INTERNATIONAL COMMISSION FOR  THE NORTHWEST ATLANTIC FISHERIES

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REPORTS ON RESEARCHES IN THE ICNAF AREA IN 1966

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Note

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PART II. REPORTS ON RESEARCHES IN THE ICNAF AREA IN 1966

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I. Canadian Research Report, 1966

A. Subareas 1, 2 and 3
by W. Templeman

The St. John's Biological Station of the Fisheries Research Board of Canada carried out fisheries and oceanographic researches in Subareas 2 and 3 and the Arctic Biological Station of the Fisheries Research Board of Canada continued researches on harp seals. The Bedford Institute of Oceanography of the Department of Energy, Mines and Resources and the St. Andrews Biological Station of the Fisheries Research Board of Canada also carried out oceanographic researches in Subareas 1-3. Canadian landings by subarea were not available at the time of writing this report and the figures used for Newfoundland landings are preliminary and not by subarea, except where the fishery is mainly or wholly confined to one subarea.

Subareas 1 and 2

A. Status of the Fisheries

I. Cod, *Gadus morhua* L.

Cod landings of 27,000 tons in the inshore Labrador fishery were slightly higher than the 26,000 tons landed in 1965. In Labrador the cod trap and jigger are the most important inshore gears. Small amounts are taken by gill net in southern Labrador.

Peak sizes in trap catches were at 52-55 cm, with a secondary peak at 46 cm. Age determinations are not complete, but the latter probably represents fish of the 1961 year-class. Peak sizes by jigger were at 58-64 cm. Gill nets are fished later in the season and in deeper water than the other gears, and normally take much larger fish. Virtually all fish taken in southern Labrador samples in August were greater than 70 cm in length (gill net mesh sizes 152-178 mm).

There was no Canadian fishery in Subarea 1.

II. Harp seal, *Pagophilus groenlandicus* (Erxleben)

The landings of harp seals by Canadian ships, small craft and landsmen in Subareas 2 and 3 were 68,500 compared with 64,300 in 1965. The landings of young seals increased from 53,600 to 61,100 while those of seals one year old and up decreased from 10,700 to 7,400. The number of ships increased from 8 to 9. Seven of them had taken some young seals in Subarea 4, where the sealing season opens 5 days earlier, before sealing in Subareas 2 and 3.

Landings by Canadian ships rose from 45,800 seals in 1965 to 57,000 seals in 1966, while landings by landsmen fell from 18,500 seals in 1965 to 11,500 seals in 1966. The overall landings including those by other nations rose much more than these figures indicate, thus the overall landings of young seals nearly doubled from 92,300 in 1965 to 168,100 in 1966. The increase was largely due to weather and ice conditions which kept the patches of young seals close to shore on the Labrador coast in 1965, making them available largely to Canadian ships and landsmen. It is believed also that the decrease in landsmen's catch in 1966 was due to a small escapement of young seals after heavy catches by the ships.

III. Hood seal, *Cystophora cristata* Erxleben

Canadian ships and landsmen took 5,700 hood seals in 1966, of which 3,600 were young and 1,800 adults. The Canadian landings alone are not significant, but the overall landings including those of Norway were 25,000 hood seals, the highest since 1918. A trend of increased landings of hoods over those of the 1920's and 1930's has been apparent since resumption of the seal fishery in 1946, but there are large fluctuations from year to year.

B. Special Research Studies

I. Environmental Studies, Subareas 1 and 2

Between 12 March and 12 May a physical oceanographic cruise was undertaken by the Bedford Institute of Oceanography in the Labrador and Irminger Seas. The primary purpose was to measure the temperature, salinity and dissolved oxygen in order to gain knowledge of the characteristics, formation and movement of the water mass. In addition, investigations on bacteria and dissolved organic matter were conducted by investigators from Dalhousie University. The cruise was undertaken at the end of the cooling season so that the deep convective overturn of surface water masses at that time might be studied. Although analysis of the data is not complete, it seems apparent that convective overturn did not penetrate as far as the depth of 2,000 m sometimes quoted in the literature.

The oceanographic stations used by the US Naval Oceanographic Office in their ice forecasting were again occupied in 1966.

The marine geological program included bottom sampling and bathymetry in northern Baffin Bay and Davis Strait.

II. Biological Studies, Subarea 2

1. Cod. The inshore cod of the Newfoundland fishery along the Labrador coast were sampled for age and length.

A cod survey by otter trawl over the Labrador Shelf was carried out by the *A.T.Cameron* from 4 to 20 October on lines of stations across the shelf off Cape Chidley, Cape Mugford, Nain and Spotted Islands, and across the Hawke Channel. Catches were very small, the largest being 260 kg in a 1/2-hr haul at 183 m on the northern side of Hawke Channel.

2. Harp seal. A capture-recapture experiment was carried out from the icebreaker *d'Iberville*, put at the service of the Fisheries Research Board for 10 days by the Canadian Department of Transport. Between 8 and 13 March, six men tagged 3,581 young seals with cattle ear tags of monel metal applied to the web between hind flipper and tail. Hunting in this region started on 12 March. Recoveries coming largely from sealing ships are not complete but 1,551 tags have been returned and at least 1,728 are known to have been taken. This indicates a fishing intensity on the particular herd of seals of at least 48%. No other herds were located by research or industry in Subareas 2 and 3. Recoveries from Canadian sealing ships are virtually complete and indicate a production of about 200,000 young seals in this herd. Landings of 168,000 young seals of this herd by all agencies suggest a kill of 84% of young.

There were only three returns of these tags from West Greenland in summer 1966 and one return from the southward migration in December 1966. By contrast, there were 25 returns from West Greenland and two returns from southward migrants from 1,550 disc tags placed on young harp seals in Subarea 4 in 1966 after the end of the quota kill. Although the returns from two different types of tag are not directly comparable, cattle ear tags applied to young grey seals, *Halichoerus grypus*, in 1966 gave a 7% rate of return in the first summer. Thus the low rate of return of cattle ear tags from young harp seals tagged in Subareas 2 and 3 in 1966 suggests that the rate of survival of the young was low, *i.e.* that the fishery was intensive.

Observations from a commercial sealing vessel and by the tagging team show a natal and early post-natal natural mortality of about 0.3%, significantly lower than the 1.0% found in Subarea 4. The lower rate may be the result of less disturbance by aircraft, or a more suitable environment in the colder climate of Subarea 2 and in the northern part of Subarea 3, since the insulation of the white coat of the newborn harp seal is better in snow than in rain.

3. Hood Seal. An age sample of 200 adult animals, three quarters of them females, was obtained from the catch of a commercial sealing ship. Analysis shows no obvious change in mortality rates from a sample of similar size collected in 1953, and the mortality rate of the females does not exceed that of the males in spite of a higher hunting rate of females. The evidence therefore does not suggest that the stock is yet receiving intensive hunting, which implies that hood seals in Subareas 2 and 3 are part of a stock which extends to the northward.

Subarea 3

A. Status of the Fisheries

I. Cod

Newfoundland landings of cod from the great inshore fishery and from the subarea were lower than in 1965.

II. Haddock, *Melanogrammus aeglefinus* (L.)

Newfoundland total landings of haddock fell to about 2,000 tons compared with 3,247 tons in 1965 (2,601 in Subarea 3 and 646 in Subarea 4). The stock still remains at a low level with no very large year-class appearing since that of 1955 and the smaller one of 1956. No strong year-classes were evident in a research vessel cruise over the haddock area. The length composition of the catches taken on the Grand Bank in the May survey showed modes at 26 and 46 cm mainly composed of fish of 2 and 4 years of age respectively but they are not numerous enough to be of much commercial importance. There are still considerable variations in size of year-classes but the spawning stock is at a low level.

III. Redfish, *Sebastes mentella* Travin and *Sebastes marinus* (L.)

Newfoundland redfish landings, almost all *S. mentella*, increased to about 35 thousand tons as against landings in 1965 of 29 thousand tons of which 20 thousand tons were from Subarea 3.

IV. American plaice, *Hippoglossoides platessoides* (Fabricius)

Newfoundland landings of American plaice, almost all from Subarea 3, rose to about 43,000 tons compared with 39,480 tons in 1965.

V. Witch flounder, *Glyptocephalus cynoglossus* (L.)

Newfoundland witch landings for Subarea 3 rose to about 4,300 tons from 1,673 tons in 1965. The witch in this area were previously caught as a by-product of the haddock fishery on the southwestern, western and southern slopes of the Grand Bank and St. Pierre Bank. With the reduction in the haddock fishery since 1962 this population has probably increased somewhat and may have been more available than usual.

VI. Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum)

Greenland halibut landings, almost all from the deep east coast Newfoundland bays in Subarea 3, increased greatly to 16,400 tons from 8,100 tons in 1965 and 1,770 tons in 1964. The increased catch was due to increased effort for these fish by gill net and longline.

VII. Herring, *Clupea harengus* L.

Newfoundland herring landings, mainly from Subareas 3 and 4, increased to 28,000 tons from 12,900 tons in 1965 (8,100 tons from Subarea 3 and 4,800 tons from Subarea 4). This was due to greatly increased purse seine effort to supply herring for meal.

VIII. Atlantic salmon, *Salmo salar* L.

Newfoundland commercial landings of Atlantic salmon (total from Subareas 2, 3, 4) increased to 1,380 tons from 1,160 tons in 1965.

IX. Capelin, *Mallotus villosus* (Müller)

Capelin landings were about 4,850 tons and have not changed much in recent years. The use of capelin as fertilizer and bait is gradually declining and its use for fish meal increasing but no attempt has been made in recent years to utilize capelin on a large scale for this purpose. In a short-lived earlier attempt to use capelin for fish meal about 18,000 tons of capelin were used for this purpose in 1950.

X. Swordfish, *Xiphias gladius* L.

Landings of about 1,200 tons from Subarea 3 by Canadian mainland vessels were about 28% higher than in 1965. This was the result of the exploitation of a new fishing area to the east of the tail of the Grand Bank.

XI. Short-finned squid, *Illex illecebrosus* (LeSueur)

Squid were scarcer, Newfoundland landings declining to 4,800 tons from 7,800 tons in 1965 and 10,400 in 1964; all from Subarea 3.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. Observations were made on only one (St.John's-Flemish Cap, Fig. 1) of the 6 sections taken annually since 1951. Temperatures were higher than in 1965, and higher than usual, both in the colder part of the Labrador current in the Avalon Channel and over the Grand Bank and in the warm slope water to the east of the Grand Bank and over Flemish Cap.

Bottom salinities in the Avalon Channel were higher than in 1965 but otherwise salinities were generally similar to those of 1965.

At Station 27 near St. John's (Fig. 2) the deeper water temperatures were higher than usual throughout the year. Also, winter temperatures in both 1966 and early 1967 were higher than usual from surface to bottom. Upper water temperatures in summer-autumn were about average.

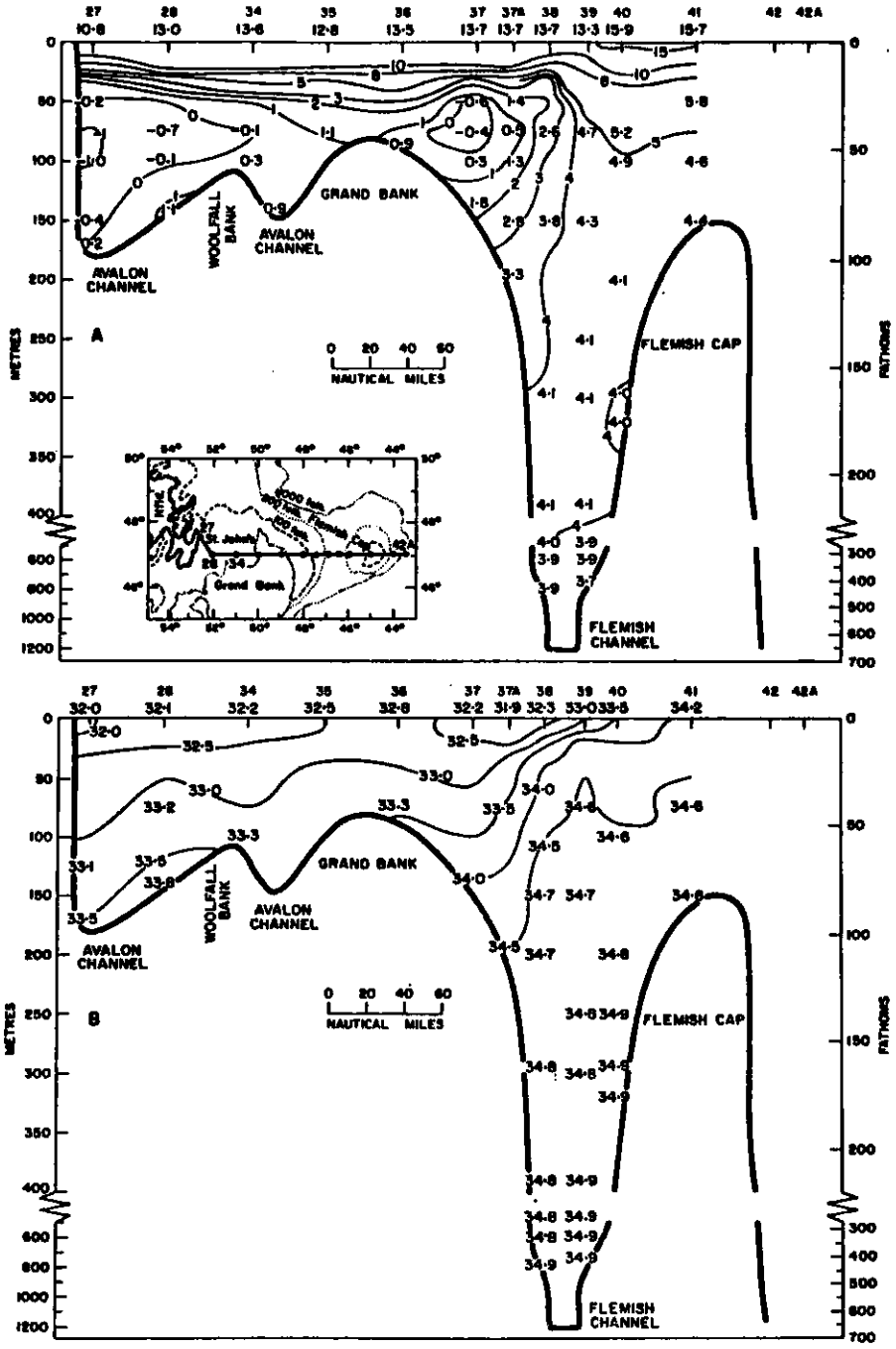

Fig. 1. A, temperature, °C and B, salinity, ‰, sections, St.John's-Grand Bank-Flemish Cap, 25-27 July 1966.

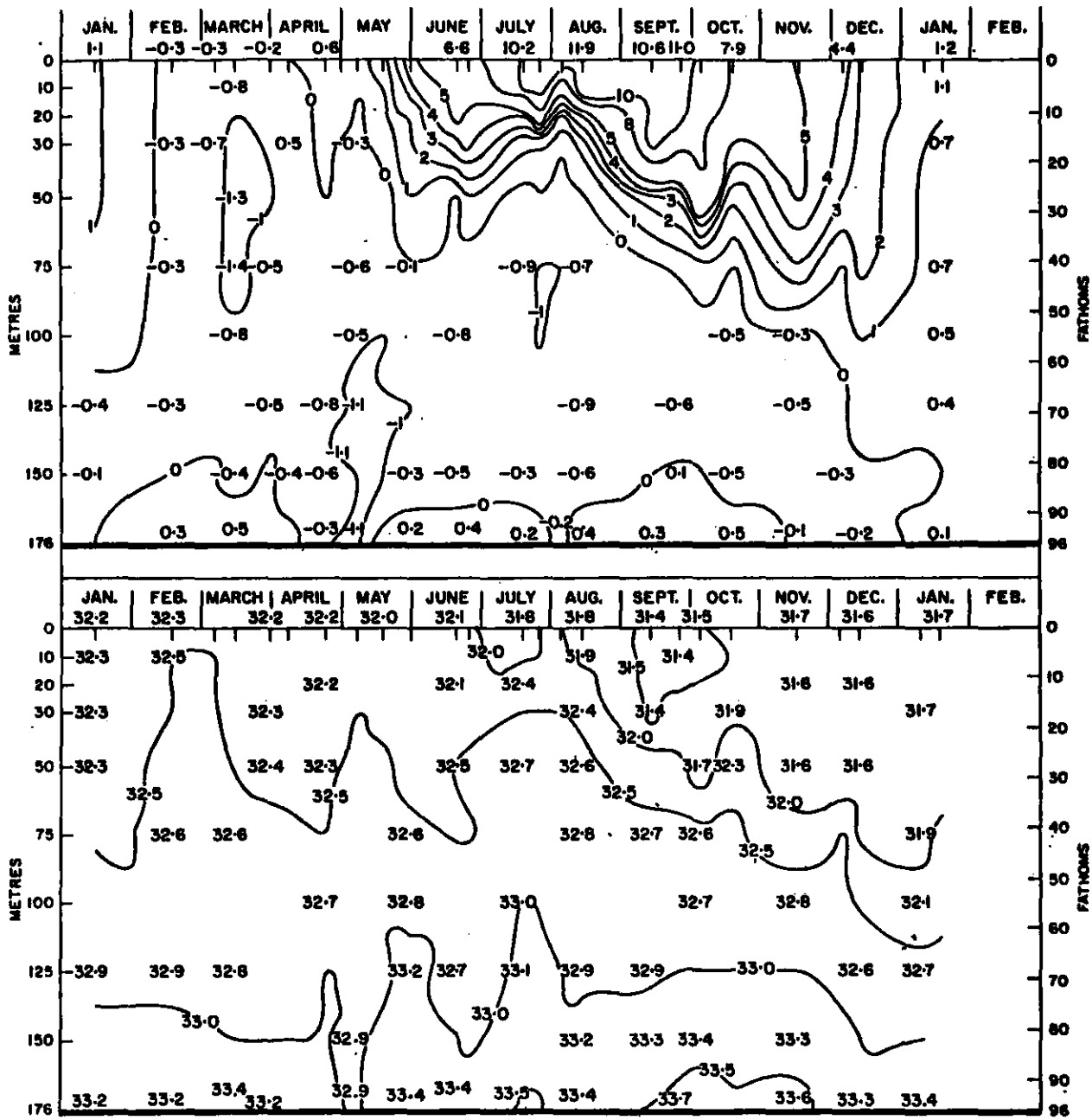

Fig. 2. Above, temperature, °C, and below, salinity, ‰, January 1966–January 1967, from surface to bottom at Station 27 (see Fig.1 insert), 2 nautical miles off Cape Spear near St. John's.

