches did not exceed 5-10%.

The same applies to the 6-year-old cod belonging to the 1958 year-class (mean length 64-70 cm). The 6-year-olds were most abundant in spring on Frederikshaab Bank. Cod belonging to the rich 1957 year-class which formed the basis of fishery in 1962-63 occurred in considerably smaller numbers.

The 7-year-olds were most abundant in catches (15-30%) at the beginning of the year on Banan, Fyllas and Fiskenaes Banks during the period of their spawning migrations through these areas. In May, 7-year-olds made up about 36% by number of the spawning cod on Frederikshaab Bank. Towards the end of the year (November-December) they were again caught in considerable numbers on the central banks. The mean size of 7-year-olds was 71-74 cm in the first half of the year and 79-80 cm in the second half of the year. The 8-year-old cod (80-88 cm mean length) of the 1956 year-class were of some importance on Frederikshaab Bank in May where they made up 12-13% of the catch; on other banks, their numbers were insignificant (2-4%). Older age-groups were represented in very small numbers (0.1-8%) and mainly in spawning and post-spawning concentrations on the southern banks. On Frederikshaab

Bank, cod belonging to the rich 1953 year-class amounted to 7-8%.

In 1964 fishing conditions off West Greenland were less favourable than in 1963. Concentrations of wintering cod in the area of central banks which contributed to a good and stable fishery in the first half of 1963 were, in 1964, less abundant and unstable. Cod belonging to the rich 1956 and 1957 year-classes which formed the basis of the fishery in 1963 were, in 1964, almost all mature and started performing earlier and longer migrations to spawning grounds, which resulted in a shorter winter fishery on Banan and Fyllas Banks. The bulk of young cod of the 1960 and 1961 year-classes which were spending the winter on these banks had not yet reached commercial size and could not contribute to a productive fishery.

The fishery for post-spawning cod in 1964 was hampered due to severe ice conditions.

The cod fishery off West Greenland in the next 2 or 3 years is expected to be good due to the abundant 1960 and 1961 year-classes.

2. Redfish. Investigations were carried out in May and September. In autumn, only individual specimens of young redfish, up to 25 cm long, were caught by trawls with fine-meshed flappers. South of 64°N mid-water trawls caught up to 400 one-summer-old fish from depths of 200-300 m.

Serological studies were carried out in the latter half of the year in an attempt to extend knowledge on the systematics of the genus Sebastes and to distinguish local stocks.

Subarea 2

A. Status of the Fisheries

Catch (tons)

	Cod	Haddock	Redfish	Flatfish	Other fish	Total
1963	20,833	8	3,808	251	216	25,116
1964	57,097	-	8,636	1,268	2,293	69,294

I. Cod

In Div. 2J, cod occurred in commercial quantities from January to mid-July and from October to December. Most stable catches were taken during the former period. In Div. 2H, dense cod concentrations were discovered in the latter half of January and, in Div. 2G, in the latter half of February.

However, difficult ice conditions prevented the fishery from utilizing commercial cod concentrations in these divisions.

The efficiency of the cod fishery by stern trawlers (BMRT) in Div. 2J remained at the 1961-63 level. The size composition of cod in trawl catches was similar to that in 1963. The bulk of the catches consisted of 45-63 cm long fish. Cod belonging to the 1956 and 1957 year-classes were numerically predominant in the catches.

II. Redfish

The greater part of the redfish catch in the Labrador area was obtained in the spring during the cod fishery when considerable amounts of redfish were caught with cod at depths over 400 m. In October, dense concentrations of Sebastes mentella with about 10% of Sebastes marinus were fished successfully in 300-450 m off central Labrador. BMRT catches per hour trawling amounted to 7-8 tons. Males, 38 cm long, with gonads at stages V, VI and VI-II of maturity were dominant. The mean length of females was 38-40 cm.

B. Special Research Studies

I. Environmental Studies

1. Hydrology and plankton. Altogether five research and exploratory vessels took part in collecting hydrological and hydrobiological material, some of them performing two or three cruises.

Compared with 1963, a slight warming of water masses was observed. However, 1964 remained a moderately cold year. The inflow of cold polar water increased towards summer. The section occupied off Cumberland Peninsula in September showed that the Canadian Polar Current was more intense than anytime during the past four years.

Along the coasts of Baffin Island, mass development of phytoplankton and spawning of Calanoida was observed in September.

II. Biological Studies

1. Cod. Observations on the distribution of pre-spawning and spawning concentrations of Labrador cod were conducted from May to September. These observations seem to confirm the conclusions reached in 1963 that the main spawning grounds of cod are located in Div. 2G.

Spawning cod also occurred in Div. 2J and 2H. They belonged mainly to age-groups younger than those in Div. 2G. The dominant size of mature cod was 54-56 cm in Div. 2G and 48-50 cm in Div. 2J and 2H.

In March, April and early May, cod eggs were found along the whole length of the edge of the continental slope in Subarea 2. The greatest number of eggs per one vertical haul by egg net was obtained in Div. 2G. Eggs at the earlier stages of development were dominant.

2. Redfish. Material was collected regularly on size and age composition, feeding and distribution. Observations at depths over 600 m were continued and showed that mature redfish were absent from great depths.

In June 1964, work aimed at studying the structure of the redfish stock in northwestern Atlantic was started to confirm the presence or absence of isolated local populations and groups of Labrador-Newfoundland Sebastes mentella.

Subarea 3

A. Status of the Fisheries

Catch (tons)

	Cod	Haddock	Other gadoids	Redfish	Flatfish	Other fish	Total
1963	40,201	372	108	19,485	2,056	1,534	63,756
1964	56,464	1,943	1,272	31,339	3,431	2,474	96,923

I. Cod

Big deep-freeze trawlers fished for cod mainly on Flemish Cap Bank in March and on the northern Newfoundland Bank from February to April. Side trawlers fished on the northern Newfoundland Bank in March and June and on Flemish Cap Bank throughout the entire second half of the year. Redfish were also caught here.

II. Redfish

Fishing for Sebastes mentella was carried out in late May and in December on Flemish Cap Bank at depths over 500 m. In May, the catch per 2 hours' trawling was 5 tons. The bulk of the catch was composed of 33-35 cm long specimens. Females were in post-spawning condition and were feeding heavily. Main concentrations occurred in feeding areas. In the second half of November, side trawlers operated on the northeastern slope and in the adjacent area of the northern Newfoundland Bank where they fished on fairly dense cod and redfish concentrations. The mean daily catch by a side trawler was 5-7 tons. In December, dense redfish concentrations were located and successfully fished at depths over 500 m on the slopes of Flemish Cap Bank.

B. Special Research Studies

I. Environmental Studies

1. Hydrology and plankton. Studies conducted by five research and exploratory vessels revealed that there was a slight warming both in Subarea 3 and in Subarea 2 in the first half of 1964. Thus, in the spring of 1964, in the section made along 47°N the mean temperature of the 0-100 m layer was 1.14°C higher and that of the 0-500 m layer 0.15°C higher than in the spring of 1963.

In January-February 1964, the annual quantitative survey of Euphausiidae was conducted off Labrador and Newfoundland. Oceanic species, Meganyctiphanes norvegica and Thysanoessa longicaudata, were dominant in these areas. Considerable amounts of Th. inermis and Th. raschii were only recorded on Saint Pierre Bank and on the southwestern slope of the Grand Newfoundland Bank. The latter two species were absent from samples taken on Flemish Cap Bank.

II. Biological Studies

1. Cod. A young cod survey was carried out in January-March and in December 1964. Samples were taken with a 25 m bottom trawl with a conventional bag and a 6-8 m long, 10 mm mesh, codend flapper. Specimens up to 35 cm long were only considered.

In February 1964 on the part of the northern Newfoundland Bank surveyed (Div. 3K), the majority of young cod occurred in 200-300 m in the frontal zone of mixed waters of Polar and Atlantic origin with temperatures ranging from 2° to 3°C. In January, catches at 300 m contained up to 200 specimens of young cod per hour's trawling. The bulk of the catches contained young cod 24-35 cm long. Only single young specimens were taken by trawl at depths over 350 m.

Great numbers of young cod were discovered on the northeastern slope of the Grand Newfoundland Bank (Div. 3L). In February, test fishing revealed that, in this division, young cod occurred mainly from 150 m to 350 m, in mixed waters with temperatures varying from -1° to 3°C. At 200-350 m, young cod catches per hour trawling were 100 to 200 specimens. Young cod, 26-33 cm long, were dominant in the catches.

On Flemish Cap Bank (Div. 3M), single specimens of young cod occurred in catches taken in February. The total number of young cod caught here was considerably lower than in the other areas surveyed. In December, the catch per hour trawling at 145-160 m contained 90 specimens.

On Saint Pierre Bank (Div. 3P) in March, the majority of young cod occurred at 100-300 m. The catch per hour trawling at 150 m was sometimes as high as 200 specimens.

On the southwestern and southeastern slopes of the Grand Newfoundland Bank (Div. 3O and 3N), young cod occurred in March in insignificant quantities. In December 1964, a large concentration of young cod was discovered here mainly at depths ranging from 100-250 m. Catches per hour trawling were sometimes as high as 250 to 900 specimens. Young cod did not occur in catches taken below 250 m.