Salinities were slightly higher near the bottom. They were lower in the upper part of the water column in late autumn-early winter of 1966-67 but otherwise were generally similar to those of 1965.

Drifter experiments were initiated in Subarea 3 (L, O, Ps) to study the surface and bottom non-tidal drift. Releases of bottles and drifters were made regularly at Station 27, 2 nautical miles off Cape Spear near St. John's.

The survey, by the Bedford Institute of Oceanography, of Sir Charles Hamilton Sound (between Fogo Island and northeastern Newfoundland) was continued from 1965. The purpose of the project is to provide charts and information on currents in this sheltered passage.

A major hydrographic charting survey, completed on the tail of the Grand Bank during the period 16 May-9 November, will result in the first modern detailed charts of this area. In addition, bottom grab samples were collected for sedimentological studies.

Limited physical oceanographic studies were undertaken in the deep water off the southwest side of the Grand Bank. The purpose of the survey was to gain more information on the westerly flow of Labrador water in the upper layers near the shelf, and the southeasterly flow of slope water between the Labrador water and the Gulf Stream.

Charts of sea-surface temperature and surface layer depth covering Subareas 3, 4 and 5, are prepared on a daily basis. These charts are broadcast on radio facsimile as well as mailed to interested users including fisheries and oceanographic laboratories, fishing companies and meteorological offices. A program of research, aimed at improving the accuracy of the charts, is continuing.

II. Biological Studies

1. Groundfish generally. Monitoring of the commercial inshore fishery for cod and the offshore fishery for various groundfish species was continued in important Newfoundland fishing centres. Information is obtained on age, growth, maturity, and spawning, factors affecting distribution and abundance, catch per unit of effort and contribution of various year-classes to the fishery. The program provides essential basic information for stock assessment studies for national and ICNAF purposes.

2. Cod. During inshore surveys the commercial fishery was characterized generally by low catches, with trap cod of smaller average size than in 1965 but with little change in sizes from other gears.

A research program on cod caught by synthetic gill nets in Placentia and St. Mary's Bays is being completed this year and information on age, growth, spawning, fecundity, and food are being analyzed preparatory to publication.

During research cruises by the *A.T.Cameron* in May to the southwestern part of the Grand Bank and in July-August to the northeastern part of the bank the biology and distribution of cod at various depths were studied. Catches were generally small, although 1,360 kg of small cod were obtained in a 1/2 hr haul on the northeast slope in 230 m. Cod catches were also small during a survey cruise off Labrador in October.

3. Haddock. Biology and distribution of haddock were investigated during a survey by the *A.T.Cameron* on the southwestern part of the Grand Bank in May. The average catch per 1/2 hr haul was about 18 kg compared with 250 kg in 1960. There were no indications of the appearance of a strong new year-class in the stock.

4. American plaice. In continued studies of spawning of American plaice from Labrador, the Northeast Newfoundland Shelf, and the Grand Bank, it was evident that old, large fish spawn first and that plaice in shallow water spawn earlier than those in the deep. Fifty percent of female plaice from these regions are mature at 12-14 years of age and 40-50 cm in length. On the Flemish Cap 50% of the females are mature at 5-7 years of age and 20-29 cm in length.

5. Greenland halibut. A research program begun in 1965 was intensified in 1966 and surveys were conducted on the biology and distribution of the species in White, Notre Dame and Trinity Bays, while fishing gill nets and longlines. The sizes of Greenland halibut caught by gill nets averaged smaller than those caught by longlines. Catches in gill nets of 178 mm mesh were 25% higher than those caught in 152 mm mesh. Peak sizes for the 152 mm mesh were at 52.5 cm and for the 178 mm mesh at 57.5 cm. The Trinity Bay commercial catch was composed principally of 8- to 12-year-old fish.

6. Herring. With the recent expansion in the herring fishery for meal, herring investigations were intensified. Preliminary analyses indicate that fish from the south and west coasts of Newfoundland are smaller and younger than during the period of highest catches (1942-48) and that there are fewer year-classes contributing appreciably to the present population than at that time. A change in spawning time is also evident. Spring spawners predominated in this area in the late 1940's but autumn spawners now appear to be the dominant group. This change in spawning habits and the changes which have occurred in the areas of major catches suggest that extensive changes have taken place in the composition and location of the stocks over the past two decades.

7. Atlantic salmon. Between 21 March and 16 April 1966, 38 salmon were taken by the *A.T.Cameron* in 6 surface drift sets (each set about 21 nets and each net about 85 m long) over oceanic depths east of the Northeast Newfoundland Shelf in temperatures of 3.7-6.1°C. No salmon were caught in a set at 9.2°C. The greatest numbers of salmon were caught closer to rather than more seaward from the 1000 fathom (1,829 m) isobath. On 1 May, 7 salmon were

taken in a similar surface set off the southwestern slope of the Grand Bank at a temperature of 5.4°C.

8. Pink salmon, *Oncorhynchus gorbuscha* (Walbaum). Eggs of Pacific pink salmon numbering 3.3 millions collected in Lakelse River, British Columbia, were planted in North Harbour River in November-December 1965. The resultant fry run in the spring of 1966 was estimated at 3.0 millions. Predation by anadromous and salt-water fish appeared light during the migration down river and out to sea.

From the transplant of 3.4 million eggs to North Harbour River in January 1965 a run of 2.9 million fry migrated in the spring of 1965. The return of adults from this run in 1966 was as follows: 419 to North Harbour River and 40 to Colinet River, with an additional 178 caught in the commercial net fishery in St. Mary's Bay and 1 on a spinner in salt water, a total of 638 fish all caught in St. Mary's Bay. The first returning adult was caught in salt water on 1 June but the run into North Harbour River began 4 August and ended 27 September with peak days 6 and 16 September. These fish in the North Harbour River run were approximately equal numbers of males and females.

Spawning of adults in North Harbour River appeared normal and was observed in the lower 7 km of the river and in one of the tributaries.

A transplant of 5.9 million pink salmon eggs obtained from the Lakelse River by the Fisheries Research Board of Canada Nanaimo Station was made in North Harbour River in the first 2 weeks of November.

9. Capelin. Capelin from representative areas of the Newfoundland and Labrador coast and the Grand Bank were sampled to evaluate any differences which might indicate separate stocks. Although no significant differences in anal and pectoral fin-ray and in vertebral counts could be found between capelin of these areas, the capelin from the south coast of Newfoundland were the smallest and youngest and the Grand Bank and Labrador capelin were the largest, while those from the east coast of Newfoundland were intermediate in size.

In 1965, 3-year-olds (1962 year-class) dominated the spawning schools and this year-class was even more dominant in 1966 as 4-year-olds. This suggests not only a very successful 1962 year-class but also a relatively poor 1963 year-class. Accompanying the dominance of 4-year-olds in the spawning schools in 1966 was an increase in the average size and fat content of the capelin.

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

Canadian researches in Subareas 4 and 5 were carried out by many scientists whose submissions on their researches were compiled in preparing this report and whose names are to be found in the list of ICNAF scientists.

The contributing institutions are: the St. Andrews Biological Station, the Atlantic Oceanographic Group, and the Arctic Biological Station of the Fisheries Research Board of Canada; the Bedford Institute of Oceanography of the Canadian Department of Energy, Mines and Resources; and la Station de Biologie marine du Ministère de l'Industrie et du Commerce of the Province of Quebec.

Subarea 4

A. Status of the Fisheries

I. Cod

Canadian landings of cod from Subarea 4 continued to outweigh those of any other single species. Preliminary figures indicate that total mainland landings of cod are about 4% below those of 1965. Landings of cod in northern New Brunswick have been used for advance estimates of success in Div.4T and they continued to decline. Beginning in 1965, however, these landings were not indicative of total landings from the southern Gulf of St. Lawrence (4T); we believe that total landings of cod from 4T probably remained steady. Most of the cod landed from Div.4T were in the 34 to 70 cm length range, and 4-year-olds dominated the landings in the 3rd quarter of 1966 as they did in 1965. Discards of cod in the Gulf were reported to remain low, near the 1% level by weight. Cod landings between 1960 and 1965 for other divisions of Subarea 4 show downward trends in Div.4R (6,000 to 1,500 tons), 4S (16,000 to 7,000 tons), and upward trends in 4Vn (7,000 to 13,500 tons), and 4X (12,000 to 24,000 tons). Landings in 1966 probably remained in the same pattern.

II. Haddock

Landings of haddock on the Canadian mainland increased about 25% over those of 1965. Although statistics for area of capture are not yet available, it seems likely that part of the increase came from Subarea 4 and probably mainly from Div.4X. No particular change in sizes of haddock landed was recorded.

III. Flatfishes

Total mainland flatfish landings increased about 10% over those of 1965. Canadian landings of flatfish from Subarea 4 have shown a continuing steady growth, reaching about 40,000 tons in 1965, a 50% increase over the past five years. As in the past, preliminary Canadian landing statistics are not separated by species or area and precise information about flatfish landings cannot be provided. However, our tabulations from monthly landing reports suggest the following developments:

American plaice. Landings from the southern Gulf of St. Lawrence (Div.4T) increased slightly, even though many larger otter trawlers expended their effort for redfish. Increased efforts by smaller trawlers and seiners

and an earlier start at fishing (mid April) sufficed to keep landings high. Landings from Div.4Vs and 4W probably also increased with increased effort for flatfish there. Sizes landed were unchanged. Discards of small American plaice remained high; in Div.4T they probably reached 70 to 80% by number.

Witch. Landings of witch remained about the same as the previous year. Catches from the Middle Ground area (4W) decreased slightly, but this loss was balanced by greater catches from the Cape Breton and Laurentian Channel areas (4T and 4Vn). Discards were negligible and catches of Danish seiners appear to have increased slightly.

Yellowtail, *Limanda ferruginea* (Storer). Landings from all regions of Subarea 4 were lower in 1966. Most yellowtail are landed from Banquereau, Middle Bank, and Sable Island (Div.4Vs and 4W), and in all these regions effort as well as landings appeared to be reduced. Few yellowtail were landed from the Gulf of St. Lawrence (Div.4R-T).

Winter flounder, *Pseudopleuronectes americanus* (Walbaum). Landings of winter flounder increased to about 4,500 tons. The Chaleur Bay, Northumberland Strait (4T), and St. Mary's Bay (4X) stocks were the most important. This species continues to increase in importance, particularly for small otter trawlers in more protected inshore areas such as Northumberland Strait.

Atlantic halibut, *Hippoglossus hippoglossus* (L.). Halibut landings were higher in 1966 than in 1965. Although catches from the Gulf of St. Lawrence (Div.4R-S-T) in the early season were not encouraging, prices were good and continuing effort provided better landings during the latter half of the year both from the Gulf and Banquereau (4Vs).

IV. Pollock, *Pollachius virens* (L.)

Pollock landings continued to decline and were about 30% lower than in 1965. The decline may have been related to greater availability of haddock and transfer of fishing effort. Other evidence concerning abundance of stocks is lacking.

V. Redfish

Landings of redfish on the Canadian mainland continued to increase and were about 60% higher than those in 1965 and three times the average landings in 1963-64. Most of the increase resulted from good recruitment in the Gulf of St. Lawrence (Div.4R-S-T) and a consequent transfer of effort to this species.

VI. Sea scallop, *Placopecten magellanicus* Gmelin

As in 1964, offshore landings came principally from Browns Bank (about 1000 metric tons whole weight). No effort was expended on Middle Bank in 1966,

from which 1965 landings were approximately 700 metric tons. A general decline in inshore landings was noticed, both in the Bay of Fundy and the Gulf of St. Lawrence. Landings from the Fundy region (Div.4X) declined from 4,200 to about 2,000 tons (247,000 kg meats). The southern Gulf of St. Lawrence (Div.4T) showed a decrease in landings from 2,700 to about 1,400 tons (166,000 kg meats). Economic factors rather than reduced abundance are probably responsible for these declines.

VII. Herring

Herring landings in Subarea 4 (excluding Div.4R) amounted to more than 220,000 tons, an increase of nearly 30% over the 1965 landings. Most of the increase occurred in Div.4X where for the third consecutive year record landings were made. Increased landings were also made in the Chaleur Bay region of the Gulf of St. Lawrence, but for Div.4T as a whole landings decreased nearly 10%. Smaller landings were also recorded in Div.4W and 4V. Landings in Div.4S were slightly higher in 1966.

VIII. Swordfish

Total Canadian landings of swordfish amounted to slightly more than 4,400 tons, a decrease of 5% from the 1965 landings. In Subarea 4, however, the landing of about 1,200 tons was substantially higher than in the previous year. The increase (15%) may be accounted for by intensified fishing effort and expansion of the fishery offshore to warmer waters near the Gulf Stream.

IX. Mackerel, *Scomber scombrus* L.

Preliminary tabulations indicate that mackerel landings in Subarea 4 amounted to 11,500 tons, an increase of 4% over the 1965 landings. In Div.4X, landings were about 1000 tons less than in 1965, but in all other divisions they were higher. Greater landings occurred mainly in the southwestern part of the Gulf of St. Lawrence (4T) and in the eastern counties of Nova Scotia (4W).

X. Tuna

The total Canadian catch of tuna amounted to about 200 tons. This was taken by inshore fishermen in the St. Margaret's Bay region of 4X, and by swordfish fishermen in offshore areas. Only bluefin tuna, *Thunnus thynnus* (L.), are taken in the inshore fishery whereas the offshore catch is a mixture of several species, but predominantly bluefin and bigeye, *Thunnus obesus* (Lowe).

XI. Sharks

Small quantities of porbeagles, makos and hammerheads are now being landed by swordfish fishermen. Total landings amounted to about 100 tons - twice as much as in the previous year.

XII. Atlantic salmon

The catch of Atlantic salmon has remained at a high level. In the Maritime Provinces the total catch, commercial plus angling, was 883 tons, the greatest since 1950. Grilse have continued to form a very large proportion of the angling catch.

XIII. Harp seal

Canadian catches of harp seals in Subarea 4 were 97,700 taken by ships, aircraft, small craft (less than 9 m in length) and landsmen. The catch in 1965, erroneously given last year as 73,000, was in fact 100,116 seals. Catches in the two years were therefore very similar. The catch of young seals fell from 89,676 in 1965 to 83,158 in 1966, while the catch of seals one year old and up rose from 11,440 to 14,542. Since 1965 a rising trend in the catch of young harp seals has apparently been halted by a quota of 50,000 young seals applicable to (Canadian) ships over 9 m in length and aircraft in Subarea 4 south of 50°N. Lat. The remaining catch in 1966 was due to ships in that part of the Gulf of St. Lawrence north of 50°N, and to landsmen and small craft, whose catch is unrestricted, throughout the subarea. The number of ships rose from 7 in 1965 to 8 in 1966.

XIV. Hood seal

This species is now protected by Canada in most of the Gulf of St. Lawrence. The catch in 1965 was 160 seals. Several hundred hood seals were taken legally in northern 4R, north of the limit line from Flowers Cove, Newfoundland, to Point Amour, Labrador.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic studies. Monitoring of coastal surface temperatures was continued in 1966 at several stations from the Bay of Fundy to the Gulf of St. Lawrence. Observations at Sambro L.V. were discontinued, starting in October. Annual temperatures at stations in the Gulf of St. Lawrence (4T) were above average while those at other stations (4WX) showed a negative anomaly. At St. Andrews the negative anomalies were predominant during the second and third quarter. In general the surface temperatures were higher in 1966 than in 1965. The average increase between the two years amounted to 0.4°C in the Bay of Fundy area (4X) and 1.4°C in the Gulf of St. Lawrence (4T). Bottom temperatures at the entrance to the Bay of Fundy (4X) indicated that autumnal cooling was less intense in 1966 than in 1965.

Physical oceanographic studies in the Cabot Strait area determined the flow pattern and mass-field distribution in the Strait. Current meters were moored at stations across the Strait for a 29-day period. Observations of drift patterns through the Strait were also made using parachute drogues.

Temperature observations in Cabot Strait indicated a continued gradual cooling of the deep warm layer. The 1966 conditions are similar to those of a cold period such as in the thirties, a relatively low temperature (4.3°C) and a reduced volume of the warm layer.

The Halifax section was monitored twice for fisheries purposes, and the Gulf ice forecast survey was undertaken in November.

Circulation studies were continued in all areas with an increased effort in the northeastern sector of the Gulf of St. Lawrence (4RS), in Northumberland Strait and the deeper waters of the Laurentian Channel. Seasonal trends of the circulation over the Magdalen Shallows (4T) were studied to show the relative strength and direction of the surface drift from west to east across the Laurentian Channel. The coastal drift off the Nova Scotia south coast (4WX) was studied in relation to wind direction and tide at the time of daily drift bottle releases over a period of 1,800 days.

Studies of the activity coefficients of major ions in sea water have been continued with special attention to NaCl and $MgSO_4$. Partial molar volumes of major salts in sea water have been determined. The distribution of total alkalinity, carbon dioxide and degree of saturation of calcium carbonate is being studied in the near-shore natural environment (4X) in relation to usual physical oceanographic parameters.

2. Plankton studies. Multiple, floating plankton nets were used to detect vertical micro-distribution of surface plankton. The copepod *Anomalocera patersoni* was found to live in the surface 10 cm. Research begun in 1965 on the parasites of *Sagitta elegans* has been continued. Infestations vary widely with season and physical conditions.

3. Benthic studies. In 1966 bottom topography was mapped in a sector enclosed by lines joining Southwest Point, East Point of Anticosti Island, Orphan Bank and Chaleur Bay in Div.4T and 4S.

Further detailed studies of the topography and sedimentology of the northeast part of the Gulf of St. Lawrence and Cape Breton trough were undertaken during 1966 (4RST). The core samples were supplemented by Sparker records of subsurface structure. Geochemical studies of the whole Gulf have been concerned mainly with distribution and significance of calcium carbonate and major elements such as silicon, aluminum, magnesium, sodium, potassium, iron, manganese and phosphorus.

Analysis of samples of benthic organisms of potential value as fish food in the Gulf of St. Lawrence (4T) is being continued.

Studies of the total production system of a partially enclosed small bay have been undertaken (Div.4X) including observations of primary and secondary producers, benthos, and fish in an effort to better understand the relation

of fisheries production potential to the availability and production of fish foods. Laboratory experiments designed to provide field measures of food intakes, growth and metabolism of offshore fish populations have been undertaken. It is expected that methods used in these special experiments will be applicable to the study of the dynamics of international commercial fisheries.

Sedimentological studies of Northumberland Strait were continued in 1966. A preliminary map of the bottom sediments of the western and central part of the Strait has been completed. On the Scotian Shelf, bottom sampling and coring were undertaken in the vicinity of Sable Island and to the southwest of the island. Work is continuing on the production of a chart showing the general physical features of the bottom, such as roughness and sediment types. It is hoped that this will augment the fisheries charts of the Shelf.

In the Bay of Fundy, the marine geological program was concerned primarily with bathymetry studies, analysis of bottom grabs, and shallow water sedimentation under conditions of strong tidal currents. Preliminary analyses of the current meter data collected in 1965 were completed.

II. Biological Studies

1. Cod. The annual survey with small-mesh otter trawl in the southern Gulf of St.Lawrence (Div.4T) was carried out in September. Catch per tow in numbers was about 4% lower than in 1965; however, smaller, younger fish were more numerous in the catches, particularly the 2-year-olds with a modal length of 25 cm. Along with monitoring yearly changes in sizes and ages in the cod population, food and maturity data were collected to study annual variations. A study of bottom fauna on the survey stations was furthered by photographing the bottom with a multi-exposure underwater camera attached to the headline of the otter trawl. The relation of these observations to those on the feeding and distribution of cod is being analyzed.

2. Egg and larval studies. Two cruises with the *A.T.Cameron* and five with the *Harengus* to study egg and larval stages of groundfish and their recruitment to the southern Gulf of St. Lawrence (4T) were carried out during May-September. Results from the May cruise indicate that cod spawned earlier in 1966 than 1965 and that total abundance of their eggs in the southern Gulf appeared about equal in the two years. In 1966, however, cod eggs were spread more evenly throughout the area than in 1965. American plaice eggs were taken with cod eggs on most stations.

The summer cruises were aimed at defining distribution of larval groundfish. Flatfish larvae were abundant in Isaacs-Kidd tows, particularly the larvae of yellowtail, American plaice and witch. Cod larvae were still difficult to catch in numbers but occasional catches suggest that we may be missing larger schools. There were also indications of an association between *Cyanea capillata* and cod larvae.

3. Haddock. Parts of two short cruises in February with the *A.T. Cameron* and in July with a chartered vessel surveyed a portion of the Scotian Shelf (Div.4W). In the winter cruise catches of commercial-sized haddock (40 cm and over) were small. Few small haddock (under 30 cm) were taken, suggesting that the 1964 and 1965 year-classes may be weak. Previous predictions suggested that the 1962 and 1963 year-classes would be strongly represented. However, their abundance was presumably affected by the 1965 Soviet fishery in Div.4W, which took about 45,000 metric tons, more than double any previous annual landing from Div.4W.

Fishing in the July cruise in the vicinity of Sable Island provided fairly typical catches with fish of about 28 to 35 cm (1964 and 1963 year-classes) predominating. No continuing series of summer surveys in this region is available for comparison of results.

4. Hake. Studies of hake (*Urophycis* sp.) biology in the southern Gulf of St. Lawrence (Div.4T) continued during the summer fishery. The otter-trawl fishery for hake was observed to concentrate in the Cape St. Lawrence and St. Paul Island area in June, and to move to the Cape Bear-Wood Island area of Prince Edward Island (Div.4T) in July and August. Of various methods of age determination tried for hake, otoliths appear to be the best possibility for this population. Food studies showed a variety of items in hake stomachs, among which were pandalid shrimps, euphausiids, amphipods, and small crabs. Larger hake also contained various fish including small plaice, sculpins and herring.

Studies of gonad development indicated that males were 50% mature at 49 cm and females at 52 cm. Fecundity studies are being carried out.

5. Redfish. During a trip of the *A.T. Cameron* to the Scotian Shelf in November, 5 lines across the shelf were examined. On the southern part of the shelf the water temperatures were considerably lower than in 1962 when the area was last surveyed for redfish, and redfish were not found in commercial quantities. Although bottom temperatures in the shelf depressions were around 5°C on lines almost as far eastward as Sable Island, redfish catches in these depressions were rather small. A notable exception to this was in the area of Sambro Bank where, particularly on the east side, good catches of 860 and 1060 kg of redfish were obtained in depths of 100 and 125-145 m respectively. These fish were of commercial size and averaged 0.5 and 0.4 kg.

Catches of redfish at the seaward edge of the shelf followed the usual pattern with few redfish being caught on the westward lines. In the central part of the shelf two lines showed indications of good commercial fishing in that catches of 2400 and 1350 kg of redfish were obtained in sets at 365-460 m and 410-510 m at a position opposite Halifax and 2050 and 1200 kg at 345-375 m and 405-485 m southwest from Sable Island.

6. Yellowtail flounder. Earlier work on stock definition indicated that differences between Middle Bank and Sable Island Bank in Div.4W were clinal

but Div.5Z yellowtail stocks were discrete. Recent studies show that yellowtail from Banquereau (Div.4Vs) tend to be larger than those from Sable Island Bank (4W). However, meristic studies indicate that differences are only clinal.

Meristic characteristics of yellowtail from the small population in Magdalen Shallows (4T) suggest that these are discrete from those on the Nova Scotian banks (4W and 4Vs), and also that they do not reach as great a size as Banquereau yellowtail.

Analyses of seasonal distribution of catches taken by research vessel in 4W and 4Vs suggest that yellowtail maintain the same areas and depth throughout the year. They are thus to be found in an environment with bottom temperatures ranging from -0.4 to 2.8°C (winter) to 3.0 to 8.0°C (summer).

Observations in early 1966 showed an *Ichthyosporidium* infestation in yellowtail. A further survey covering most of their habitat in 4Vs and 4W indicated that the most heavily infected and the greatest proportion of infested fish occurred on Sable Island Bank (Div.4W). A continuing study of distribution and rate of infestation is planned.

7. American plaice. Growth and longevity studies of American plaice from four areas were completed. Longevity (28 years) and average maximum size (79 cm) were greatest in the area of intermediate growth (Banquereau, 4Vs). The area with the most rapid growth rate (Passamaquoddy Bay, 4X) had the lowest longevity (12 years) and smallest L_∞ (53 cm). Otoliths from this area are extremely clear. Contributing to the rapid growth rate are availability of small herring for food (fish are a minor item in diets elsewhere) and high bottom temperatures. Longevity in the Gulf of St. Lawrence (4T) was close to that of Banquereau (Vs), but plaice did not attain as large a size.

8. Argentines, *Argentina silus* Ascanius. Studies on argentines were extended to the eastward by fishing with a chartered vessel in Div.4Vs and the eastern sector of Div.4W. Maximum catches of up to about 2 tons of argentines in a 30-min tow were taken from depths of 180 to 275 m south of Sable Island (Div.4W). In both the Banquereau region (Div.4Vs) at depths of 180 to 320 m and in the Sable Island region (Div.4W) best catches of argentines (along with a few redfish) were associated with echo-sounder traces which impinged on bottom at the depth where the fish were caught but also extended off the edge of the shelf in the same water layer.

Argentines taken in 4Vs tended to be somewhat longer (25 to 30 cm) than those from 4W (20 to 25 cm). Age-determinations, studies on fecundity, gonad development, food habits, and differentiations of stocks are being carried on.

9. Scallop. Survey effort on the Nova Scotian side of the Bay of Fundy (Div.4X) revealed low abundance of scallops on the inshore (Digby) beds. Most scallops were of an advanced age. Some hope for the future may be placed on young stocks recruited to the fishery in certain areas during the fall of

1966. The more offshore beds in the Bay of Fundy support good populations of scallops, although these are less attractive to the inshore fishermen because of their small meat size and the distance from port.

Underwater observations on scallop dispersion were begun in Passamaquoddy Bay this year, using Scuba diving techniques.

Surveys for potential scallop fishing grounds were made between the 20 to 40 m isobaths. Three important colonies were found south of the Magdalen Islands (4T). The sea scallop, *Placopecten magellanicus*, and the Iceland scallop, *Chlamys islandicus*, were both involved.

10. Herring. During the year 82 samples of herring (10,481 fish) were examined from the southern New Brunswick region of 4X. Most (80%) of the samples were from weir catches - the remainder from bottom trawls and purse seines. Individual lengths varied from 4.1 to 37.7 cm and mean lengths of samples from 9.9 to 28.6 cm. During the early months of the year, the 1964 year-class predominated in the samples (86.7% during February). The 1963 year-class was second in importance, but did not contribute significantly until April. From April through August the 1963 year-class was dominant (up to 65%). The 1965 year-class appeared in the samples in September and contributed substantially to the fishery for the remainder of the year.

In the southwest Nova Scotia region of 4X, 57 samples (7,764 fish) of herring ranging in total length from 10.0 to 39.5 cm were obtained from purse seines, weirs and gill nets. Most (95.7%) of these fish were autumn spawned. The 1963 year-class predominated in the catches (45.7%). The 1961 year-class was second in importance (36.8%). The 1964, 1962, 1960 and 1959 year-classes were represented, but were relatively weak, the highest percentage for these being 7.9 for the 1962 year-class.

Condition (fatness) studies gave values that ranged from 3.49 to 18.63% in the Bay of Fundy (4X) and from 5.05 to 14.76% in the Gulf of St. Lawrence (4T). There was some indication that fatness increased with size especially among small fish (less than 20 cm). No recognizable trends were observed in fat content variations with time except in 4T where there was a rapid increase in May and June, but little change thereafter.

Herring tagging was restricted to studies of tag types, retention of tags and tagging mortality. Both external and internal tags were tested. Mortalities were high for small fish (16.6 cm mean length), but most of the larger fish (19.9 cm mean length) survived the 40-day experiment. Mortalities due to external tags were greater than those for internal tags.

Three cruises were made during the year to explore the distribution and availability of herring in offshore areas. Catches were generally poor - the best ones (136 to 182 kg per 30-min tow) being made in the Corsair Canyon region of Georges Bank.

11. Mackerel. Mackerel investigations involved sampling commercial landings along the Nova Scotia coast (4X, 4W and 4V) and in the Gulf of St. Lawrence (4T) for size, age, sex and maturity. Tagging was carried out in both areas and egg and larval surveys in 4T. Sizes throughout the year ranged from 195 to 395 mm and ages from one to eight years. Growth in the first three years of life is very rapid, but thereafter the annual increase is small. The 1959 year-class was dominant in samples from 4T followed by the 1960, 1964 and 1963 year-classes in that order.

Substantial spawnings in 4T were indicated by the large number of eggs taken with plankton nets in late June. However, very few larvae were caught subsequently.

Recaptures of mackerel that were tagged in 4X suggests migrations to the northeast along the shore at least as far as Cape Breton Island (4V).

12. Swordfish. Special research on swordfish is reported under Subarea 5.

13. Tuna. There was no purse seine fishery for tuna in 1966 and research was limited to bluefin tagging in inshore areas and sampling offshore catches for species composition and size. In late summer 71 giant bluefin (182 to 273 kg) were tagged and released in St. Margaret's Bay (4X) and Halifax harbour (4W). Offshore catches of tuna by swordfish fishermen consisted of a mixture of small yellowfin (11 to 18 kg), small (18 to 25 kg) and medium (50 to 68 kg) bigeye and large (91 to 182 kg) bluefin.

14. Atlantic salmon. Smolt tagging operations have been continued on an increased scale, with the object of obtaining additional data regarding the effects of the Greenland fishery. Nearly 65,000 were tagged in 1966, mainly in the Northwest Miramichi River, N.B., and the Margaree River, Cape Breton Island, N.S. From 42,000 smolts tagged in 1965, about 430 were recaptured as grilse in Canada and rather over 100 were caught in the Greenland fishery in 1966.

15. Harp seal. Studies of mortality of young seals at and shortly after birth were made from a commercial sealing ship in 4T in early March. This mortality was found to be of the order of 1%.

Young harp seals aged 2 to 3 weeks were tagged from a helicopter in 4T in mid March after the end of the quota kill, when the probability of escapement was high. Monel metal tags with nickel pins were attached to the tails of the seals. From 1,550 seals tagged, about 80 tags were recovered from Subarea 4 between March and June. Some 25 tags were recovered from West Greenland (Subarea 1) and eastern Baffin Island, the summering area of these seals, between May and November. Two tags were returned from Labrador (Subarea 2) on the southward migration in November and December. The primary purpose of the experiment is to test the degree of mixing between the populations of harp seals

inhabiting Subarea 4 on the one hand (Gulf population) and Subareas 2 and 3 (Front population) on the other.

16. Hood seal. About 200 hood seals were seen on the ice (northwest of Cape Breton Island) in 4T on March 18 and whelping was in progress. An excess of adult males over females was noted.

Subarea 5

A. Status of the Fisheries

I. Cod

Canadian landings of cod have remained around 7,000 metric tons from 1963 through 1965. Although statistics for 1966 showing area of capture are not yet available, it is believed that Canadian landings of cod from Subarea 5 remained at about the same level.

II. Haddock

Landings of haddock from Subarea 5 by Canadian vessels in 1964 and 1965 were about 11,000 to 12,000 metric tons annually. It is expected that landings of haddock from Subarea 5 probably increased in the current year, and the 1963 year-class continued to contribute the greatest proportion of the catch. Sampling at sea on a Canadian stern trawler in October showed discards to be negligible.

Sampling of landings from Subarea 5 by commercial vessels was continued. The scales obtained along with records of length composition were forwarded to the Woods Hole laboratory of the U.S. Fish and Wildlife Service for compilation and analysis.

III. Scallop

Scallop landings from Georges Bank (Div.5Z) increased slightly over 1965 from 38,000 to about 41,000 metric tons. Most effort was concentrated on the northeastern edge of the bank.

The number of vessels in the offshore fleet increased once again to 63, of which 57 fished scallops regularly. A number of boats converted to herring purse seining during the year. A considerable proportion of fleet effort continued to be expended south of the ICNAF Area on the Virginia beds. However, landings from this area showed a decline from 26,500 to around 23,000 metric tons.

IV. Herring

There was no Canadian herring fishery in Subarea 5 during 1966.

V. Swordfish

Swordfish landings from Subarea 5 and the region southward to Cape Hatteras amounted to about 2,000 tons. This is nearly 700 tons less than in 1965. Landings from Subarea 5 were only slightly (8%) less than in 1965 and most of the decrease occurred in the Cape Hatteras area where both the effort and the catch per unit of effort were substantially smaller in 1966. The distribution of swordfish catches for all areas in 1966 is shown in Fig. 3.

VI. Tuna

There was no purse seine fishery for tuna in Subarea 5 and southward to Cape Hatteras during 1966.

B. Special Research Studies

I. Biological Studies

1. Scallop. Scallop catch statistics continued to be collected from offshore fleet log records and catches were assigned to 10-min squares for Georges Bank. Collaboration and exchange of Georges Bank scallop data with the U.S. Fish and Wildlife Service continues.

A cruise was made to Georges Bank and scallop distribution was examined in certain areas of the bank. Data are still in process of analysis.

2. Herring. Three samples of herring (684 fish) were obtained during July and August with bottom trawls in the Corsair Canyon region of Georges Bank (5Z). Total lengths ranged from 27.8 to 37.0 cm. Most (93.4%) of the 439 otoliths examined were of the autumn-spawned type. Five year-classes (1959-1963 inclusive) were included in the samples with the 1961 year-class making up 69% of the total. The 1960 year-class made up 20% of the samples followed by the 1962, 1959 and 1963 year-classes in decreasing order of importance.

3. Swordfish. Research on swordfish was done with little reference to subarea boundaries and is all reported under Subarea 5. From 1963 to 1965 the average weight of swordfish landed in Canadian ports fell approximately 9% per year. In 1966, however, the average weight (62 kg) was only 5% less than that for 1965 (65 kg). Average weights (51 to 92 kg) from various fishing areas were very similar in both years and the observed decrease was due primarily to changes in the relative proportion of the catch from different areas. In general average weights (50 to 55 kg) from the western areas (Subarea 5 and southward) are lower than those (86 to 91 kg) from the more easterly areas.

Sex and maturity studies and attempts to tag swordfish were continued in 1966. There was a higher proportion of males (35% of 231 fish examined) than for any previous year. Thirteen (13) swordfish were tagged and released, and a fish that had been tagged two years previously in Subarea 5 was recaptured about 60 miles from the point of release.