In the northern part of Div. 3K, commercial concentrations of cod occurred from January to July. In late June and early July, cod concentrations migrating toward the Newfoundland coast were discovered in the western part of the area. Size composition changed during the course of the year. The dominant length was 55-57 cm in January-February, 46-48 cm in March, 49-51 cm in April-June, 58-60 cm in July, 55-57 cm in August, 43-45 cm in September, 58-60 cm in November and 55-57 cm in December. These changes in size composition were connected with the spring migration of mature cod to the Labrador area and summer migration back to the coast of Newfoundland. In Div. 3K, cod eggs occurred from March to May. The eggs were at different stages of development, more often at stages III and IV. These eggs appear to have been carried from the northern Labrador area (Div. 2G) and partly from central Labrador (Div. 2H).

2. Haddock. Distribution of young and adult haddock was studied in four areas. A young fish survey was conducted with the help of a trawl with an 8 mm mesh flapper.

In mid-March haddock were scattered over the southern part of Saint Pierre and Green Banks (Div. 3P) and were caught in 140-490 m at near-bottom temperatures ranging from -1.2°-3.3°C. Catches of 0.1-0.2 tons per hour trawling were obtained in 180-250 m at the water temperature from 2.2°-2.3°C. The bulk of the catch was haddock belonging to 1962 year-class. The largest catch of young fish (450 specimens per hour trawling) was taken on the southern part of Saint Pierre Bank at 150-300 m and at 0.5°C. In Div. 3O, haddock were also scattered from 100-590 m. Water temperature just off the bottom was 0.2° to 3.2°C. Catches of 0.1-0.2 tons per hour trawling were taken at 155-215 m in temperatures from 1.2°-1.3°C. Haddock caught (up to 660 specimens per hour trawling) were of the 1962 year-class from 230-275 m at 1.4°C, trawl catches were 0.3 tons per hour. The bulk of the catches was made up of haddock belonging to the 1962 and 1961 year-classes. Up to 0.1 tons of mature haddock per hour trawling were caught in 300-590 m depths at 3.2°C. In early June, no commercial concentrations were found on the shallows of Div. 3N. In early October, trawl catches of up to 0.3 tons per hour were made on the southern part of Saint Pierre and Green Banks at 110-185 m. The bulk of the catch consisted of 1961 and 1962 year-classes. No commercial

concentrations were found in Div. 3N. In mid-December, 554 haddock of the 1964 year-class were taken after an hour's trawling in the western part of Saint Pierre Bank (Div. 3P) at 85-150 m depth and 0.1°C.

Larger haddock were dispersed along the edge of the bank slopes at the bottom temperatures of 2° to 4°C. The bulk of the catch consisted of the 1962 year-class.

On the southwestern and southern slopes of the Grand Bank (Div. 3O and 3N), haddock were at 100-240 m in 2° to 3°C. The best trawl catches of 0.2-0.3 tons per hour were made at 100 m and 2°C and at 180-240 m and 1.4°C.

The bulk of the catch was made up of the 1962 and 1961 year-classes. Individual specimens of the 1964 year-class were caught.

Subarea 4

A. Status of the Fisheries

	catch (tons)						
	Cod	Haddock	Silver hake	Other gadoids	Redfish	Scups	Herring
1963	10,221	3,701	123,023	1,443	12,228	1,946	2,707
1964	10,064	5,499	81,147	5,000	3,659	-	2,472

	Argentine	Flatfish	Other fish	Total
1963	8,127	631	1,353	165,440
1964	4,943	146	2,236	115,116

I. Silver hake

As in 1963, the main fishery in Subarea 4 was for silver hake. A decline in the 1964 catch may be attributed to conditions less favourable for fishing than in 1963.

In 1963, trawlers were able to fish for silver hake throughout the year. In 1964, hake concentrations were only observed from late February to the second half of September. The concentrations were unstable and the trawlers often had to start searching for concentrations. The absence of hake concentrations in the winter of 1964 from areas where they occurred in previous years seems to be accounted for by a drop in the temperature of water on the Nova Scotian

Shelf. Thus, in the winter of 1962-63, the temperature in the off-bottom layer in the depression between Sambro and Emerald Banks, where dense hake concentrations were observed, was between 5.5° and 7.8°C; at the same period in 1963, it never rose above 6°C. In early February BMRT-type vessels were fishing for hake on the slopes of LaHave Bank. In March BMRT-type trawlers were fishing successfully on the slopes of Sambro Bank. Trawl catches per hour ranged from 2-4 tons and contained up to 5% of argentine. In May some vessels were fishing on the edge of the slopes off Sable Island. The average trawl catch was 3.2 tons per hour. In June, the density of hake concentrations decreased and trawl catches did not exceed 3 tons per hour. In July-August, successful fishing was carried out in the Nova Scotian gut at 80-180 m and, in September, on the shallows of Sable Island. In late September, there was a sharp drop in hake catches and in October-November, contrary to the previous year, no commercial concentrations were discovered in the area of Sable Island.

The by-catch of the hake fishery in Subarea 4 consisted of cod, redfish, haddock and argentine.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. Hydrological investigations were carried out from research-exploratory vessels. A total of 5 cruises was made to Subareas 4 and 5. Investigations were conducted both in standard sections and in areas of commercial concentrations of fish.

In 1964, the Nova Scotian Shelf and Georges Bank were characterized by a considerable drop in water temperature as compared to 1962-63. This may be explained by a stronger influence of cold Labrador water and a weaker intrusion of warm Atlantic water. The average temperature in the mid-water and near-bottom layers was everywhere 2° to 3°C lower than in the previous year and in some areas (the Eastern Channel) as much as 5°C lower. The greatest decline in water temperature was observed in April and May. A decline in water temperature which started in 1963 continued up to May 1964. From May to August, a considerable warming of lower water layers from 2.8°-4.5°C to 6.5°-6.9°C was observed. Later the temperature was not stable, it was higher in the Eastern Channel and lower on the southeastern slopes of Georges Bank and the Nova Scotian Shelf. Toward the end of 1964, the mean temperature of the mid-water and near-bottom layers in the area of the Nova Scotian Shelf and Georges Bank reached the level observed at the end of 1963.

II. Biological Studies

1. Silver hake. In 1964, observations were continued on the size and

age composition of the catches. As in 1963, scales were used for age reading. Some otoliths were also collected for comparison. A comparison of the results of age readings by scales and by otoliths showed that neither method is more advantageous. Difficulties in age determinations were experienced in both cases.

In 1964 the bulk of the catch was made up of 3- and 4-year-olds; the number of 5-year-old and older fish was insignificant. In July 3-year-olds made up 48.3% of the catch, 4-year-olds 40.6%, while 5-year-olds belonging to the 1959 year-class only 2.7%. In August, the percentages were 54.4, 31.3 and 7.7 respectively. The size composition of catches did not change much from the 1963 composition and ranged between 25 and 35 cm (mean length 30 cm). The bulk of the catch was made up of 3-year-old males and 4-year-old females which had attained sexual maturity for the first time. The number of 5-year-olds in the catches was insignificant due to the high natural mortality of hake at this age.

Subarea 5

A. Status of the Fisheries

Catch (tons)

	Cod	Haddock	Silver hake	Other gadoids	Redfish	Scups	Herring
1963	5,350	2,361	107,357	3,977	1,086	4,632	97,329
1964	5,428	5,483	167,308	5,558	445	1,494	130,723

	Argentine	Flatfish	Other fish	Total
1963	4,210	309	4,221	230,832
1964	12,830	59	6,602	335,930

I. Silver hake

In 1964, the USSR silver hake catch from Subarea 5 increased from that in 1963 and the fishery was conducted not only in summer but in winter and spring as well.

In January, BMRT-type vessels fished on hake concentrations in 150-300 m north of Georges Bank. The average catch per hour trawling was 3.3 tons. Better catches were made during the night hours. During the third

10-day period of February, the catches obtained in the daytime were dominated by argentine and the daytime catches were greater than those taken at night. Toward the end of March, dense hake concentrations were discovered on the southwestern slopes of Georges Bank. From late March to late April, BMRT-type trawlers fished successfully in depths ranging from 180-280 m. The average catch per hour trawling was 4.2 tons in March and 4.6 tons in April. In May, there was a drop in catches. Catches obtained in June were comparatively low. The mean catch per hour trawling by BMRT-type vessels was 2.9 tons in May and in June. The decline in hake catches observed in May and in June seems to have been caused by the unfavourable hydrological conditions.

In 1962-1963, spawning concentrations of hake were observed on the southern slopes of Georges Bank in areas with near-bottom temperatures of 10° to 12°C. In 1964, the temperature of the near-bottom layers on the southern slopes of Georges Bank was only 6° to 7°C. Spawning concentrations were unstable and scattered over a large area along the edge of the continental slope. The temperature of 6° to 7°C was apparently not high enough for the formation of stable concentrations of spawning hake. The 1964 spawning was extended over a longer period of time than in 1962-1963. With a rise in temperature to 10° to 11°C in July, hake concentrations became comparatively more dense and trawl catches were 2.5 to 4.0 tons per hour.