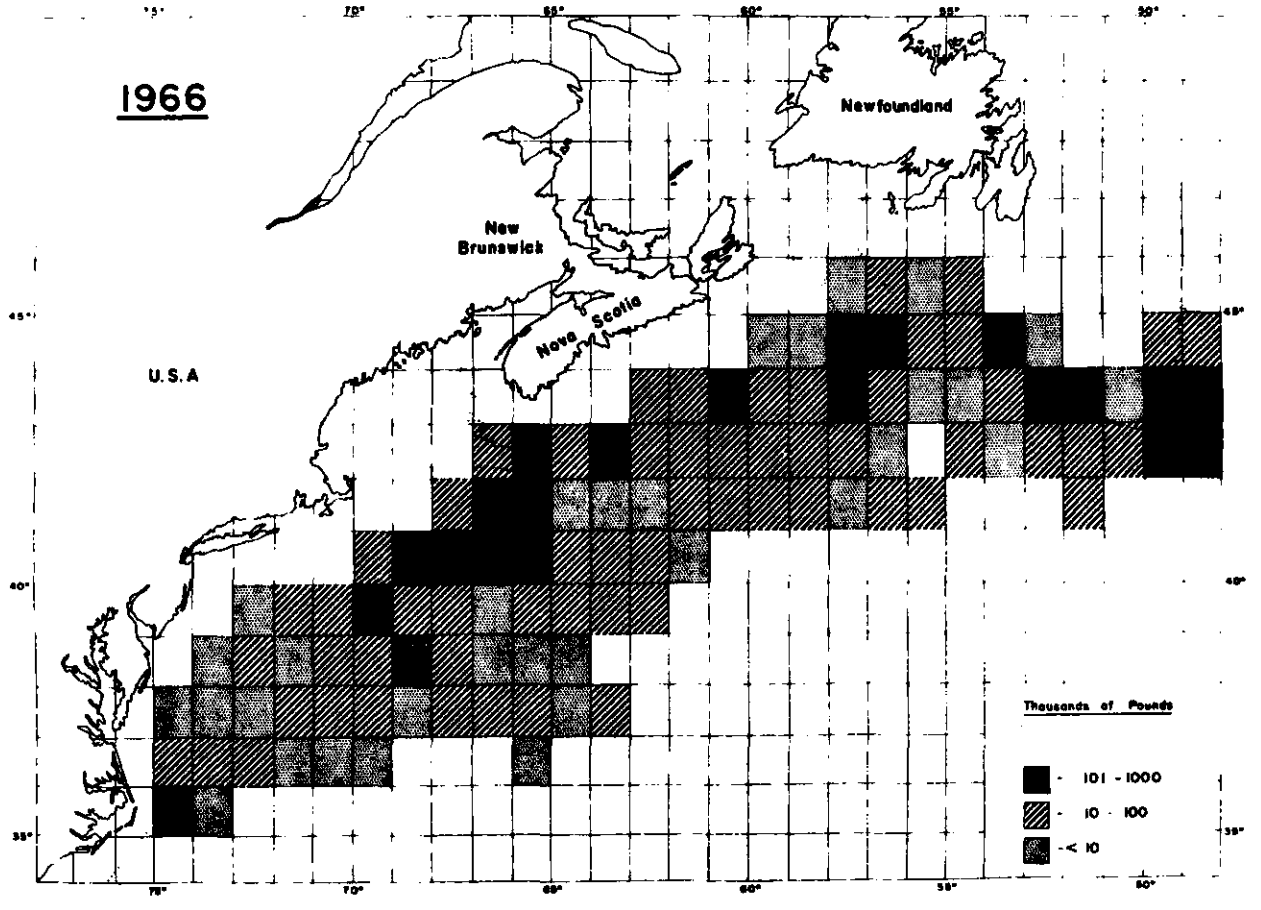

Fig. 3. Distribution of Canadian swordfish catches in 1966.

II. Danish Research Report, 1966

by Paul Hansen

Subarea 1

A. Status of the Fisheries

I. Cod

1. The fisheries. The output of the cod fishery was 30,000 tons which is 5,000 tons more than in 1965 but 7,000 tons below the output in the best year, 1962.

The increase may, to some extent, be due to an increase in the number of Greenland fishing boats and extension of the fishing factories. As usual, the fishery was mainly carried out in inshore waters. Four fishing vessels, two of 100 tons and two of 200 tons fished with longlines in Davis Strait.

The two year-classes, 1960 (age-group VI) and 1961 (age-group V), predominated strongly in all catches, the latter especially in catches from Div.1E and 1F.

Most of the catches consisted of small- and medium-size cod between 54-58 cm (weight 1.5-1.8 kg) and 65.5-68 cm (weight 2.5-3 kg).

2. Forecast for the cod fisheries. The two rich 1960 and 1961 year-classes will possibly predominate the catches also in 1967. There is, however, reason to believe that the former year-class will be less abundant as it was more exposed to heavy fishing than the younger year-class. In Div.1E and 1F small 4-year-old cod will be common in the catches.

II. Salmon

The output of the Greenlanders' gill net fishery for salmon in coastal waters was 1,250 tons. In Davis Strait the Faroese fishing vessel *Bakur* took about 70 tons in drift nets.

The weather conditions in the fishing season, which is from September to the middle of December, were very bad and hampered the fishery severely especially in November and December. The fishery stopped in fact about the middle of December.

III. Other commercial fish species and crustaceans

The catches of Greenland halibut decreased from about 3,000 tons in 1965 to 2,500 tons in 1966. Also the catch of wolffish decreased to about 1,700 tons.

Capelin which is mainly used for fish meal, but in dry condition also for consumption and dog food, was fished in about the same quantity as in 1965, namely, 1,357 tons.

The production of lumpsucker roe for caviar was 579 tons, which is nearly double that produced in the previous year.

The deep sea prawn fishery continued to increase. The catch in 1966 was 5,378 tons, 300 tons more than in 1965.

B. Special Research Studies

I. Environmental Studies

As in previous years R/V *Adolf Jensen* and *Tornaq* made annual observations especially in Div.1D. R/V *Dana* carried out hydrographic work from the end of June to the beginning of August in the Irminger Sea and in Davis Strait. The hydrographic material is treated by Mr Frede Hermann (Res.Doc.67/59).

1. Hydrography. Temperature observations at the entrance to Godthaab Fjord showed a special strong inflow of warm water near the bottom in November and January. The winter 1965-66 was unusually mild and no temperatures below zero were observed in the surface. In the first months of the year the temperatures were above normal. Later the temperatures were normal.

In Davis Strait the temperatures were rather high in the deep water west of Fylla Bank. In July very high temperatures were recorded in depths below 300 m west of the fishing banks. For instance, temperatures of more than 4.5°C were found north of Store Hellefiske Bank. In Disko Bay temperatures about 3.5°C were recorded on the prawn grounds. It is 1.5° above the normal temperature.

There seemed to be an inflow of cold polar water in the southern part of the area in August.

2. Other environmental studies. Plankton were collected during the whole year near Godthaab (Div.1D). Measurements of the primary production by means of Carbon 14 were made in Div.1D.

Plankton was taken from R/V *Dana* especially in Div.1B, 1C and 1D.

II. Biological studies of fish by species

1. Cod

a. Larvae (Fig. 1). *Dana* fished for cod larvae with 2 m stramin net in July in Div.1B, 1C and 1D (between 63°40'N and 66°50'N, and from the coast to 57°00'W). The catches were rather poor. It looks like the year-class 1966 will be a rather poor year-class.

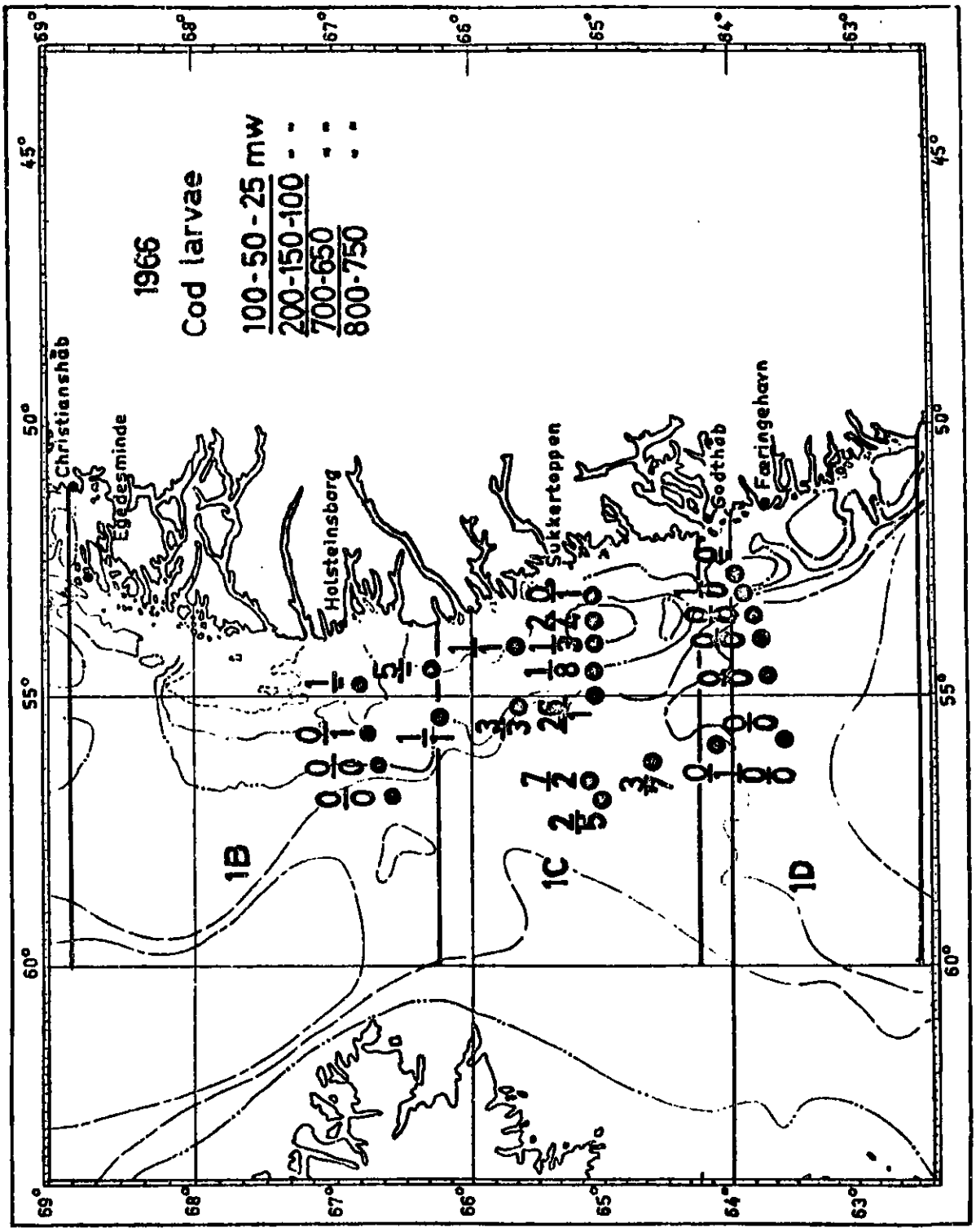

Fig. 1. Cod. West Greenland. Larval distribution, 1966.

b. Occurrence of small cod (age groups I, II and III). Cod belonging to the age-groups I and II seemed to be very rare, while cod belonging to age-group III(1963 year-class) were found in rather large numbers especially in Div.1E and 1F. In 1965, this year-class seemed to be rather poor. The apparently rich occurrence of this year-class in Div.1E and 1F seems to show that it has recently been transported by the current from East Greenland to southern West Greenland.

It is worth mentioning that the studies on occurrence of cod larvae in 1963 (NORWESTLANT Survey) showed very poor occurrence of cod larvae off West Greenland while rather large numbers were found off East Greenland south of Angmagssalik. Some cod larvae were also found here in April and cod eggs were found in July. The phenomenon can possibly be explained by a long spawning period off East Greenland together with a mixing of cod eggs and larvae transported by the current from the southwest Iceland spawning grounds.

c. Age and size of cod in commercial stock. Length measurements and otolith collections were made from cod taken with different commercial gears by the Faroese trawler *Skalaberg* and R/V *Dana*, *Adolf Jensen* and *Tornaq*. In addition samples were collected from the Greenlanders' catches at different places along the West Greenland coast. One sample was taken in Angmagssalik Fjord in East Greenland.

Figures 2, 3 and 4 show the age compositions of catches with trawl (Fig. 2), with longline, handline and prawn trawl (Fig. 3) and with the Greenland fishermen's handline and longline (Fig. 4).

In all catches except one the two rich 1960 and 1961 year-classes (age-groups VI and V) predominated. In 13 of the 29 samples these two year-classes together amounted to more than 80%. In 11 offshore samples from trawl catches the 1961 year-class was predominant in 9. In two of the southern catches more than 80% belonged to the 1961 year-class. The differences in numbers of cod belonging to these two year-classes were rather small in the catches taken with longline (Fig. 3).

In the inshore catches (Fig. 4) the 1961 year-class is very strongly represented in Div.1E and 1F. It was mentioned in the Danish Research Report, 1965, that there is reason to believe that the 1960 year-class is of West Greenland origin while the 1961 year-class originates from East Greenland waters and has been transported as fry to the West Greenland coast by the current.

In the sample from commercial catches in Angmagssalik Fjord in East Greenland the 1961 year-class predominates with 59%, 1960 with 24.9%, 1962 with 10.7%, 1959 with 2%, 1958 with 2.9% and 1957 with 0.5%.

The two rich 1956 and 1957 year-classes which were very important to the fisheries in the period from 1961-64 were no longer important. The 1956 year-class had practically disappeared from the catches while the

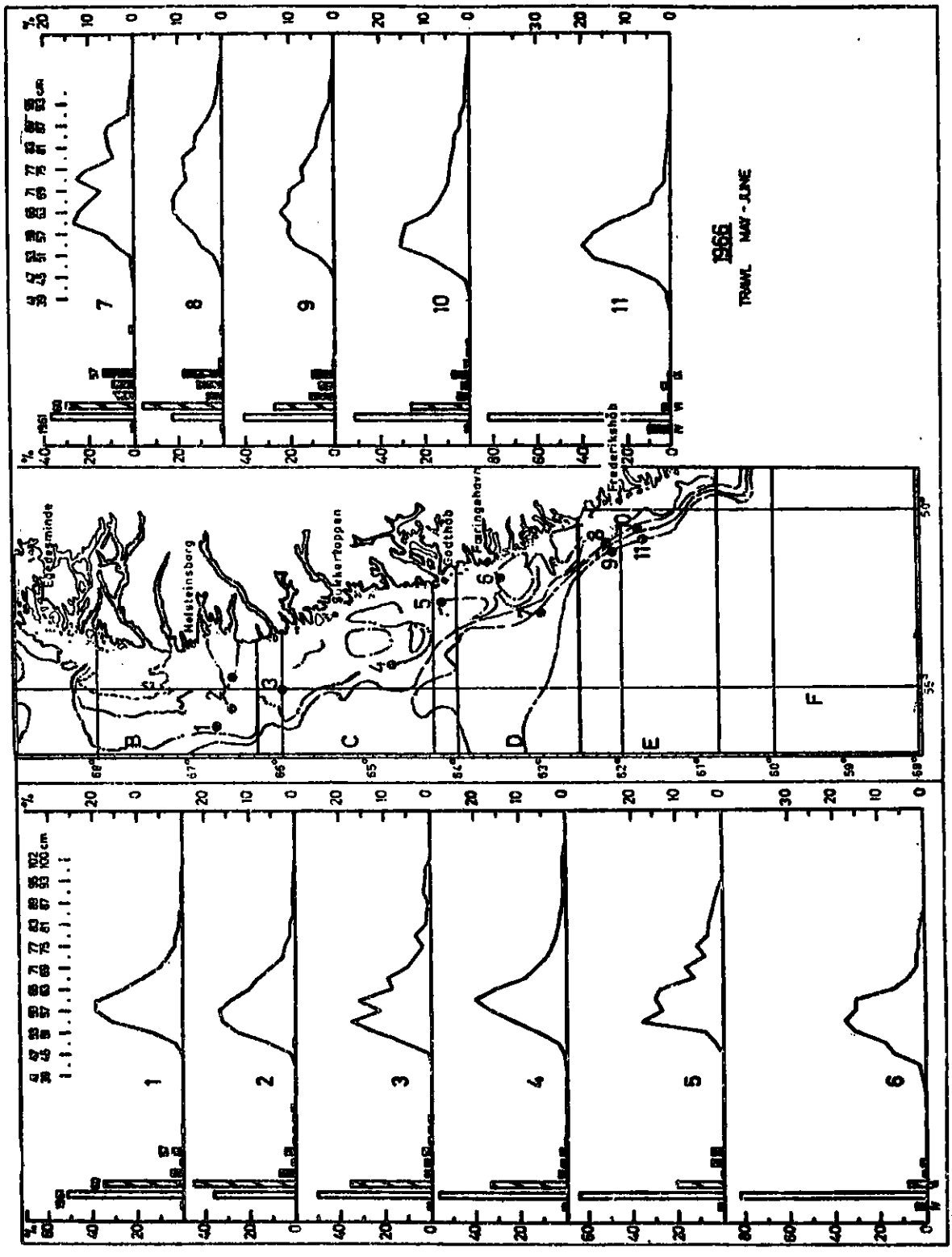

Fig. 2. Cod. West Greenland. Length and age composition of catches made by Faroese trawler *Skalaberg*, May-June 1966.

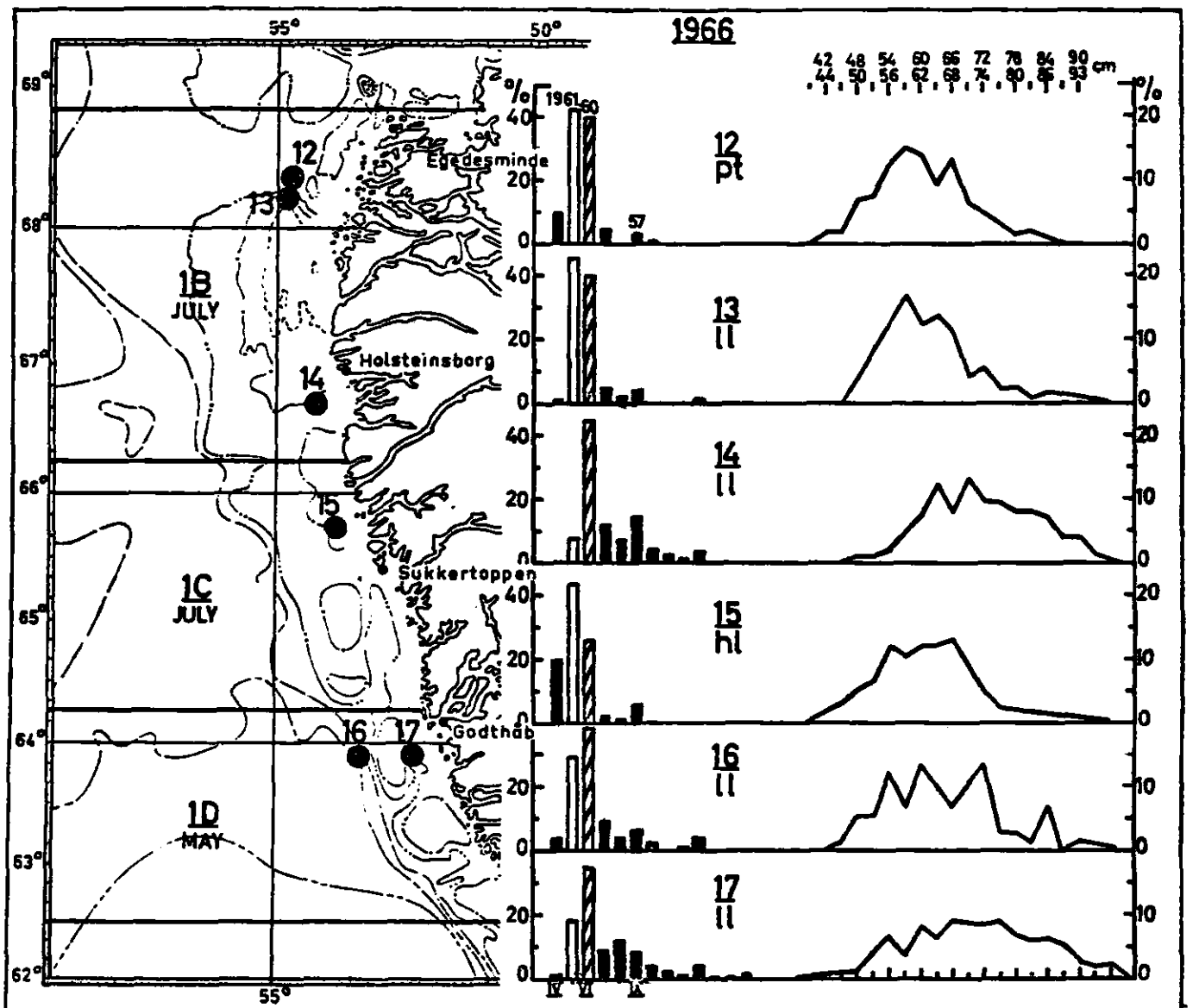

Fig. 3. Cod. West Greenland. Length and age composition of longline (ll), handline (hl) and prawn trawl (pt) catches, May-July 1966.

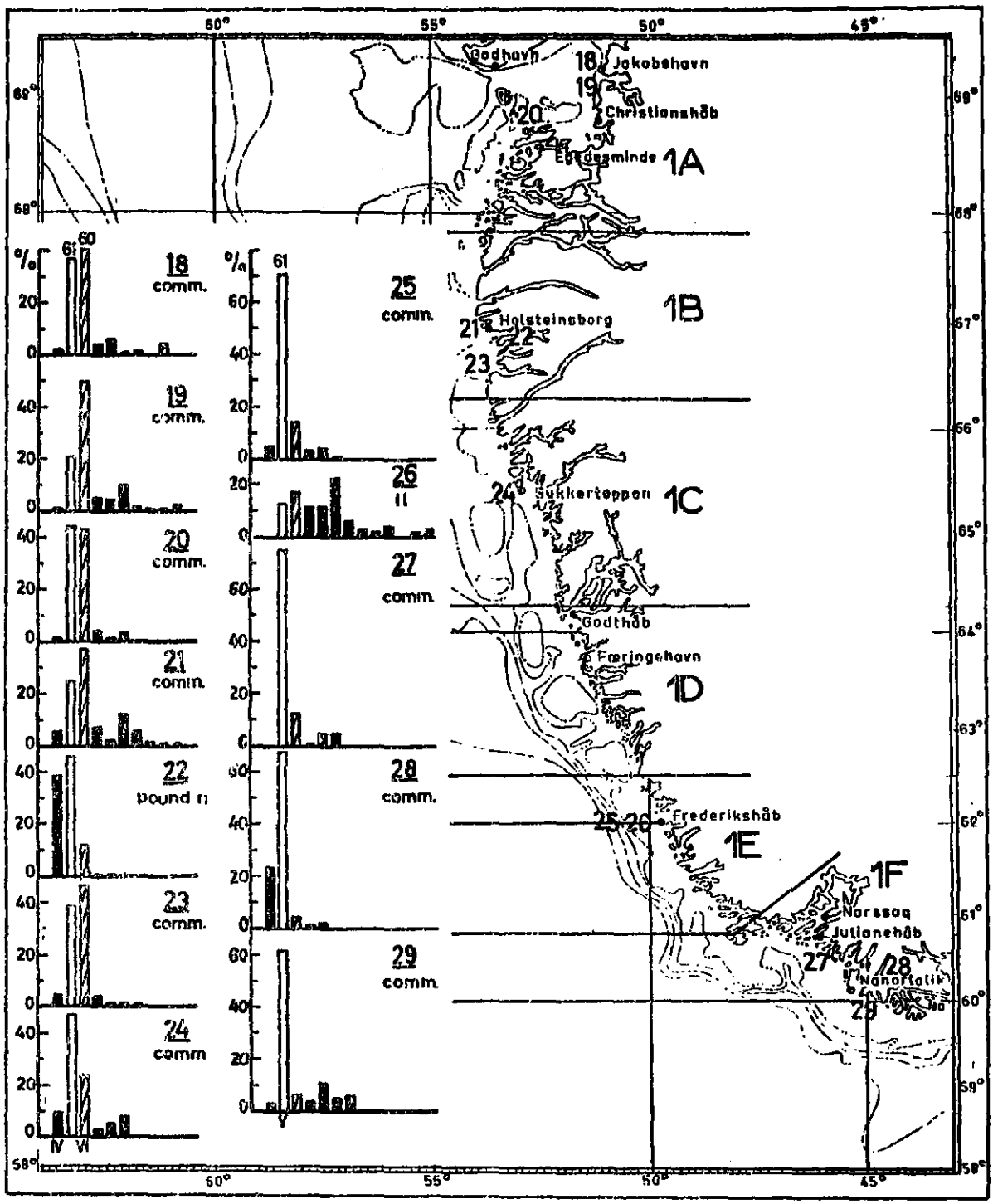

Fig. 4. Cod. West Greenland. Age composition of Greenlanders' catches from inshore waters, 1966.

1957 year-class was about 10% in 5 samples and 20% in one sample. In all other samples it was almost absent. In recent years the rich year-classes disappear from the catches at a younger age than previously. Ten-year-old cod or older which were rather common in the catches until about ten years ago are now very rare. The intensive trawl fishery takes cod at an earlier age than before. A rich year-class has its maximum in the catches when it is about 5 years old: at 7 and 8 years of age it decreases very much, and when 9 years old it occurs in such small numbers that it is without importance to the fishery.

The length of the cod is in the majority of the samples between 50 and 70 cm, with maximum about 60 cm, and weight between 1.5-3 kg.

d. Tagging experiments. Tagging experiments have been carried out with cod of different sizes in all divisions except 1A in both inshore and offshore waters. A total of 2,905 cod was tagged.

Of cod tagged during the 1959-66 period 431 recaptures were reported in 1966, 382 in West Greenland waters, 7 off East Greenland and 39 in Iceland waters. Three recaptures were delivered without exact information about the place of recapture. They have presumably been recaptured either off East Greenland or in Iceland waters.

2. Atlantic salmon. Electro-fishing experiments were carried out in rivers in Div.1F. In a river in which Norwegian salmon eggs were planted in 1958 and 1959, 3 parr measuring 16-17 cm were caught. Scale reading showed that these small salmon were 4 years old and possibly second generation from eggs planted in 1958.

Fishing experiments with drift nets were carried out in June in the Irminger Sea off Southeast Greenland. Four salmon were caught. This is the first salmon taken far from the coast in this area. They were smaller than the salmon caught in the Greenland fishery with gill nets in the autumn. Possibly they are salmon which have left their home rivers to go to the feeding area off West Greenland.

From mid September to mid November, research work was carried out by Scottish, English, Canadian and Danish salmon experts in Div.1D. Here 728 salmon caught in gill nets were tagged in inshore waters.

Of the salmon tagged in foreign rivers, 130 were recaptured in inshore waters in Greenland. The recaptures were from tagging experiments carried out in Canada (111), England (6), Scotland (11) and USA (2).

3. Other fish species. In Godthaab Fjord 177 redfish caught in pound nets were tagged. During 1966, 21 redfish tagged in previous years were caught. Two of these recaptures were taken about 6 years after tagging. Special biological work was carried out on capelin *(Mallotus villosus)*. Samples in frozen condition were sent to the laboratory from many fishing places in Greenland.

4. Crustaceans. Fishing experiments started in 1965 with crab trawls were continued in 1966. At some places in Disko Bay rather good occurrences of crabs *(Chionoecetes opilio)* were found, at other places very few crabs were found.

Some trawling experiments for prawns showed larger occurrences than normal in Disko Bay perhaps due to the high bottom temperature in 1966.

III. French Research Report, 1966

by R. Letaconnoux

In 1966, the French vessels took 140,000 tons of cod, of which 41,000 were taken in Subarea 1, 31,000 in Subarea 2, 53,000 in Subarea 3 and 15,000 in Subarea 4. The best catches were made in May-June and in September-October in Div.1B, also particularly in March-April and from September to October in Div.2J, 3K and 3L, and in February and June in Div.4R.

Subareas 2 and 3

Observations were made in this area from R/V *Thalassa* in August-September between 47°00 and 56°30'N from north of the Grand Bank to north of Hopedale Channel.

I. Environmental Studies

Four oceanographic sections of 46 stations were made as follows:

1. At the 47th parallel of latitude from Flemish Cap to the Avalon Peninsula, across the north of the Grand Bank and the Woolfall Bank, from 9 to 11 August 1966.

2. From Cape Bonavista NE, at 1,500 m depth across the plateau NE of Newfoundland, above 300 m depths from 19 to 21 August.

3. From Seal Island NE at depths of 1,500 m, across the south of Hamilton Bank, from 4 to 6 September.

4. From Nanuaktok Island (at the mouth of Hopedale Channel), at depths of 1,500 m, across the southern extremity of the N plateau of Labrador, from 13 to 15 September.

A total of 483 salinity and temperature measurements were made on these sections. At the same time 115 temperature observations were made with the bathythermograph at fishing sites. These data make it possible to prepare a good chart of environmental conditions in the region studied.

Temperature distribution at different depths

Surface. The map of surface conditions (Fig. 1) shows in relief the opposition of the cold water of the Labrador Current which flows toward the south (minimum temperature observed: 4°C in the north) to that of the warm Atlantic water which covers the Grand Bank (maximum observed: 14.5°C in the Avalon Channel).

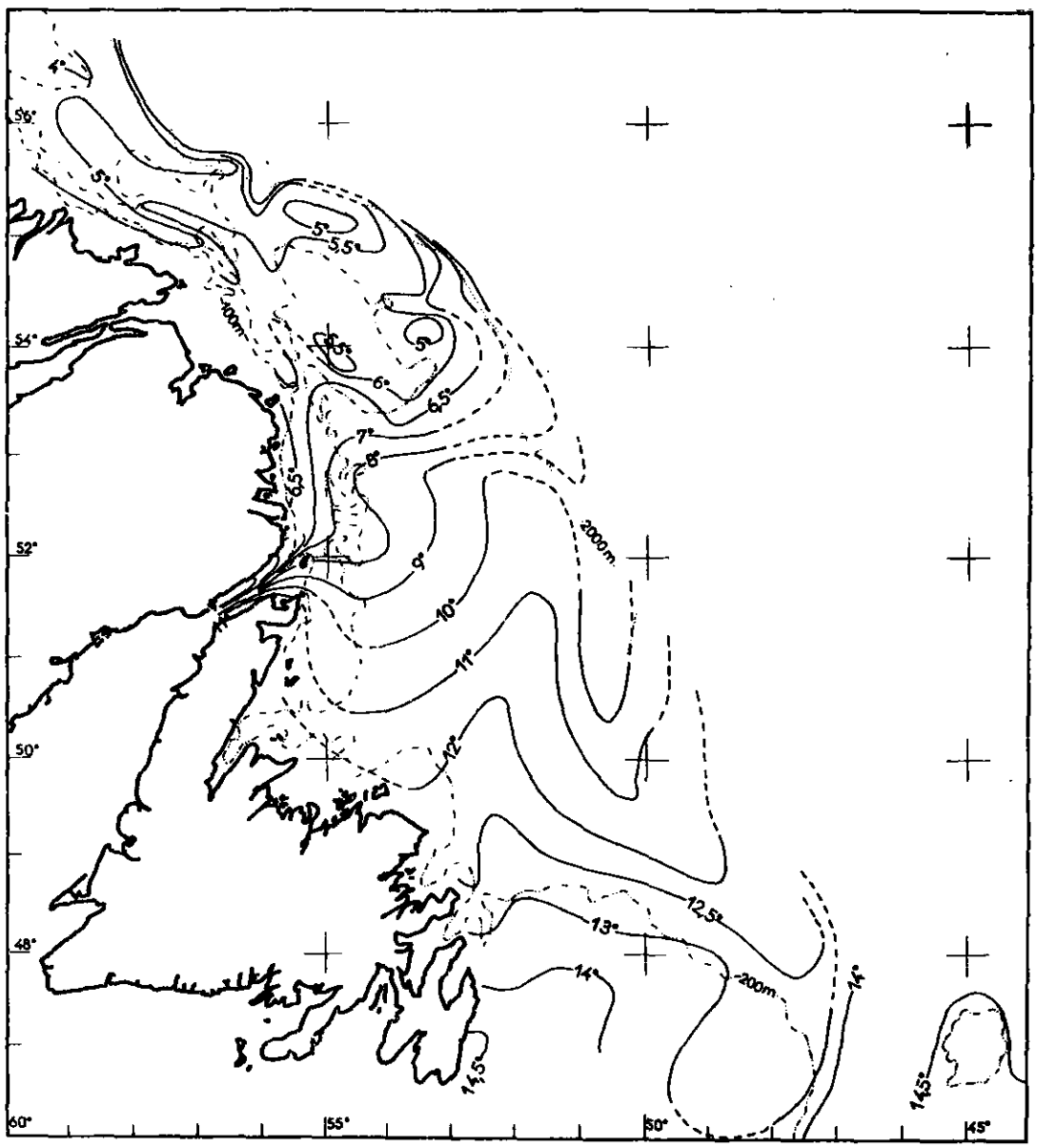

Fig. 1. Surface temperature distribution

This invasion from the south, originating from the North Atlantic drift and well known since the work of Beaugé (1928-29), is particularly important at this time, as much for its higher temperature as for its extension toward the north which splits the Labrador waters into two lobes, the one which runs along the eastern side of Newfoundland and the other, more important, which develops along the shores with a temperature from 6°C to 13°C.

The progression of the tongue of warm water is broken to the south of Hamilton Bank where one observes it as a strong gradient zone between the

6°C to 10°C isotherms. The warm tongue is then found deflected toward the west, in the coastal section, but a northerly finger is detached which extends as far as Hopedale section with a temperature of 5°C, showing that to this time the influence of the superficial water of the slope is felt as far as the Labrador section.

The main cold current overruns the banks to the north and flows down the length of the coast.

One will notice that in the Belle Isle section the coldest water lies along the Labrador side where one finds a minimum temperature of 4°C indicating a certain moving upward of the sub-surface layer, while the warm water (11.7°C) which has progressed along the eastern side of Newfoundland from Cabot Strait maintains its position against the coast of the island.

In general, in the southeast section, the influence of the North Atlantic drift is felt equally on Flemish Cap where it rises to a temperature of 14.5°C. A little to the east, over the deep waters, the 16°C isotherm is found.

Minimum Temperature Distribution

Figure 2, made up from the bathythermograph observations of minimal temperature, without taking the depth into account, makes it possible to follow the advance of the coldest waters from the Labrador Current.

One sees that its axis, represented by a temperature down to -1°C is located a little off the coast, along which one verifies a certain warming up again in the neighbourhood of 1°C and doubtless very important to the shallower inner bays. This very cold tongue, -1.4°C to -1°C, spreads over the shelf in finger-like projections along the coast as can be seen on Hamilton Bank and on the Grand Bank. Although it occupies an important part - on an extension of 600 miles in the section studies - one does not observe any significant variation from north to south in the interior of this lobe. Its temperature only begins to increase to the southeast of the Grand Bank.

The depth of this minimum temperature is unsteady enough: when it is found between 40 and 100 m in the Labrador section, it has a tendency to rise again from the Newfoundland deeps to 23 m in the north of the Grand Bank.

The pushing of the wide band of waters in the section of the slopes northeast of Newfoundland is characterized by a minimum thermal warming to 1°C.

Onshore, the temperature gradient is important, notably northeast of Hamilton and of Grand Banks. In these sections, the temperature minimum is selected on the basis of the thermocline.