In August and September some of the vessels started fishing for hake on the northwestern slopes of Georges Bank. Along with hake, they caught some herring and haddock. In October-November, hake concentrations were poor.

II. Herring

The increase in herring catches in 1964 was due to higher abundance resulting from the recruitment of the relatively rich 1960 year-class into the fishable stock.

In winter and in March, herring were fished on the northwestern and southern slopes of Georges Bank. Herring were fished intensively from May to early October. In May-June, trawl catches per hour by SRT-R and SRT-type vessels were 0.7-0.9 tons. In August when herring concentrated on the northern slopes of Georges Bank and on the Bank itself, trawl catches increased to 1.5 tons per hour. During the pre-spawning and spawning period in September and early October, herring formed abundant concentrations in the northern part of Georges Bank at 40-50 m. SRT- and SRT-R-type vessels obtained high trawl catches per hour (average 10 tons).

After spawning in October, herring moved away from Georges Bank and fishing operations were terminated.

B. Special Research Studies

I. Environmental Studies

1. Zooplankton. In 1964, zooplankton samples were collected from the exploratory vessels at standard stations in March, May, August and October. Additional samples were taken on the slopes of Georges Bank in June and September. In all cases the entire depth from the bottom to the surface was sampled. A total of 567 samples was taken.

Analysis of the material collected suggests that, during the spring period, the abundance of plankton on Georges Bank was, on the whole, higher in 1964 than in 1963.

In 1964, two breeding periods for Calanus finmarchicus were observed: in February-March and in July-September.

The specific composition of zooplankton was poorer in 1964 than in 1963 due to lower temperatures.

2. Ichthyoplankton. In August 1964, ichthyoplankton was sampled on the hake spawning grounds in the southern part of Georges Bank. Observations showed that, from 13 to 18 August, all samples taken on the southern slope contained hake eggs. In the 0-50 m layer, one cubic metre contained 1.1 to 30.4 eggs. Small numbers of eggs were encountered on the southeastern slopes. From 19-25 September, samples contained a single larva of silver hake.

II. Biological Studies

1. Silver hake. In 1964 observations were continued on the size and age composition of the hake catches. Analyses of size and age composition of commercial and test catches seem to have confirmed the previous year's conclusions that the bulk of the catch consists of 3- and 4-year-old hake. The share of the 3-year-old fish (1961 year-class) was 31.8% in April, 33.3% in May, 45.4% in June, 54.3% in July and 44.1% in August.

The percentage of 4-year-olds was 52.3, 48.5, 40.6, 35.4 and 41.6 respectively. The average percentage of hake aged 5 full years and older for this period was only 11.0%. Males were predominant among the 3-year-olds but females among the 4-year-old fish.

Thus, observations conducted in 1964 seem to confirm that hake over 4 years of age are subject to high natural mortality.

Hake were tagged on Georges Bank from 18-28 August at 41°37'N and 68°18'W. Altogether 5,200 fish were tagged. Hake for tagging were taken from

trawl catches. A total of 55 tags have been returned. However, since most of the tags have been returned by the consumers, it is difficult to say where the fish were caught.

2. Herring. In 1964, observations on the age composition of catches revealed that, in January, herring belonging to the 1961 and 1960 year-classes were predominant in the catches (32.6% and 24.0% respectively). In March and April, catches were dominated by older herring belonging to the 1957 (up to 53.0%) and the 1956 (up to 37.3%) year-classes. In June, there was an increase in the percentage of herring of the 1959 and 1958 year-classes.

From July to October, when the main part of the herring stock was concentrated on the northern slopes of Georges Bank, the 1960 year-class was dominant (47.9% in July, 46.0% in August and 34.3% in September). Samples taken in July-September seem to give the most representative picture of the age composition of Georges Bank herring. The bulk of the catch is obtained at this time. Data on age composition seem to suggest that the 1960 and 1961 year-classes will predominate in the 1965 catches. The commercial herring stock is expected to increase somewhat from that in 1964.

In September and early October, the northern slopes of Georges Bank were surveyed to find out the areas, time and conditions of spawning and the numbers of eggs laid in order to be able to estimate the absolute abundance of the herring spawning population.

Four surveys were performed in the areas of pre-spawning and spawning herring concentrations. Egg samples were taken at stations with the "Ocean-50" bottom sampler (0.25 m^2). At the same time, observations were made on the biological condition and distribution of herring and on the hydrological conditions in spawning areas. No eggs were taken during the first three surveys (4-5 September, 16-17 September and 27-28 September). The fourth survey (5 October) made after mass spawning from September 29 to October 4 resulted in masses of eggs being discovered over an area of about 50 km^2. Of the 25 stations sampled eggs were taken at 10.

Eggs were deposited in several rows in a continuous 0.5 to 4 cm thick layer on pebble, gravel and shelly grounds in waters with temperatures ranging from 6°-12°C. At all stations sampled, eggs were at the stage of larval formation (mainly at the stage of formation of head capsule). Individual dead eggs were discovered.

X. United Kingdom Research Report, 1964

by C. E. Lucas and R. J. H. Beverton

Subareas 1-5

A. Status of the Fisheries

In 1964 UK landings from the ICNAF area increased to 44,000 tons compared with 25,000 tons in 1962 and 35,000 tons in 1963. Landings from Newfoundland (Subarea 3) rose to 15,000 tons and accounted for the greater part of the increase, but the amount of UK fishing in the Newfoundland area has more than doubled. Landings from West Greenland (Subarea 1) remained steady at 24,000 tons with the fishing effort concentrated mainly in Divisions 1EF as in 1963. At Labrador (Subarea 2), Nova Scotia (Subarea 4) and New England (Subarea 5), the UK fishing effort and landings increased slightly but together these only represent 6% of the UK landings from the ICNAF area.

The catch per 100 hours fishing remained steady at West Greenland (Subarea 1) but fell at Newfoundland (Subarea 3).

B. Special Research Studies

I. Environmental Studies

UK research vessels did not work in the ICNAF area in 1964, but a number of members of the Lowestoft, Aberdeen and Edinburgh laboratories have been actively engaged in processing, evaluating and reporting upon the material collected during the 1963 NORWESTLANT Surveys. The Continuous Plankton Recorder Survey has been maintained and developed in the ICNAF area, on which a more detailed account by Mr R. S. Glover is attached.

II. Biological Studies

Routine sampling of landings by conventional trawlers has been continued at Hull and Grimsby and is being extended to landings of freezer trawlers. Sampling has also been maintained on board the Fairtry factory trawlers. The sampling is summarised in Table 1; results will be presented for inclusion in the Sampling Yearbook.

Table 1. Number of fish measured and otolithed (brackets) from the ICNAF area in 1964.

Area	Trawler Type				
	Conventional		Factory		Freezer
	Cod	Cod	Haddock	Coalfish	Cod
West Greenland	9,324 (448)	2,003 (34)			)
Newfoundland	1,390 (34)	31,941 (652)	323 (6)	190	) 1,133
Labrador	626				)
Nova Scotia		434 (33)	185 (5)	129	
New England			319 (11)	105 (6)	

Annex to
United Kingdom Research Report, 1964

by R. S. Glover

The Continuous Plankton Recorder Survey was continued on the same basis as in previous years. Danish, Icelandic and British merchant ships, and US Coast Guard cutters provided nearly 28,000 miles of sampling. Whenever possible, samples were taken once in each month on nine standard routes within the ICNAF area, as part of a survey of the North Atlantic Ocean and North Sea which yielded a total of almost 110,000 miles during the year. The program was supported by a grant from the British Treasury and Contract N62558-3612 between the Office of Naval Research, Department of the United States Navy, and the Scottish Marine Biological Association.

The mileage sampled in 1964 is shown below for each of the ICNAF subareas in each month and for the whole year.

Subarea / Month	1	2	3	4	5	Total	No. of Records
	miles	miles	miles	miles	miles	miles	
Jan.	20	220	2,035	287	-	2,562	9
Feb.	-	230	1,439	155	-	1,824	5
Mar.	520	306	1,399	216	-	2,441	8
Apr.	40	271	787	-	-	1,098	3
May	192	250	1,615	417	127	2,601	10
June	175	542	1,872	255	-	2,844	9
July	659	248	145	210	128	1,390	4
Aug.	828	1,479	426	-	-	2,733	9
Sept.	555	557	1,292	377	130	2,911	8
Oct.	490	878	894	476	122	2,860	9
Nov.	305	680	454		-	1,439	6
Dec.	533	905	1,510	200	120	3,268	10
Total	4,317	6,566	13,868	2,593	627	27,971	90

The results will be incorporated into the analysis of the distribution and abundance of the plankton which is the primary objective of the Edinburgh laboratory. Among topics studied during 1964 relating especially to the ICNAF area were:

a. Analysis of plankton collections made by Danish and German ships (as well as the Plankton Recorder) during the NORWESTLANT Surveys.

b. Studies of the food of larval cod and redfish, especially during the NORWESTLANT Surveys. This work has shown that the diet of redfish larvae consists almost exclusively of Calanus eggs, but cod larvae from the same area take very few eggs and many nauplii and copepodites. For a given size range, the guts of cod larvae contain fewer but much larger organisms than redfish larvae.

c. Analysis of parasites, food, fecundity and other biometric characters of adult Sebastes taken at Weather Station ALPHA and by Danish research vessels in the NORWESTLANT cruises.

d. A detailed morphological and ecological study of Calanus finmarchicus and Calanus glacialis. This has shown that there is a continuous morphological series between the two so-called species: there are no firm diagnostic distinctions between them.

e. The preparation of further publications in the "plankton atlas" series, incorporating results from the western Atlantic, including the ICNAF area.

XI. United States Research Report, 1964

by Herbert W. Graham

The United States landed fish from Subareas 3, 4 and 5 and conducted research in these three subareas as well.

Subarea 3

A. Status of the Fisheries

I. Redfish

US landings for Subarea 3 were mostly from the Grand Bank, Divisions 3N and 3O.

Landings in 1964 dropped sharply over the 1963 figure which, in turn, was somewhat lower than the preceding years. The sharp drop in landings in 1964 was the result of lowered effort. Landings per day fished increased slightly in 1964 (Table 1).

Table 1. US redfish statistics, Subarea 3, 1964 (metric tons, round fresh).

Year	Landings	Days fished	Landings/Days fished
1954	31,269	1,786	17.5
1955	13,406	1,126	11.9
1956	13,304	943	14.1
1957	4,797	289	16.6
1958	10,859	688	15.8
1959	16,871	1,120	15.1
1960	15,393	1,049	14.7
1961	16,706	1,056	15.8
1962	14,257	898	15.9
1963	12,098	918	13.2
1964	4,692	328	14.3

B. Special Research Studies

I. Environmental Studies

The US Coast Guard, as the agency operating the International Ice Patrol, examined the temperature and salinity distribution from the surface to 1,500 m in five network surveys of the Grand Banks region. The first survey, 15-27 March, covered the waters over and immediately seaward of the southern slopes of the Grand Banks from just westward of the Tail of the Banks northward to approximately 44°15'N. The second survey, 4-16 April, covered

the waters over and immediately seaward of the eastern slope of the Grand Banks from 44°15'N northwestward and included Flemish Cap and the Bonavista Triangle. The third survey, 2-13 May, covered an area similar to the combined first and second up to Flemish Cap. The fourth survey, 27-30 May, covered the Bonavista Triangle and the waters eastward to approximately 47°40'W. On the fifth survey, 9-19 June, the waters to the south of Flemish Cap were covered as in the third survey. The post season survey, 17-28 July, occupied the Bonavista Triangle and the Labrador Sea section, South Wolf Island, Labrador, to Cape Farewell, Greenland, to within 20 miles of shore at Cape Farewell. A 24-hour period was spent on Ocean Station BRAVO 56°30'N 51°00'W. Six oceanographic casts were made in an effort to tie in the OSV time-series data with the general study of the Labrador Sea.

A 10-day project was carried out between the third and fourth surveys. During this time, iceberg drift and deterioration parameters were studied. Station buoys, drogues, bathythermograph drops and Nansen casts were utilized in the vicinity of an iceberge for this study.

A buoy was moored in 340 m of water on the eastern slope of the Grand Banks at approximately 45°00'N. A continuous temperature pressure recorder was suspended at 50 m below the buoy to monitor possible intrusions of the warm water to the east. The buoy was moored on 13 May 1964 and retrieved on 16 June 1964.

The season was characterized by a normal amount of sea ice and icebergs along the east Newfoundland coast. Labrador Current along the eastern slope of the Grand Banks was about 0.3°C colder than normal for the entire season above 100 m, and less saline down to 500 m by 0.05-0.10 ‰. As the season progressed, conditions tended more toward the normal but still remained below normal. The Atlantic Current intruded to the northwest more than normal giving severe horizontal temperature and salinity gradients as far north as 45°30'N.

In January 1964 the US Coast Guard initiated the first of the long term time-series of oceanographic observations planned for all Ocean Stations at Ocean Station BRAVO. A sufficient number of vessels having oceanographic installations and equipment were available to take stations during 6 three-week patrols in 1964. They were taken on three alternate patrols during the January-April period, and on three during the July-December period. During the first three patrols, 13 bottle casts to 1,500 m were taken daily when weather permitted and twice during each patrol sampling was extended to the bottom. On the basis of the results of the first three patrols, the interval between stations was increased to three days. The temperature and salinity data have been processed by CGOU and deposited with the National Oceanographic Data Center. Reports containing the data with descriptive material on the patrols will be issued by the Coast Guard.

Utilization of the Ocean Station vessels for the study of the seasonal variation in flow and characteristics of the Labrador Current was begun in November 1964 in support of INTICEPAT research. The CGC Mendota occupied a series of seven stations across the current in the vicinity of 44°30'N en route to Ocean Station CHARLIE.

Subarea 4

A. Status of the Fisheries

I. Haddock

US haddock landings from Subarea 4 increased again in 1964 (Table 2). As has been true for the last 5 years, the US effort was expended almost entirely in Div. 4X. Catch-per-day fished regained its 1962 level after a small drop in 1963 (Table 3).

Table 2. US haddock landings, Subarea 4 (metric tons, round weight).

Years	Divisions				Total
	R-S-T	V	W	X	
1956	86	147	1,661	12,130	14,024
1957	2	120	1,533	7,296	8,951
1958	.	71	427	12,141	12,639
1959	5	270	4,804	5,465	10,544
1960	-	24	127	8,315	8,466
1961	-	1	23	9,306	9,330
1962	-	1	51	6,388	6,440
1963	-	2	61	7,223	7,286
1964	-	11	42	8,535	8,588

Table 3. US haddock statistics, Div. 4X (metric tons, round weight).

Year	Days fished	Catch per day
1956	1,106	10.963
1957	871	8.377
1958	1,389	8.739
1959	970	5.636
1960	1,209	6.877
1961	1,384	6.722
1962	869	7.343
1963	1,117	6.464
1964	1,133	7.498

The age composition of landings for 1964 (Fig. 1) indicated that the 1959 year-class (5 year olds) provided the bulk of the catch. The strong 1956 year-class is still in evidence. The 1960 year-class appears relatively weaker as 4 year olds than the two year-classes that precede it; however, it may not yet be fully recruited. The 1959 year-class should continue to contribute heavily to the fishery in 1965, but the overall level of abundance of fish available to the fishery will probably show a decrease until the 1962 and 1963 year-classes are recruited into the fishery beginning in 1967.

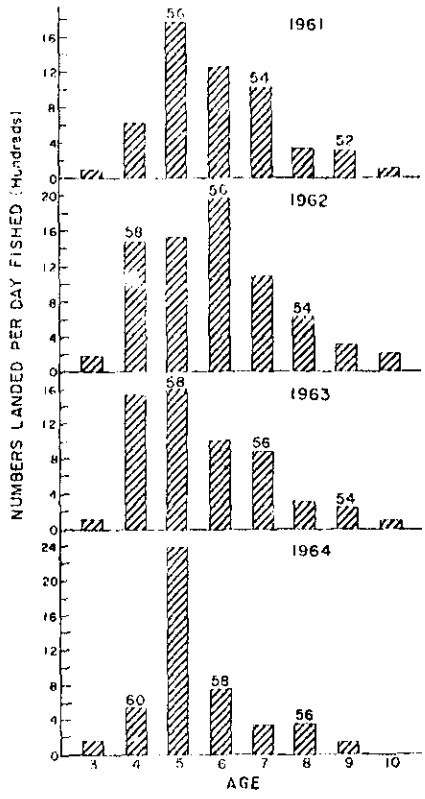


Fig. 1. Age composition of US landings of haddock from Div. 4X.

II. Cod

US landings of cod from the subarea were up slightly again in 1964, but were still near the average of the last 10 years (Table 4). Cod are taken almost entirely within Div. 4X as a by-catch of the haddock fishery.

Table 4. US cod statistics, Subarea 4 (metric tons, round weight).

Year	Landings
1954	2,659
1955	1,371
1956	1,624
1957	1,083
1958	1,147
1959	862
1960	1,605
1961	1,261
1962	1,197
1963	1,347
1964	1,452

III. Redfish

Landings from Div. 4RST (Gulf of St. Lawrence) in 1964 were nearly three times the amount landed in 1963 (Table 5). This increase in landings from 4RST continues the trend begun in 1963. Catch-per-day fished increased considerably in 1964. The greater apparent abundance in this area undoubtedly caused a shift in effort from Subarea 3.

Table 5. US redfish statistics, Div. 4RST (Gulf of St. Lawrence) (metric tons, round fresh).