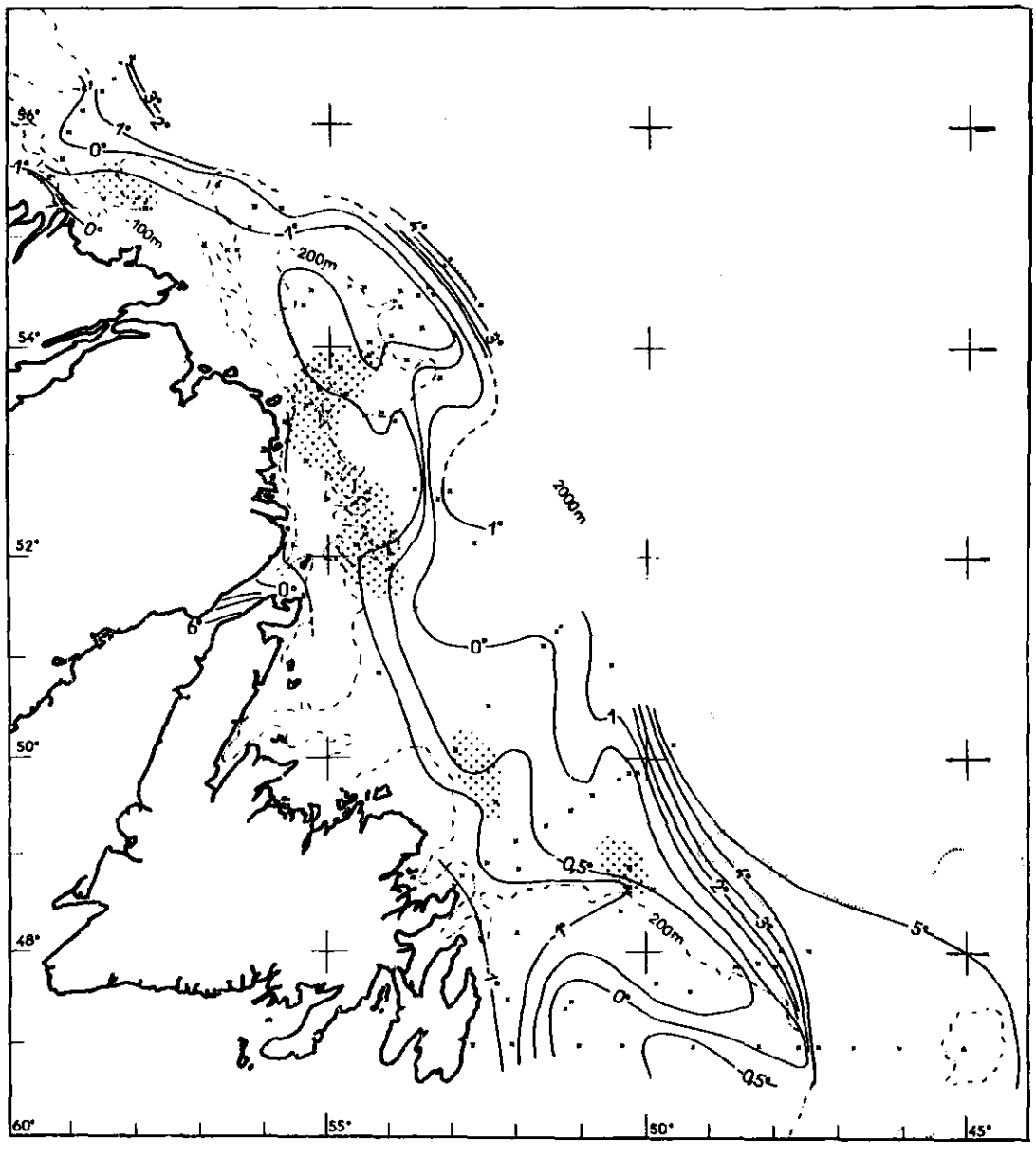

Fig. 2. Distribution of minimum temperature and location of capelin concentrations.

Near bottom temperature. Figure 3 is especially important for the establishment of correlations between the distribution of fauna and the temperature conditions. It shows that in the littoral zone and on the greater part of the shallower depths, Labrador water predominates with a lower temperature of 0°C from the Labrador fringe to the north of the Grand Bank.

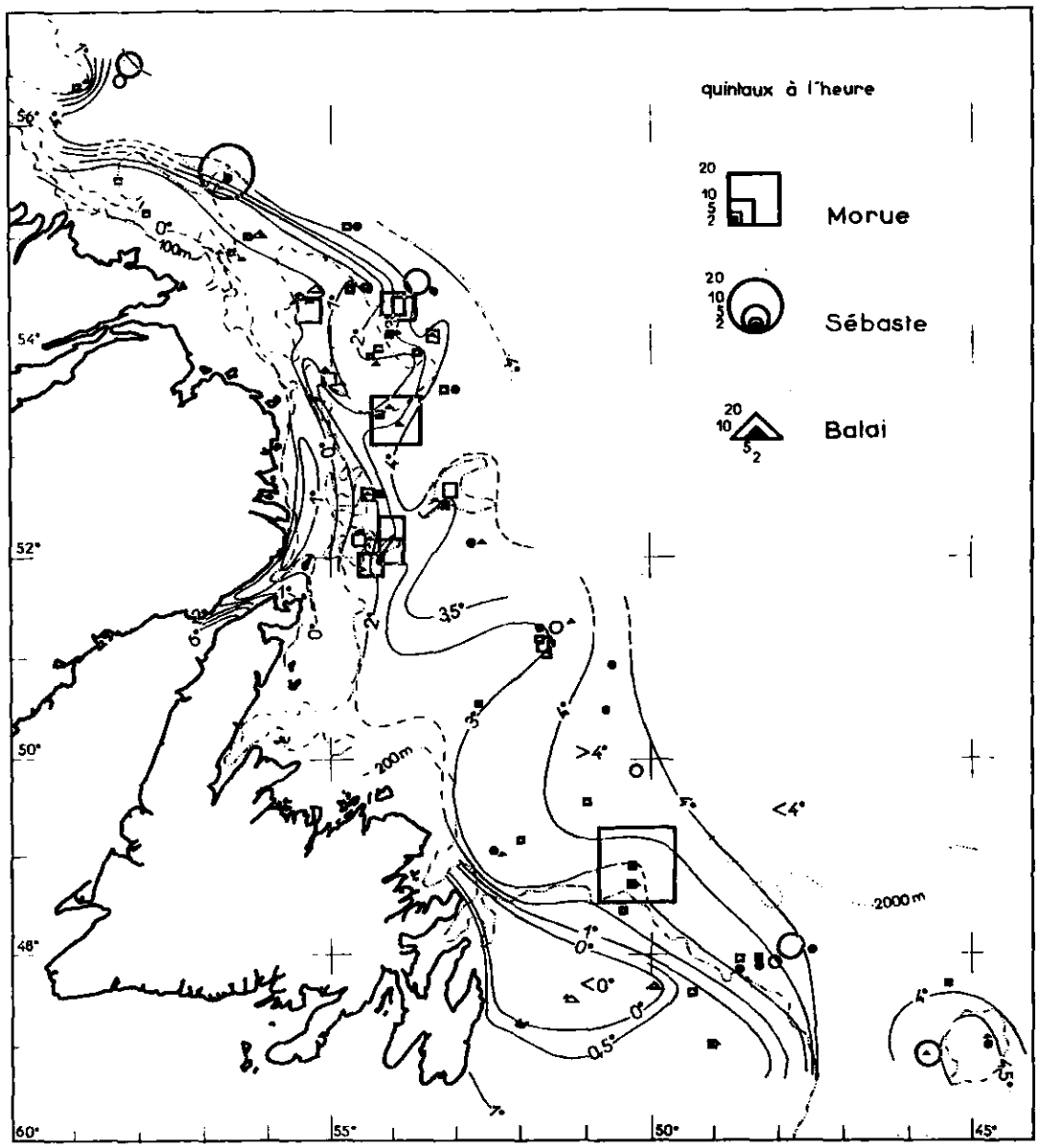

Fig. 3. Bottom temperatures and yields of cod, redfish and American plaice

By contrast, below 200 m there is an extensive penetration of colder water and the temperature increases to 4°C to 4.6°C with depth. The isothermal gradient is thus very weak over the gradual sloping bottom, such as that of the depression situated to the north of the Grand Bank and is very strong over the steep slopes.

It seems, however, that on the Labrador section certain depressions escape the penetration of the cold waters, notably those situated in the north-west of the banks. This situation suggests a general movement of cold water to

the south, with deviation toward the right in the valleys and then the presence of Atlantic water from West Greenland running out of the Irminger Current, which makes a circular movement to the south of the sill of Davis Strait.

About 500/600 m the temperature decreases again and tends toward that of the mixed water of the Labrador Basin.

On Flemish Cap the situation is different and the 4.5°C temperature in the upper layers marks the direct influence of the Atlantic derivative in this section.

Section from Seal Island to the northeast passing over Hamilton Bank. This is the only section illustrated in Fig. 4 because it sums up the vertical temperature distribution. The axis of the Labrador Current is clearly marked by a cold intermediate lobe at 90 m with a minimum temperature of -1°C to 0°C. This cold layer largely covers the slope where it undergoes warming and overlies the Atlantic vein from Davis Strait which presents a maximum temperature of 4.63°C at 400 m. It is covered by a film of water warmed by the local insulation and the influence of the superficial Atlantic formation and of which the temperature varied from 6°C over the slopes to 8°C seaward.

From 400 m a decrease of the temperature is shown which stabilizes itself around 3.45°C in the neighbourhood of 1,000 m with the presence of homogeneous waters of Davis Strait, formed by the mixture from the different formations which meet again in this section.

One should note that Labrador-Newfoundland section, the thermal stratification is appreciably the same from north to south. This is why the upper depths of Newfoundland, which are more elevated than Hamilton Bank, are washed by the coldest waters of the intermediate layer of the Labrador Current in front of which they are present like a "screen" which only lets through the waters from the upper layers.

Comparing these results to the previously published works by the Americans and Canadians, one can say that the extension of Atlantic waters is more important in 1965 in that which concerns the direct influence of the North Atlantic Strait in the south of the banks of Newfoundland as well as that of the Irminger Current of which one meets the leading edge in the Labrador section. This influence is marked against the slope by an increase in temperature to 4°C.

Elsewhere, the works of the Soviet scientists in 1961 (Buzdalin and Elizarov, 1962) show that in the second fortnight in August those temperatures have not been reached in Flemish Channel. This phenomenon is worthwhile pointing out because it can have had an influence on the fishing to the extent that it has modified the habitual distribution of the cod and the capelin.

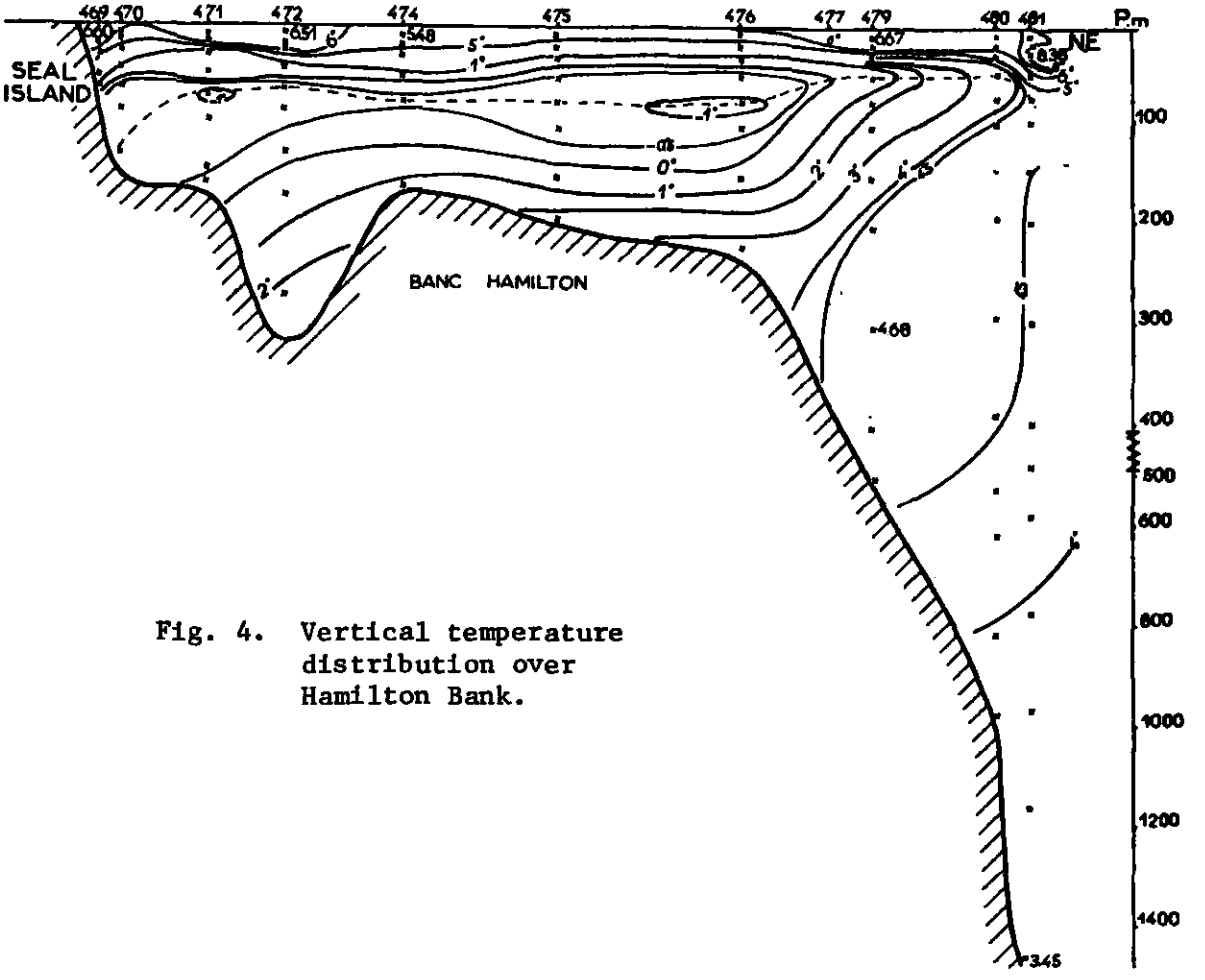

Fig. 4. Vertical temperature distribution over Hamilton Bank.

II. Biological Studies

The study of the trawl yields by location and by depth was made on 79 of the 89 trawl hauls made. Ten hauls were considered of no value, having been made to test or regulate fishing material or having been made useless as the result of major damage during the haul. Elsewhere, a fishing trawl was lost to the south of Hamilton Bank.

Most fishing was completed in one hour trawl hauls in order to compare the yields obtained during the cruise. Those hauls which did not reach or exceed this time were calculated to one hour of fishing.

Comparative trawls, made to the north of Grand Bank and to the south of Hamilton Bank by French trawlers, showed that this method of procedure was valid, the yields obtained by the R/V *Thalassa* being comparable to those of the commercial trawlers.

Most hauls were made with a trawl of "Lofoten" type, of 31.20 m headline and a stretched mesh of 140 to 110 mm. To allow the capture of individuals of small length and of samples of the benthic fauna, the codend had meshes of 50 mm and the bait meshes of 60 mm.

Major commercial catches were represented by cod *(Gadus morhua)*, redfish *(Sebastes marinus mentella)*, American plaice *(Hippoglossoides platessoides)*, Greenland or black halibut *(Reinhardtius hippoglossoides)*, witch or grey sole *(Glyptocephalus cynoglossus)*, wolffish *(Anarhicas lupus, A. minor* and *Lycichthys denticulatus)*. One can add to this list the shrimp *(Pandalus borealis)* captured in significant abundance in certain areas.

1. Bathymetric distribution of the principal species. The average yields obtained of cod and redfish, in kg per hour of fishing at the different levels studied, can be summed up in two illustrations (Fig. 5). Their examination indicates that in August-September, cod had its greatest abundance between 150 and 275 m on the Labrador Shelf (400 kg/hr) and between 175 and 250 m on the Newfoundland Shelf (700 kg/hr) with, in this second region, a tendency to again be relatively abundant toward 400 m (100 to 200 kg/hr).

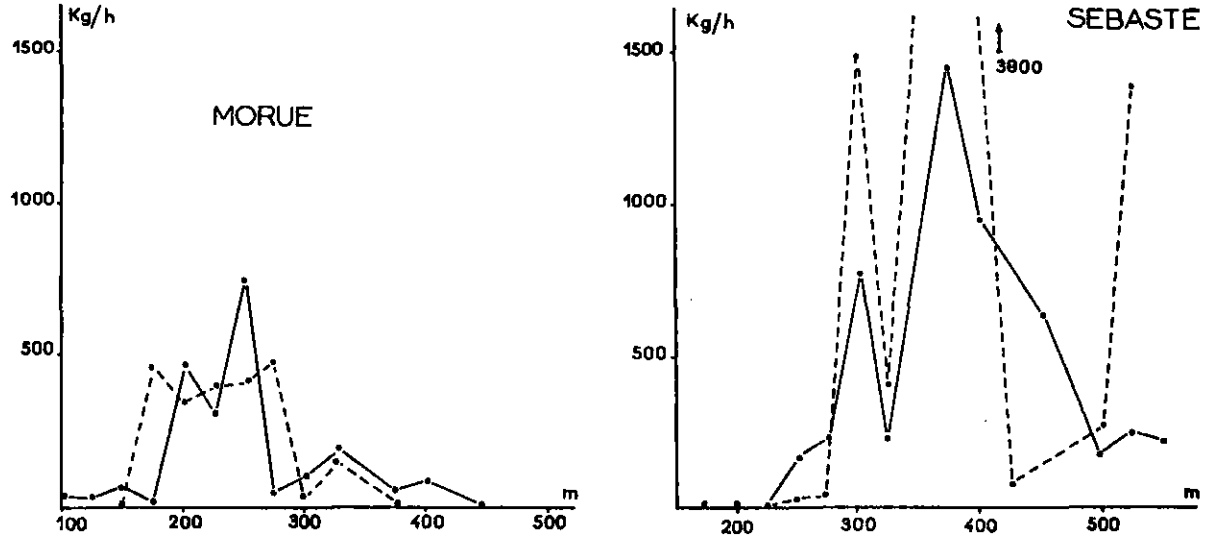

Fig. 5. Yields of cod and redfish (kg/hr) at different depths at Labrador (broken line) and north of the Newfoundland Shelf (solid line).

Concerning the redfish, it appears in the fishery from 275 m and makes up nearly the whole catch down to 550 m where it is mixed with the macrurids *(Macrourus berglax* and *M. bairdii)* known as the ratfishes and that a haul of more than 10 tons was made northeast of Makkavik Bank. The best yields of redfish were between 300 and 400 m (1,500 to 3,800 kg/hr) and around 550 m (1,400 kg/hr).

American plaice was abundant from 75 to 200 m (200 to 300 kg/hr) and disappeared between 300 and 350 m.

Witch, taken always in small quantities, was found on the Newfoundland Shelf down to 450 m, particularly between 200 and 300 m (10 to 20 kg/hr).

Regarding Greenland or black halibut, it is distributed between 150-525 m with a maximum abundance toward 500 m on the Labrador Shelf (80 kg/hr).

Among the other species, one should mention the wolffishes which were present at all depths, with yields varying from 10 to 75 kg/hr and skates, generally in very small quantities, on the Newfoundland Shelf where very irregular catches varied from 2 to 60 kg/hr.

2. Yields by divisions and zone of fishing and diverse observations. Yields varied greatly according to the regions and the depth as shown in Table 1.