Year	Landings	Days fished	Landings/Days fished
1954	17,228	1,517	11.3
1955	34,739	2,397	14.5
1956	24,825	2,024	12.3
1957	18,319	1,960	9.3
1958	7,535	844	8.9
1959	5,406	572	9.4
1960	1,412	139	10.1
1961	200	20	9.8
1962	68	-	-
1963	4,879	474	10.3
1964	12,278	682	18.0

The catch from Nova Scotian Banks decreased in 1964, being almost 8,000 tons less than in 1963 (Table 6). The decrease in landings seems due almost entirely to a decrease in fishing effort. Landings-per-day fished in 1964 was about the same as 1963, but both years are somewhat lower than the previous years.

Table 6. US redfish statistics, Div. 4VWX (Nova Scotian Banks) (metric tons, round fresh).

Year	Landings	Days fished	Landings/Days fished
1954	20,895	1,900	11.0
1955	9,330	1,100	8.5
1956	16,313	1,461	11.2
1957	21,101	1,896	11.1
1958	30,768	2,556	12.0
1959	25,281	2,448	10.3
1960	36,612	3,352	10.9
1961	28,957	3,000	9.6
1962	29,375	2,697	10.9
1963	23,282	2,836	8.2
1964	15,475	1,719	9.0

B. Special Research Studies

I. Biological Studies

The studies of the haddock fishery in Div. 4X have continued during the year. Results of the studies for the years 1956-1961 were published this year in the first issue of the ICNAF Research Bulletin.

II. Environmental Studies

The Albatross IV surveys included part of Div. 4X as well as Subarea 5 (see under Subarea 5).

Subarea 5

A. Status of the Fisheries

I. Haddock

US landings of haddock from Georges Bank increased slightly in 1964 (Table 7). The abundance index rose from 4.4 in 1963 to 5.3 in 1964. This is still lower than the values in 1961 and 1962.

Table 7. US haddock statistics[1], Subarea 5 (metric tons, round weight).

Year	Landings	Days fished	Catch per day
1954	53,539	6,702	7.9
1955	50,344	6,240	8.0
1956	58,422	8,122	7.1
1957	54,702	9,275	5.8
1958	44,404	9,802	4.5
1959	40,548	10,665	3.8
1960	45,341	8,462	5.3
1961	51,681	7,962	6.4
1962	54,412	8,646	6.2
1963	48,868	11,185	4.3
1964	49,397	9,368	5.2

1) using abundance index for Georges Bank

The 1958 and 1959 year-classes, which have been the primary support of the fishery during the past 4 years, have lost their dominance. The 1962 year-class contributed heavily to the fishery in 1964 (Fig. 2). It is probable that the low abundance level of larger fish cause a concentration of effort on the incoming year-class, and that it was harvested at a higher rate than the previous incoming year-classes have been. The young-of-the-year abundance index obtained from survey cruises did not indicate a high abundance for the 1962 year-class.

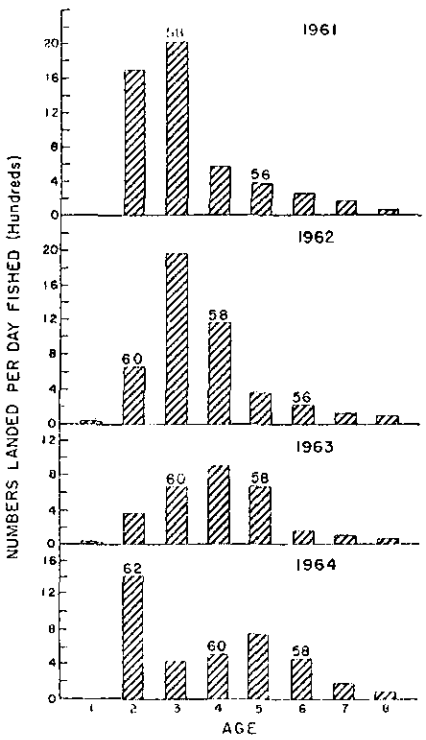


Fig. 2. Age composition of US landings of haddock from Subarea 5.

The heavy contribution of the 1962 year-class to the catch in 1964 caused the average weight of the fish landed as scrod to be quite low. In the last quarter of the year it was only 1.6 lb. (0.7 kg). The lower limit of the scrod class is normally 1.5 lb. (0.68 kg). The shift toward the harvesting of young fish should continue in 1965 when the strong 1963 year-class is expected to enter the fishery.

The abundant 1963 year-class first observed as 0-age fish in the 1963 summer and fall groundfish survey cruises was also abundant when observed as one-year-olds in the 1964

surveys. Although firm comparative indices are not available for yearling fish, those of the 1963 year-class were extremely abundant in the survey trawl hauls, relative to other year-classes. The 1964 year-class, however, appears to have about the same, relatively low, strength as the 1962 year-class as 0-age fish (Fig. 3).

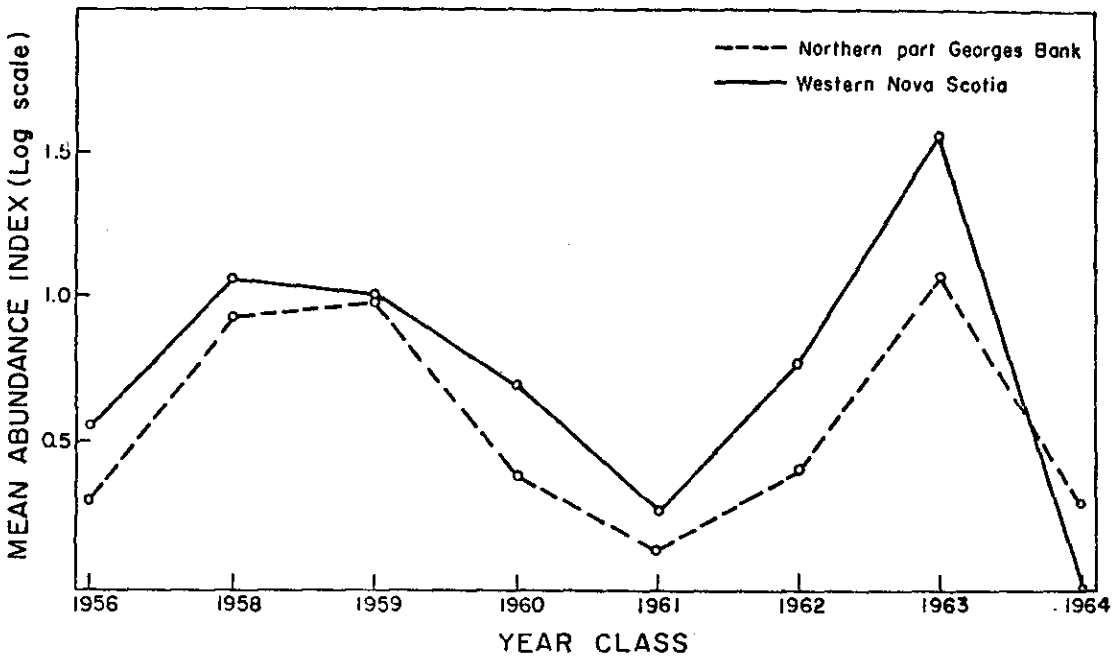


Fig. 3. Index of abundance of 0-age haddock derived from research vessel surveys.

The USSR and Canada both landed appreciable numbers of fish from Subarea 5 since 1962 (Table 8). This has caused a significant increase in the amount of effort as estimated from the US landings-per-day index. This effort was probably even greater in 1964. With this large effort, the haddock fishery in Subarea 5 will depend even more on the strength of the year-class just being recruited into the fishery. Also, this intensity exceeds by about 35% that which is estimated to correspond to the equilibrium maximum sustainable yield of about 45,000 metric tons.

Table 8. Haddock landings (tons) and effort in Subarea 5 by Canada, USSR and US

Year	US	Canada	USSR	Total	Days fished	Catch per day
1961	51,681	189	-	51,870	7,991	6.5
1962	54,412	3,568	1,134	59,114	9,394	6.3
1963	48,868	8,382	2,361	59,611	13,644	4.4
1964	49,397	11,695	5,483	67,975	*	5.3

* not yet available

II. Cod

US landings of cod continued to decline in 1964 from the recent high in 1962. The catch-per-day fished dropped to the 1961 level, although it was still above the 10-year average (Table 9).

Table 9. US cod statistics, Subarea 5 (metric tons, round weight).

Year	Landings	Days fished	Catch per day
1954	12,237	10,706	1.1
1955	12,457	8,942	1.3
1956	13,238	8,963	1.4
1957	13,160	10,023	1.3
1958	16,252	15,160	1.0
1959	16,218	11,568	1.4
1960	14,282	10,151	1.4
1961	17,669	8,532	2.0
1962	18,626	8,212	2.2
1963	16,734	4,983	3.3
1964	15,086	7,323	2.0

The limited length-frequency data available showed a shift toward larger fish in 1963 and 1964. Small fish were proportionately more abundant in 1961 and 1962. Apparently year-class strength has varied, although age readings are not available to confirm this.

III. Silver hake

US food fish landings of silver hake in 1964 remained near the recent stable level of 40,000 tons (Table 10), but the catch-per-day declined somewhat. The increase in total landings of about 12,000 tons over 1963 is due to

Table 10. US silver hake statistics, Subarea 5 (metric tons, round weight).

Year	For Food	For Industrial	For Animal Food	Total	Catch per day
1954	40,823	9,525	2,722	53,070	-
1955	50,348	10,433	4,536	65,317	-
1956	40,370	13,608	4,989	58,967	-
1957	45,300	17,200	7,200	69,700	-
1958	48,500	10,400	7,700	66,600	-
1959	49,900	11,800	9,100	70,800	-
1960	46,700	2,300	9,100	58,100	17.5
1961	38,100	3,200	4,500	45,800	23.8
1962	37,200	3,200	7,200	47,600	18.5
1963	39,247	8,477*	-	47,724	17.4
1964	39,479	20,476*	-	59,955	15.1

* includes animal food

the increased industrial catch. This industrial catch is taken primarily from southern New England waters where the food fish fleet does not operate. The catch-per-day index is computed from food fishery vessels operating north of Georges Bank.

In 1964, as in 1963 and 1962, the US silver hake fleet did not fish much on Georges Bank, the area frequented by foreign vessels, and previously of major importance to the US fleet. Abundance and catch in 1964 was highest along the Maine coast area (Table 11).

Table 11. US silver hake landings and catch-per-day in selected areas by the Gloucester fleet (metric tons, round weight).

Year	Statistical Subareas							
	Inshore Waters						Offshore	
	Maine Coast		Cape Cod Bay		Nausets		Georges Bank	
	Landed	C/D	Landed	C/D	Landed	C/D	Landed	C/D
1960	6,099	15.6	7,258	12.2	4,082	12.9	13,154	28.2
1961	6,046	16.7	7,711	18.4	7,258	24.0	5,897	47.8
1962	8,172	32.9	6,350	11.7	9,979	30.2	2,268	12.0
1963	6,222	27.7	9,979	15.0	6,804	21.9	3,175	17.9
1964	12,473	23.1	6,350	11.6	4,990	18.2	91	2.6

Fishing off Nauset was successful only in the early part of the season. Total food fish landings were maintained at normal levels by the diversion to Maine coast and by an unusually good fall fishery in Cape Cod Bay.

IV. Redfish

The US redfish landings and landings-per-day were somewhat lower than in 1963 (Table 12). The low value of landings-per-day reflects primarily a decrease during the latter half of the year, and may be caused more by diversion of fishing effort than by lowered abundance.

Table 12. US redfish statistics, Subarea 5 (Gulf of Maine) (metric tons, round weight).

Year	Landings	Days fished	Catch per day
1954	12,988	3,859	3.3
1955	13,914	3,089	4.5
1956	14,388	3,267	4.4
1957	16,468	3,862	4.2
1958	16,112	3,636	4.4
1959	14,435	3,329	4.3
1960	10,716	2,799	3.8
1961	14,040	3,077	4.5
1962	12,540	2,634	4.7
1963	8,871	2,764	3.2
1964	7,807	3,123	2.5

The stocks of redfish off New England have, for the most part, followed the expected course of reaction to exploitation. Abundance and, to some extent size of fish, declined as fishing intensity and landings increased during the early exploitation stages. In the early 1950's, stock abundance had apparently reached the level at which it was becoming uneconomic to fish. The evidence indicates somewhat greater catches could have been obtained, at least in the short run. Fishing effort declined thereafter, but since redfish are a slow growing stock, many years are required for the stocks to rebuild. The continued decline in intensity over the past decade has resulted in a general recovery of stock levels, at least up to 1962.

V. Yellowtail flounder

The US yellowtail fishery established a new peak of landings in 1964 (Table 13), due primarily to the continued increase in landings from the Georges Bank area. Estimated landings-per-day also remained at a high level.

Table 13. US yellowtail flounder statistics, Subarea 5 (metric tons, round weight).

	S. New England Grounds		Georges Bank		Cape Cod Grounds	
Year	Landings	C/D	Landings	C/D	Landings	C/D
1954	1,515	1.3	2,887	2.1	1,120	1.3
1955	2,180	1.4	2,946	2.4	1,304	1.3
1956	3,542	1.5	1,594	2.0	1,472	1.1
1957	5,441	2.3	2,302	2.8	2,357	1.6
1958	8,907	2.4	4,534	3.2	1,613	1.7
1959	7,738	1.6	4,130	2.1	1,526	2.0
1960	7,843	1.8	4,447	2.2	1,812	1.6
1961	11,632	2.5	4,248	2.4	1,880	2.0
1962	15,669	3.3	7,769	3.3	1,973	1.7
1963	21,500	4.1	10,659	4.0	2,722	2.1
1964	18,962	4.5	14,914	4.2	1,860	2.0

VI. Industrial Fishery

Landings in the industrial fishery increased 36% over 1963 (Table 14). The variations in industrial landings over the past 9 years is related to production factors within the industry rather than changes in the abundance of the species caught.

Table 14. US landings of industrial trawl fish from Subarea 5 (metric tons, round weight).

Year	Landings
1956	110,786
1957	97,736
1958	88,927
1959	75,706
1960	24,492
1961	32,132
1962	30,094
1963	41,414
1964	56,130

A limited sampling program during the months of June, July and August of 1964 enabled a rough estimate of species composition to be made (Table 15).

Table 15. Species composition of industrial trawl fish caught in Subarea 5, 1963-1964.

	1963		1964 [1]	
Species	tons	%	tons	%
Red hake	17,933	43.3	23,914	42.6
Silver hake	8,477	20.5	16,783	29.9
Sea robin	2,793	6.7	56	0.1
Skates	2,327	5.6	4,715	8.4
Flounders	1,795	4.3	8,139	14.5
Other	8,086	19.6	2,526	4.5
Total	41,414	100.0	56,130	100.0

[1] Preliminary estimate

As in 1963, the industrial fishery was concentrated in areas where silver and red hake were abundant. The size composition of landings of these species is shown in Fig. 4.

VII. Herring

The Maine fishery landed 26,244 tons of herring; only slightly more than the poor catch in 1961 of 24,154 tons. The annual catch has averaged 50,000 tons, with the 1962 and 1963 catches at 67,000 tons and 69,000 tons, respectively. Effort decreases from 1963 to 1964 were 141 to 108 stop seines, and 74 to 64 weirs. The effort of purse seines increased because of the poor success of stop seines and weirs in the inshore waters.

The causes of the catch declines in 1961 and 1964 are difficult to determine at the present time. Low availability is a possible explanation.

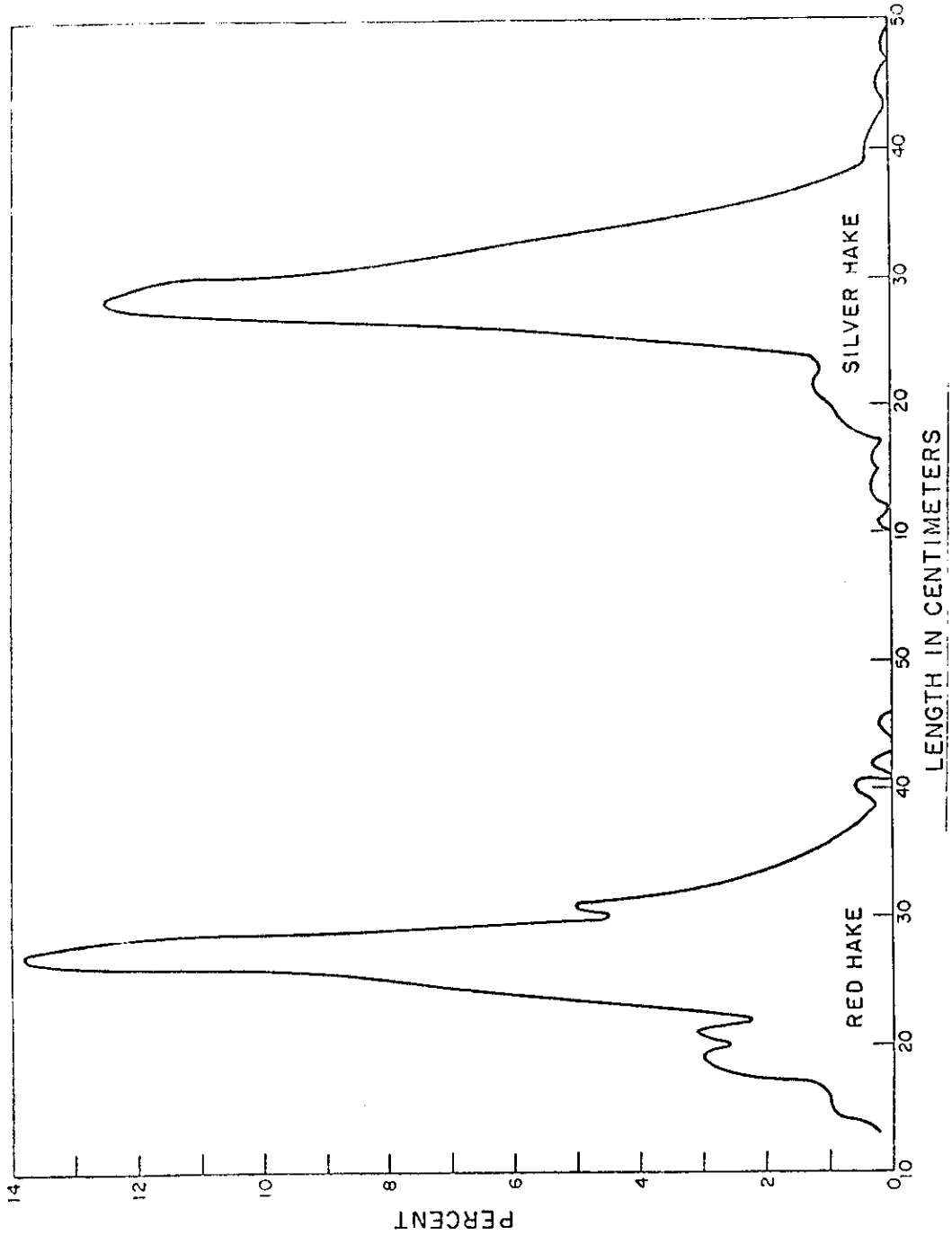


Fig. 4. Length frequency of red and silver hake in Subarea 5 industrial landings.