	Nbre Stat. [1]	Morue [2]	Balai [3]	Flétan noir [4]	Plie cyno-glosse [5]	Sébaste [6]	Loups [7]	Raies [8]
Secteur 2 H :								
N Hopedale 130 m	1	10	8				36	
320 - 440 m	2	30	7	35		995	65	
Makkovik 195 - 220 m	3	47	100	42		3	8	
360 - 490 m	2	5	0,5	57		1 975	56	
Secteur 2 J :								
O Makkovik 170 m	1	30	40				13	
Bulldog 157 m	1	500	65	10			59	
205 - 210 m	2	185	291	12			56	1
ONO Hamilton 160 m	3	468	372	8	0,3		35	2
175 - 200 m	3	691	243	46	0,3	17	76	1
ESE Hamilton 185 - 250 m (215 m)	14	449	35	12	0,5	10	45	2
295 - 500 m	4	69	6	23		561	33	1
Banc Russe 175 - 225 m	3	503	3	2	0,3		43	2
NE Belle-Isle 175 - 225 m	2	267	32	95			16	
Secteur 3 K :								
E Belle-Isle 180 - 245 m (205 m)	7	702	9	31	4	3	10	2
Baie N. Dame-Fogo 225 - 250 m	2	42	6	6	24	17	19	2
S Banc Russe 260 m	1	10	70	13	5	110	20	16
Plateau Terre-Neuve 225 - 250 m	4	684	9	4	17	166	13	0,5
E Plateau T.N. 280 - 560 m	5	30	13	10	2	390	34	4
Secteur 3 L :								
Cap N du Grand Banc 95 - 175 m	6	43	200	4	4		8	21
N Grand Banc 215 - 240 m	3	1 071	59	1		12	36	8
NE Grand Banc 250 - 305 m	2	392	27	20	10	191	10	64
325 - 505 m	4	53	2	11	2	824	6	18
NE Bonavista 305 - 320 m	2	144	10	23	41	114	11	10
Secteur 3 M :								
Bonnet Flammand 150 m	1	7	47			2	15	
O Bonnet Flammand 250 m	1	100	48			1 302		

Table 1. Catches in kg per hour of fishing in ICNAF Divisions. (1=No. of stations; 2=cod; 3=American plaice; 4=Greenland halibut; 5=witch; 6=redfish; 7=wolffish; 8=rays).

These yields have also been reported in Fig. 3 in relation to the environment. The yields are shown in quintals per hour's fishing for the principal species.

(a) Cod. Cod captured between the north of Grand Bank and Labrador belong to a complex stock but have, according to Templeman (1962), some characteristics which distinguish them from the stocks of cod of the Grand Bank or the Flemish Cap. Labrador cod, in particular, have a slow growth and rarely goes beyond a length of 80 cm. The same is true, to a certain degree, of the cod of the Newfoundland Shelf, while those to the north of Grand Bank can reach 120 to 140 cm. In this region cod spawn in May-June, while in Labrador spawning is later and can continue to July. After spawning, the cod move toward the coast during the summer warming looking again, in particular, for the capelin which it actively feeds on.

Best cod fishing takes place during the first part of the year while the fish are concentrated on the spawning grounds. At Labrador, however, a good autumn season has developed since 1955 in the region of Hamilton Bank.

Generally, in August-September the cod were well dispersed, best concentrations being located along the 3° isotherm in zones of contrast created by the neighbouring waters at 0°C or 1°C on the bottom similar to the north of the Grand Banks (1,071 kg/hr), at Belle Isle (702 kg/hr) or in the Hamilton region (450 to 690 kg/hr) (Fig. 3). In these regions shoals of capelin are detected by the sounder, principally to the north of the Grand Bank and in the region from Belle Isle to Hamilton Inlet, where the capelin are concentrated while approaching the coast for the spawning period, which takes place from the end of June to mid-August in the Labrador region (Fig. 2).

In the other regions, as on the Newfoundland Shelf, where, from 225-250 m, catches of 684 kg/hr were made. The concentrations seem to be associated with an abundance of myctophids, ordinarily known as luminous anchovies.

The majority of the fish captured were from 20 to 70 cm and presented two principal length modes. The first mode was at 31 cm at Labrador and at 28 or 34 cm in front of Belle Isle Strait and on Newfoundland Shelf; the second was observed at 55 cm on Hamilton Bank and at 55.52 or 46 cm on the Newfoundland Shelf (Fig. 6).

(b) Redfish. The *mentella*-type constitutes the main part of the catches at Newfoundland and Labrador. Best fishing takes place during the first half year at the time of pre-maturation and spawning concentrations, but because of apparently limited migrations which this fish makes and also because males and females do not make up separate stocks outside of the period of fertility, the catches have a satisfying yield all year. The vertical distribution especially changes in relation to hydrological conditions on the Continental Shelf.

Three stocks seem to exist in this region: one between Labrador and the Newfoundland Shelf, another in the region of Flemish Cap and the third to the south of Newfoundland.

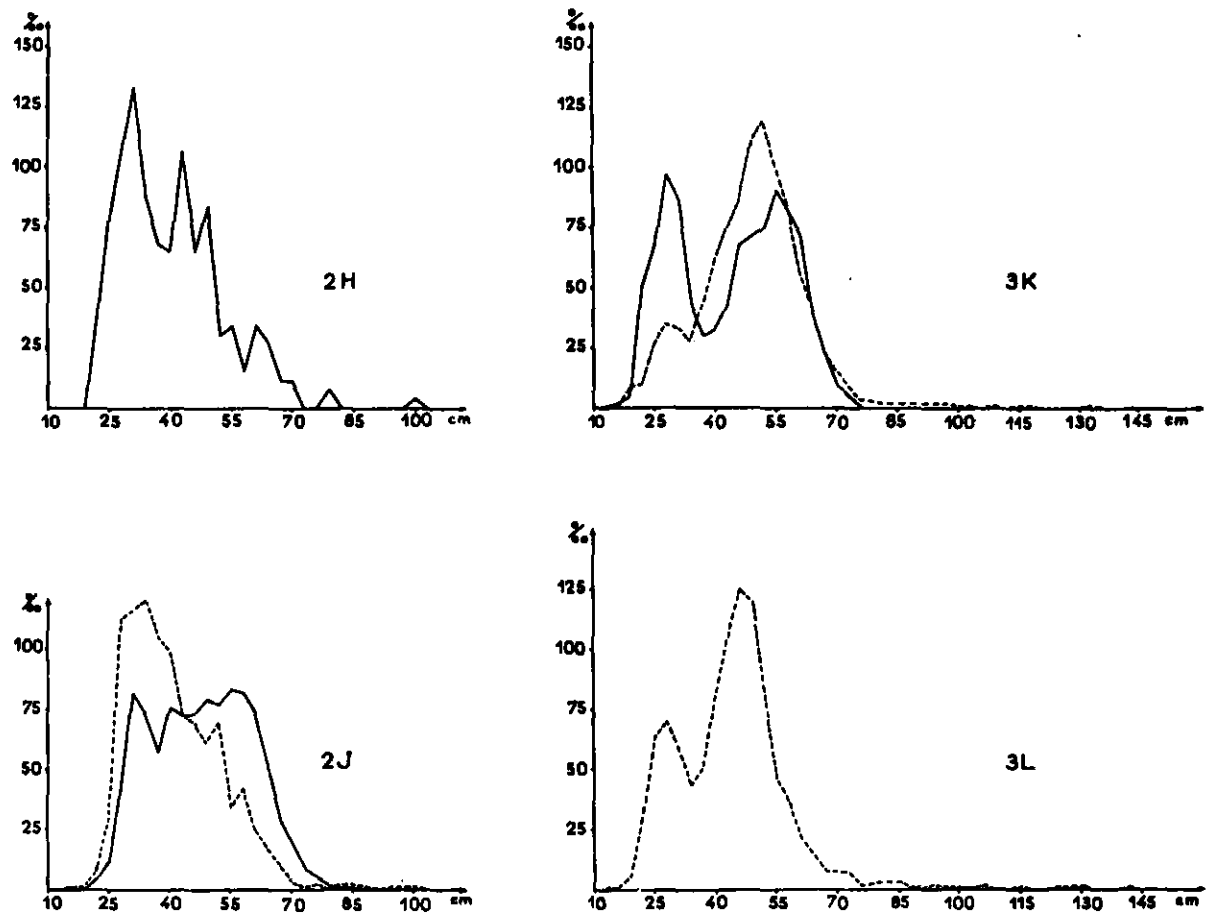

Fig. 6. Length frequencies for cod from central and south Labrador (Div.2H and 2J) from the northeast Shelf (3K) and north of the Grand Bank (3L). August (broken line). September (solid line).

The males rarely reach a length beyond 48 cm, the females 60 cm.

Redfish have been found in great abundance between 250 and 550 m, with medium yields of 390 to 560 kg/hr of fishing between Hamilton and the Newfoundland Shelf. The best catches have been made to the north of Makkovik (1 to 2 tons/hr), to the northeast of Grand Bank (824 kg/hr) and to the west of the Flemish Cap (1,302 kg/hr) in some zones where the bottom temperature was in the neighbourhood of 4°C (Fig. 3).

Unfortunately, in the region of Makkovik, redfish are heavily parasitized, particularly by a copepod *(Sphyrion lumpi)*, which the fisheries know by the name "doorkey", and by worms which make the catches unusable.

In the whole zone studied, the stock was composed of fish of 20 to 45 or 50 cm, of which the dominant modal length varied between 35 and 38

cm according to the predominance of males or females. Two other modes, generally less well represented, existed around 25 and 30 cm from Labrador to the Newfoundland Shelf at greater depths to 365 m. At greater depths to 275 m in the Hamilton region, and to 365 m in those of the Newfoundland Shelf, one also found females of 60 cm length.

Regarding the young, they have only been observed in the area of Makkovik, with a modal length of 9 cm and on the Newfoundland Shelf around 16 cm at 180 to 365 m.

This distribution suggests that the redfish of great length, males and females, representing the mature part of the stock were found especially at intermediate depths between 275 and 450 m, while the immature young were dominant at less than 350 m between Labrador and north of the Newfoundland Shelf and while, especially elsewhere, the intermediate classes were distributed between 180 and 550 m.

(c) American plaice. This species reaches a length of 50 to 60 cm. The majority of catches are represented by some individuals from 20 to 30 cm. The best catches were made between 75 and 175 m along the steep shelf in the cold Labrador Current at temperatures down to 1°C (Fig. 3).

(d) Capelin. Numerous shoals of capelin which have been recorded by the echo-sounder were detected pelagically to the north of the Grand Bank and on the Newfoundland Shelf, and at the same time on the bottom and between two waters off Labrador and off the Belle Isle Strait (Fig. 2).

In this last region, they were particularly numerous between 40 and 100 m in generally deeper waters to -1°C. Less abundant to the north of the Grand Bank, they were equally concentrated in the neighbourhood of the thermal minimum which, in this region, was at a depth of about 25 m.

This detection was often identified thanks to the catches of capelin made by the bottom trawl and by the catch of a ton of this fish by the pelagic trawl, on detection between two waters in the region of Odon Bank off Belle Isle.

(e) Shrimp. The presence of the shrimp, *Pandalus borealis*, in 50 trawl hauls seems to indicate a wide distribution of the species. Indeed only 11 hauls gave good catches, which reached a maximum of 30 kg per fishing hour. However there were interesting results since these catches were made with a trawl of 50 mm meshes. The shrimps were located principally to the north of Grand Banks on the Newfoundland Shelf off Bonavista Bay and Labrador to the northeast of Hopedale.

These interesting catches of shrimp were made between 200 and 500 m, with a maximum catch about 350-400 m on the bottom ranging from the silty sands to the sandy silt, the pure silt being more favourable. The temperature at these depths varies between 3°C and 4°C. At colder temperatures

one finds especially young small-sized shrimps.

A more profound study of this stock and of the yields that it can give would merit trials with a trawl especially adapted for the fishing of shrimps because these shrimps are of commercial interest and value.

IV. German (FRG) Research Report, 1966

A. Subarea 1 and East Greenland
by Arno Meyer

A. Status of the Fisheries

I. General

Fishing was again carried out off West Greenland throughout the year. In 1966 there was a further decrease in nominal catch to 102,000 metric tons (Table 1) which is only 51% of the 1962 catch. For the last 5 years, the catch per fishing day has decreased steadily from 30.5 tons in 1962 to 21.7 tons in 1966. The decrease from 1965 to 1966, however, was less pronounced than in preceding years. But this cannot be taken as a first sign that the Greenland fish stocks have recovered somewhat. This lessening of the decrease in catch per effort can only be ascribed to the further decrease in numbers of side trawlers fishing off West Greenland, the rapid increase of stern trawlers (more fishing hours per day fished than of side trawlers) and factory ships, the increase of average gross tonnage (Table 3), catching power, daily capacity for production of frozen products and fish meal and, as a consequence of the increase in capacity of the fish meal plants, a decrease in discards.

Also, off East Greenland, the nominal catches decreased considerably to 32,000 tons, only 45% of the 1964 top landings and the lowest yield since 1959. The catch per fishing day which decreased from 24.7 tons in 1962 to 17.5 tons in 1965, for the first time in 1966 remained at the same level.

With a total output of only 134,000 tons (1963: 251,000 tons) from both East and West Greenland, Greenland lost its top position in the German fishery to the fishing grounds off Iceland.

II. Cod

A total of 83,000 tons of cod, 54% of the 1963 catch, were caught in Subarea 1. The share of cod fished on the northern banks in Div.1B and 1C was somewhat lower than in the preceding year. Fishing for cod in Div.1E and 1F increased. The catches of cod off East Greenland, 7,200 tons only, were the lowest since 1959 and were only 25% of those in 1964.

III. Redfish

The catches of redfish off West Greenland decreased from 58,000 tons in 1962 to 15,000 tons in 1966. The catch per fishing day decreased steadily from 14.9 tons in 1959 to 3.1 tons in 1965. In 1966 it was 3.2 tons. This levelling off of catch per effort is due partly to some stabilization at a low level - experienced too in other redfish fisheries - and partly to the fact that in 1966 the southern Div.1E and especially 1F (these divisions are nearer

Table 1

German nominal catches in tons (industrial fish included) off Greenland, 1962-1966

	Year	days fishing	Cod	catch per fish.day	% ind.cod	Redfish	catch per fish.day	% ind.redf.	Total	catch per fish.day	% ind.total
West Greenland (Subarea 1)	1962	6,584	133,404	20.3	5.1	57,902	8.8	5.2	200,932	30.5	7.7
	1963	7,175	152,934	21.3	4.2	44,355	6.2	4.7	202,923	28.3	8.6
	1964	5,639	107,982	19.1	7.7	22,956	4.1	10.0	137,794	24.4	10.9
	1965	5,882	107,127	18.2	13.3	18,476	3.1	10.3	131,445	22.3	14.7
	1966	4,696	82,928	17.7	12.8	14,911	3.2	6.1	102,029	21.7	13.1
East Greenland	1962	1,660	14,317	8.6	0.5	25,032	15.1	1.2	40,999	24.7	1.2
	1963	2,182	13,677	6.3	0.5	31,368	14.4	1.4	47,700	21.9	2.2
	1964	3,287	29,400	8.9	0.2	38,154	11.6	2.3	71,364	21.7	2.5
	1965	2,734	11,746	4.3	0.6	33,491	12.2	4.5	47,877	17.5	4.4
	1966	1,827	7,231	4.0	0.7	23,222	12.7	6.3	32,006	17.5	6.0
Total Greenland	1962	8,244	147,721	17.9	4.6	82,934	10.1	4.0	241,931	29.3	6.6
	1963	9,357	166,611	17.8	3.9	75,723	8.1	3.3	250,623	26.8	7.4
	1964	8,926	137,382	15.4	6.1	61,110	6.8	5.2	209,158	23.4	8.0
	1965	8,616	118,873	13.8	12.1	51,967	6.0	6.5	179,322	20.8	11.9
	1966	6,523	90,159	13.8	11.8	38,133	5.8	6.2	134,035	20.5	11.4

Table 2

Discarded fish in Subarea 1 in 1966

	Cod	Redfish	Spec.unknown	Total
1B	155	-	-	155
1C	258	25	24	307
1D	376	13	58	447
1E	39	15	29	83
1F	175	33	64	272
Total	1003	86	175	1264

Table 3

Average gross tonnage of German trawlers fishing in Subarea 1 from 1962 - 1966

1962	832 BRT	(589 - 1561)
1963	864 BRT	(566 - 1561)
1964	890 BRT	(648 - 1561)
1965	1015 BRT	(651 - 2557)
1966	1094 BRT	(537 - 2557)

to the breeding area in the Irminger Sea) were fished more heavily than in 1965. About 51% of all redfish fished in Subarea 1 came from Div.1F.

Off East Greenland also the redfish catches dropped by 11,000 tons to 23,000 tons in spite of the increased market demand. The catch per fishing day seems to stabilize at a level of about one-third of that of 1955, when fishing for redfish began off East Greenland. It is also interesting to note that the percentage of industrial redfish in the catches has grown steadily over the last 5 years (Table 1). This is obviously a sign that the percentage of small unmarketable redfish is increasing.

IV. State of Fisheries in the first 4 months of 1967 and forecast for the remainder of 1967

Poorer catches than ever before experienced were made during the last 5 months of 1966. Monthly averages for the catch (without industrial fish) per fishing day was down to 11.5 and 11.4 tons. In the first 4 months of 1967, however, big concentrations of cod were found. The fishery was carried out in the beginning in Div.1D and the southern part of Div.1C, later mainly in Div.1E. At the same time heavy ice drift hampered the fishery off Southeast Greenland. In March/April 1966 big concentrations of spawning cod were fished in deep water down to 750 m far west of Banana Bank but in 1967 shoals of spawning cod were reported only from Bille and Fylkir Bank and from the Heimland Ridge.

In 1967, the strong 1961 year-class, which is already very heavily fished, will be the only year-class of real commercial importance. Owing to the weakness of the following year-classes the cod fishery off Greenland will experience a difficult situation, especially during the second halves of the coming years, when the cod are widely distributed on their feeding grounds. There seems no hope that the redfish, even those off East Greenland, could fill to some extent the coming gap in the fishery for cod.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. Little hydrographic work could be done during the net-selection studies carried out from R/V *Anton Dohrn* in October 1966. Although a direct comparison with the preceding year is impossible, for in 1966 the temperatures were measured one month earlier, it nevertheless may be said that the Atlantic component of the West Greenland Current flowing northward along the slope had about the same temperature (up to 6.3-6.4°C) as in 1965. However, this warm water lay considerably deeper than in 1965 (Fig. 1 and 2). Thus the banks in 1966 were covered by cooler water. This holds true especially for the southern banks, covered by water of 2°C to 4°C against 4°C to 6°C in 1965. Off Nanortalik Bank the 6°C isotherm was found in October 1966 at more than 600 m, while, in November 1965, it was found at 160 m! On the western slope of Fyllas Bank, in 1966, water of 6°C was found beyond 500 m; in 1965 Atlantic water with 35‰ salinity reached northward as far as Danas Bank at a depth of 300 m.