VIII. Sea scallops

US landings of 6,424 tons of sea scallop meats from Div. 5Z in 1964 were 23% less than in 1963; and the lowest since 1952 when they were 5,500 tons (Table 16). The drop in landings is the result both of lowered abundance (Fig. 5) on the grounds and of decreased effort.

Table 16. Landings (tons) of sea scallop meats from Div. 5Z, 1955-1964.

Year	United States		Total Landings (US & Canada)
	Days fished	Landings	
1955	11,619	8,300	8,437
1956	12,256	7,938	8,256
1957	10,500	7,847	8,664
1958	8,775	6,532	7,711
1959	8,480	8,482	10,478
1960	8,039	9,934	13,336
1961	8,671	10,705	15,286
1962	9,070	9,934	15,604
1963	7,718	7,983	13,926
1964	6,656	6,424	12,020

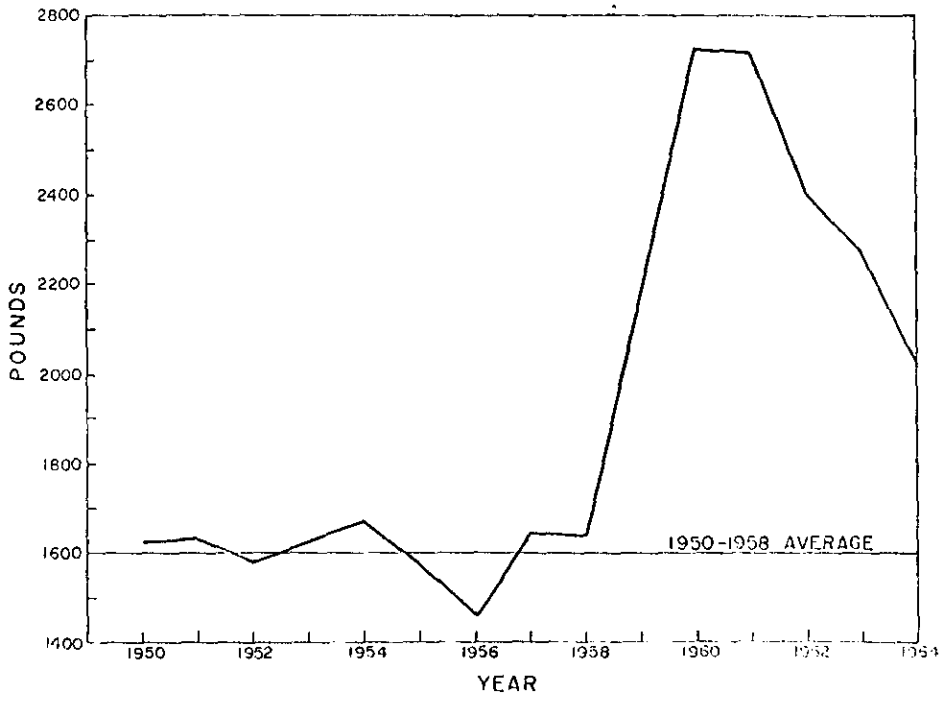


Fig. 5. Average annual landings of sea scallop meats per day spent on the Georges Bank grounds by the US fleet.

The 50% decrease in effort by the US fleet since 1955 has been paralelled by an increase in effort by Canadian vessels on these grounds. This additional fishing effort, plus the recruitment of a strong year-class in 1959, caused total landings to rise for a few years, but they now seem to be dropping back toward the levels which prevailed in the 1950's (Fig. 6).

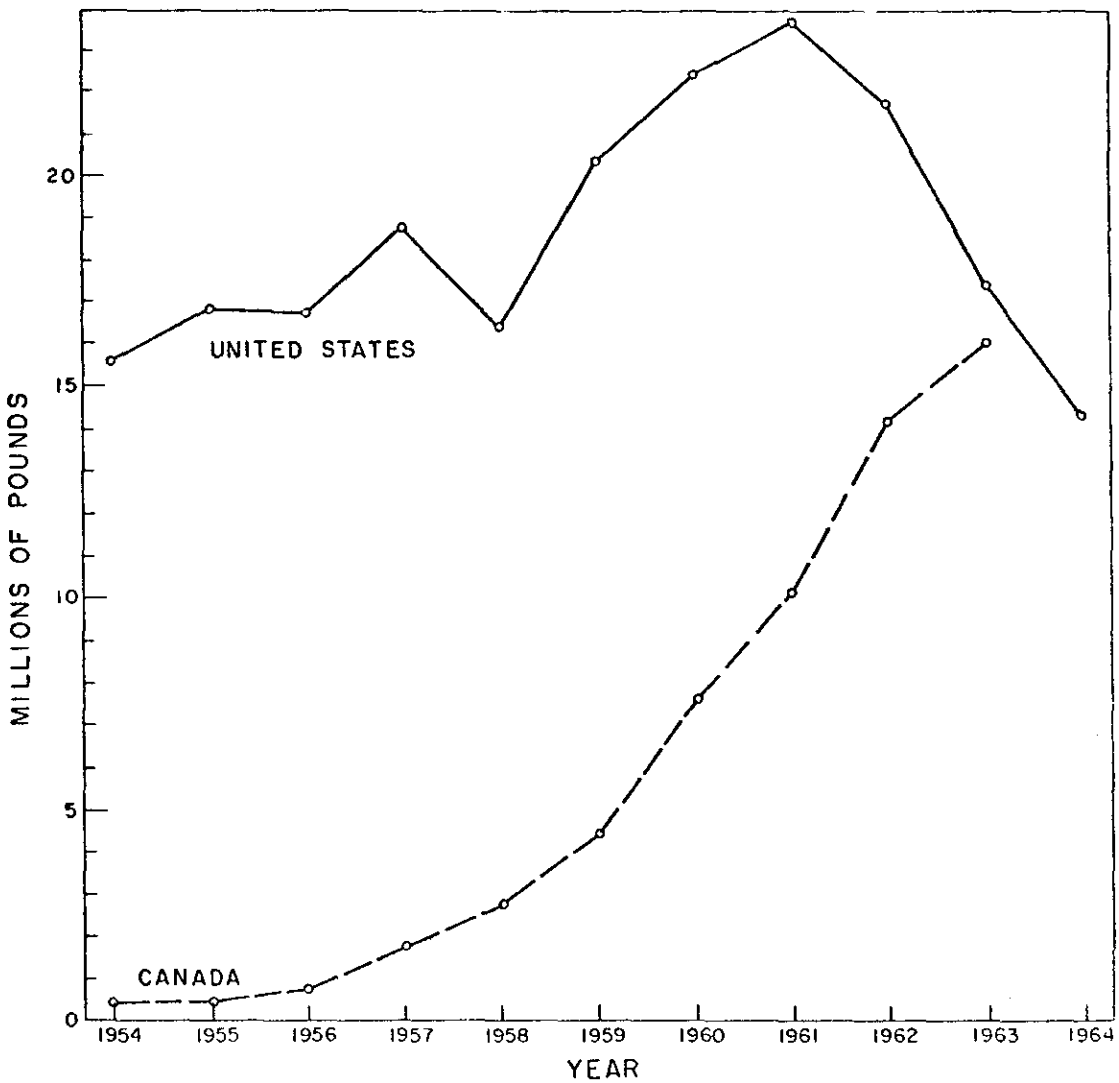


Fig. 6. Landings of meats of scallops caught on Georges Bank.

B. Special Research Studies

I. Biological Studies

1. Haddock. USA is re-working in detail the early (1916-1931) data on commercial catch and effort in order to obtain more information on the relation between abundance, effort, and yield. This period is important because it covers the early phase of exploitation of the Georges Bank stocks.

2. Silver hake. Studies on estimating abundance of silver hake from commercial fleet statistics have continued. Stratification of catch and effort by month, depth zone, and vessel tonnage is the approach which seems to promise the best results.

Otoliths have been exchanged with Canada and the USSR in an attempt to further studies of ageing silver hake. USA has over the year collected a large sample of otoliths from fish of all sizes and areas in order to validate ageing procedures.

Experiments on the selectivity of nylon nets of 30 to 73 mm have been completed. These indicate that the 50 mm nylon codend now in prevalent use by the industry provides a satisfactory escapement of small silver hake (less than 25 cm). Codends of 73 mm allow excessive escapement of fish between 25 and 35 cm which form the bulk of the fishery.

3. Redfish. Studies of methods of estimating redfish abundance from commercial catch and effort data were begun. This study impinges upon the more general problem of measuring relative abundance in a mixed-species fishery. This study is continuing.

4. Yellowtail flounder. Research in 1964 was centered on studies of age determination and estimating growth rate of fish from three subpopulations in Subarea 5. Data collected in 1955-1964 are being used. Results indicate that there are small growth rate differences between subpopulations.

5. Winter flounder. Approximately 9,000 winter flounder were tagged on Massachusetts inshore grounds, and on Nantucket Shoals and Georges Bank during March-May 1964, in a cooperative program with the Massachusetts Division of Marine Fisheries. Aims are: 1) to more clearly define seasonal and long-term movements; 2) to identify, from tag returns and meristic studies subpopulations that may be present in these areas, 3) to obtain information on the origin of the Georges Bank stock of winter flounder, and 4) to obtain exploitation level data by sport and commercial fishermen.

6. Herring

a. Age compositions. In 1964, 35 samples (2,549 fish) were obtained from Georges Bank and 46 samples (3,565 fish) from coastal Gulf of Maine. The 1960 year-class was dominant in both areas. On Georges Bank, this year-class was dominant in all months sampled, and the rank in percentage occurrence of the other year-classes remained constant throughout the year. In coastal Gulf of Maine, the 1958 year-class was dominant during the first four months of the year, and the 1960 year-class dominant during the remaining eight months. The rank in percentage occurrence of other year-classes varied considerably throughout the year, and the variation was different in the two areas. The average age composition and the length frequencies are shown in Fig. 7.

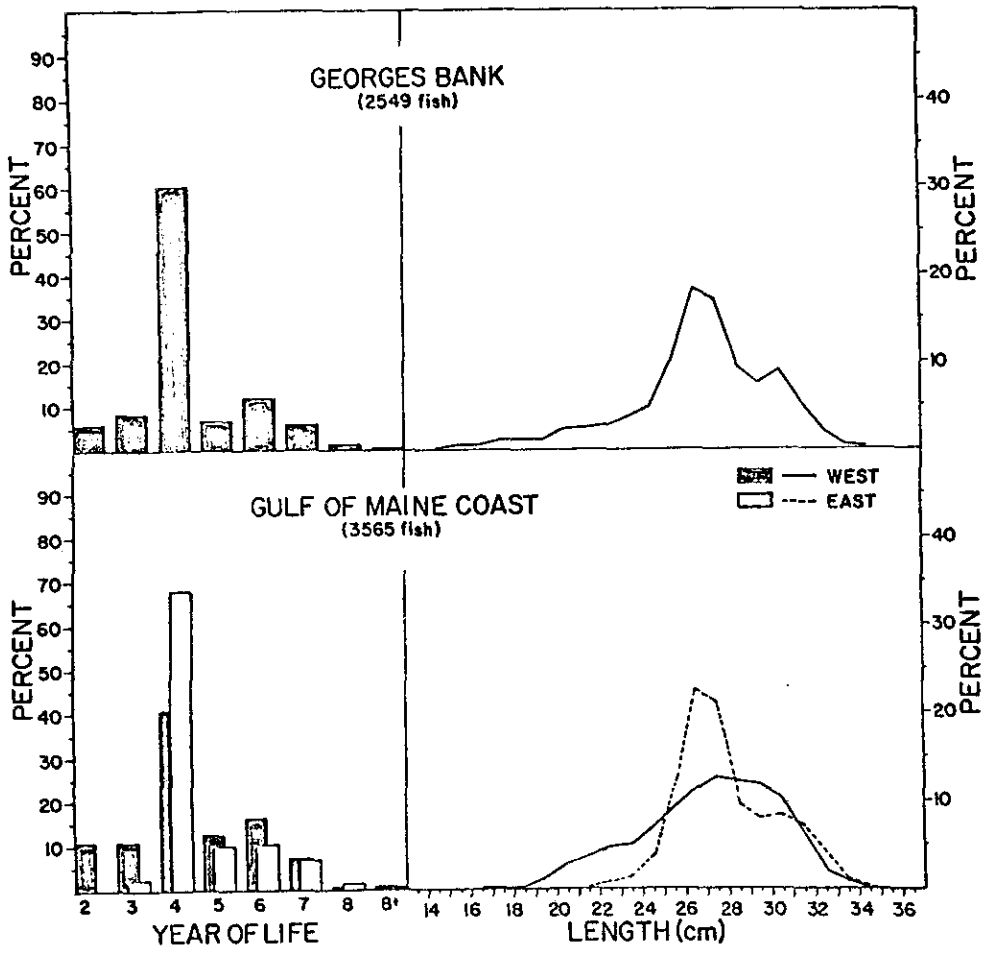


Fig. 7. Year of life and length of Georges Bank and coastal Gulf of Maine herring sampled in 1964.

b. Larval studies. Herring larval studies were conducted in the offshore waters of Georges Bank and in the Gulf of Maine during the September, October and November research cruises. Number of larvae per tow, their mean lengths, and their distribution have been compared with results in 1956-1957. Though differences in mean length occurred, the distribution of larvae in time and space was similar in both periods.

c. Behavior studies. Behavior studies are being carried out to learn some of the responses of herring to variations in environmental conditions which the fish might reasonably be expected to encounter in their coastal habitat. One example is the condition of supersaturation of oxygen in the water, which in extreme cases can be fatal to fish, and which occurred at several localities along the coast in the spring and summer of 1964. Laboratory experiments are designed to test the responses of fish to certain conditions which can be controlled and measured, either singly or in combinations; and have been essentially tests of "preference" or "avoidance" by the fish. Effects on basic physiological processes, such as respiration, have also been studied.

Analysis of maturity stages indicated that fall spawning occurred from early September to late November. The peak of spawning occurred earlier in coastal Gulf of Maine (September) than on Georges Bank (October). On Georges Bank, the last spawning noted was during early February, while in coastal waters spawning fish were obtained during late March and early April. In both areas, fall spawning fish averaged 26.5 cm long. There was no evidence of spring spawning on Georges Bank, but spring spawning was recorded from the western waters of the Gulf of Maine. Spring spawners averaged 29.5 cm long.

In the spring, adult herring were found dispersed throughout Georges Bank, while in the fall they were found congregating on the northern portion. In coastal Gulf of Maine, adult herring were found both inshore and offshore throughout most of the year. Sardines on Georges Bank were found only in the vicinity of Cultivator Shoals, where the depths are 20 fathoms or less and where temperatures are warmer than those of the deeper waters.

d. Racial studies. In the 1964 report of the Herring Subcommittee, it was recommended that increased research effort be made to determine the identity of the herring stocks in the Gulf of Maine and on Georges Bank. Following this recommendation, three aspects of the serological and biochemical studies on herring at the Boothbay Harbor Laboratory were expanded. These expanded aspects involved the development of better methods for preserving blood to allow more extensive testing; testing the blood samples with many new blood typing reagents, especially antisera developed in rainbow trout; and expanded studies on serum protein differences by starch gel electrophoresis and immunodiffusion.

Preliminary analysis of the blood typing data obtained from repetitive samples taken on Georges Bank has not indicated that more than a single population of herring was sampled. Analysis of the data obtained from inshore samples has been complicated by the discovery that herring cells change in their agglutinability. Many of the herring sampled in the western Gulf of Maine had blood cells which could not be agglutinated by any reagent. Experiments on herring held in the laboratory indicate that herring change with respect to agglutinability of their red cells. This change is apparently due to, or associated with, exposure to high temperatures. A more complete investigation of this phenomenon, necessary for the interpretation of blood group work on herring, is being conducted. Other serological techniques have also been investigated.

e. Plankton studies. Zooplankton collections were made along the coast of Maine from inshore to the 90-m isobath. Zooplankton volumes in 1964 followed the pattern of areal variation found in 1963, with highest mean-annual volumes occurring in the western region, moderate volumes in the central area, and low volumes in the eastern sector of the coast. Decreased river runoff in 1964 resulted in higher seasonal salinities, which may have affected the abundance of C. finmarchicus (outer-neritic species) and C. typicus (inner-neritic species).

f. Benthic studies. The USA continued its analysis of benthic samples collected along the Atlantic Continental Shelf, particularly in Subarea 5. The density of individual invertebrates in this area is much higher than in areas to the south, although the biomass is the same from north to south.

g. Environmental studies. The Albatross IV made four seasonal hydrographic surveys throughout Georges Bank and the Gulf of Maine determining temperature, salinity, oxygen and chlorophyll.

The Woods Hole Oceanographic Institution monitored temperature and salinity at lightships in Subarea 5. Drift bottle and sea-bed drifter studies of residual drift in connection with studies of herring life history, and in relation to changes in the circulation pattern induced by changes in river runoff, have been continued.