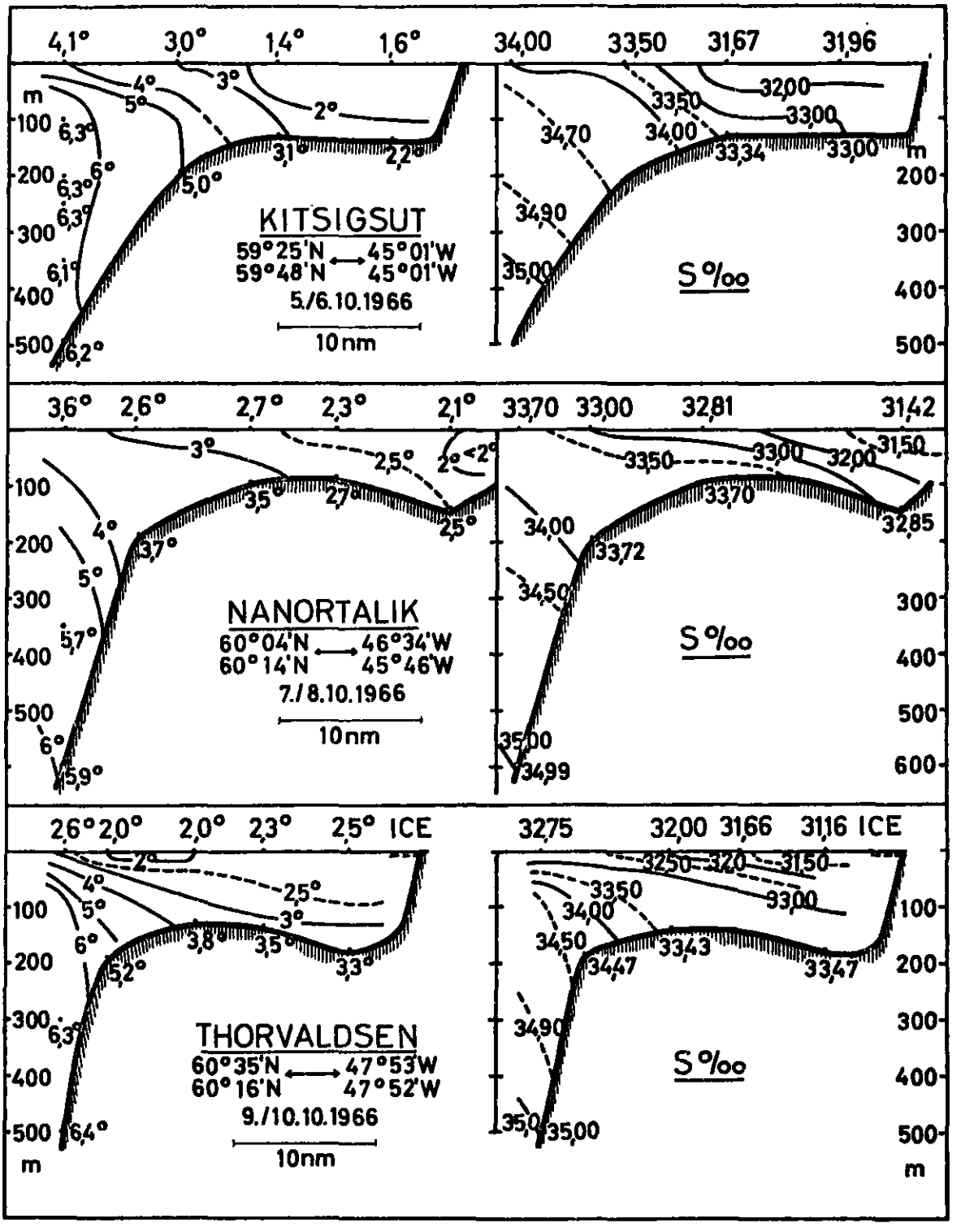

Fig. 1. Hydrographic sections off South Greenland (temperature and salinity) in October 1966.

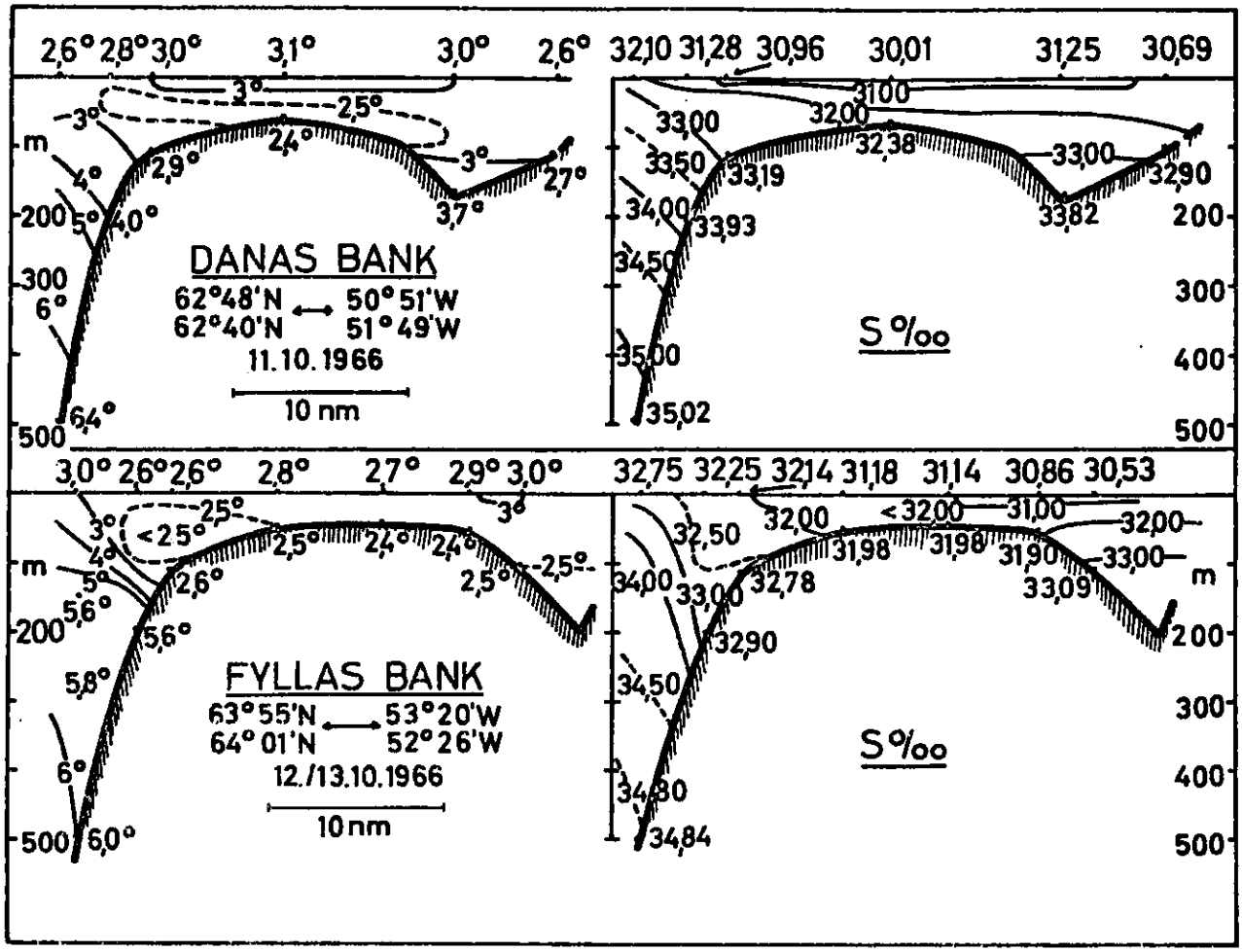

Fig. 2. Hydrographic sections off Danas Bank and Fyllas Bank (temperature and salinity) in October 1966.

II. Biological Studies

1. Cod

a. Age and size of cod in commercial stock in Subarea 1. The age determinations of the 1966 catches made by factory trawlers, some wet-fish trawlers and by R/V *Anton Dohrn*, verify the findings of the 1965 research report that the rich and promising 1960 year-class was so heavily fished during its immature stage that it was not able to provide the expected yields in 1966 when spawning for the first time. The predominant year-class in the fishery off West Greenland in 1966 was the strong but still immature 1961 year-class. It was obviously strong in both Greenlandic stocks.

Only in the fishery for real concentrations of spawning cod (to the west of Banana Bank in very deep water down to 750 m) and in the

fishery for shoals of post-spawners in May/June in Div.1E (partly returning from spawning off East Greenland) did the 1960 year-class make up 30 to 50% of the catch (Fig. 3). The older strong West Greenlandic 1957 and 1953 year-classes had only very little commercial importance.

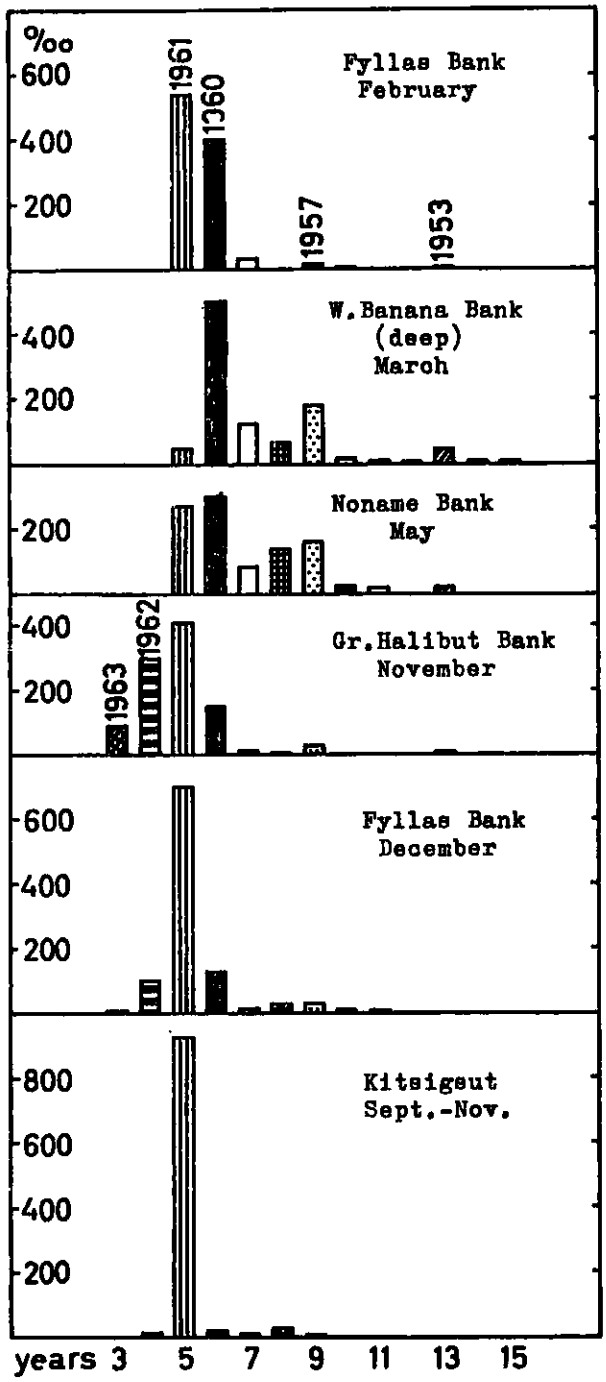

Fig. 3. Cod, age composition of commercial catches in 1966 (Subarea 1).

In all other fisheries the 1961 year-class was predominant especially off Kitsigsut (west of Cape Farewell). In the second half of the year off South Greenland almost nothing but 5-year-old cod were found. The percentage of this year-class varied between 87 and 96% (average 93%), an unusually high figure, never found before, and very characteristic for the present state of the stock of cod off Greenland.
The catches made by R/V *Anton Dohrn* for selection studies and the studies on board a factory ship (Fig. 5) provided a good opportunity to study the strength of the 1962 and 1963 year-classes. Both year-classes are, at best, moderate and probably poor. On Fyllas Bank the 1963 year-class was stronger than the 1962 year-class; off Thorvaldsen it was the opposite.

When fishing with a mesh size of 110 mm (manila), all cod of 3 and more years of age are retained by the net. All 3-year-old cod and at least 50% of those of 4 years of age are so small, however, that they cannot be filleted and must be turned into fish meal or be discarded (Fig. 5). On board wet-fish trawlers even a considerable quantity of the 5-year-old cod is too small for the wet-fish market. The pending increase in mesh size to 130 mm (manila) will have very little effect and will only allow the smaller 3-year-old cod to slip through the meshes except when a poorly adjusted chafer hinders them from doing so.

Tables 1 and 3 show the percentage of industrial cod (cod turned into fish meal) - it must be stressed that the

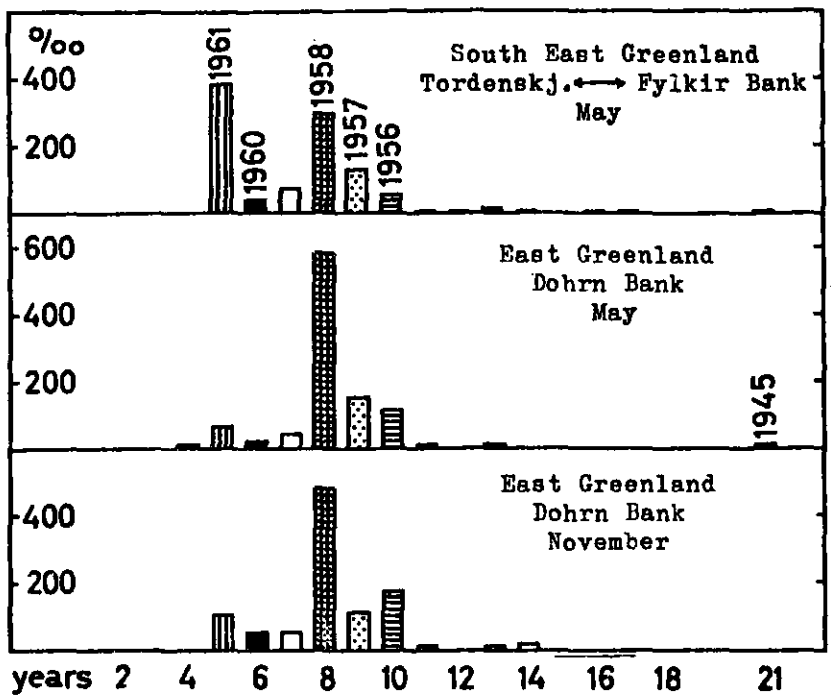

Fig. 4. Cod, age composition of commercial catches in 1966 (East Greenland).

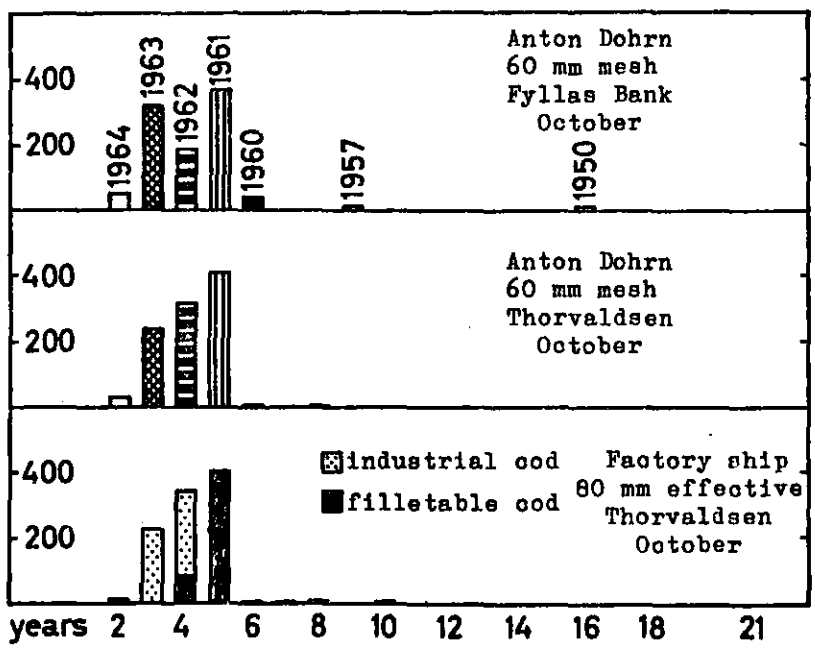

Fig. 5. Cod, age composition of catches by *Anton Dohrn* on Fyllas Bank and off Thorvaldsen and catch of a factory trawler off Thorvaldsen.

the figures in Table 1 given for the percentage of "industrial fish" are minimum figures - increased steadily to 1965. In 1966 the share of industrial cod was a little lower. This can be ascribed to four reasons: 1) in 1965, the strong 1961 year-class made up the bulk of the industrial cod; 2) In 1966, the 3- and 4-year-old cod were less in number; 3) In 1966, all factory ships had "succeeded" in getting machines for filleting small cod; and 4) In 1966, the number of wet-fish trawlers fishing in Subarea 1 decreased further.

Considering that, to 1966, all year-classes which follow the rich 1961 year-class are probably poor, it is more than regrettable and also very uneconomic for the future international yield of the cod fishery in Subarea 1 that, with 110 mm and even with 130 mm mesh size, so many small cod of these incoming poor year-classes are wasted (discarded or turned into fish meal). Owing to the very fast rate of growth during the immature stage, even these poor year-classes could still give a relatively good yield if given the chance to grow and become 6 years of age (see ICNAF Res.Doc.67/55: Meyer, A.: The estimation of efficiency of use, a simple method to show how fishery should be carried out to get the highest output from fish stocks).

b. Onset of maturity of cod in Subarea 1. In the winter of 1965/66 and of 1966/67, several samples of ungutted cod were examined to determine the age at first maturity. According to our findings the percentage of mature cod was as follows:

Year-class	1962	1961	1960	>1959
Age-class	V	VI	VII	>VII
percentage of spawners	9	61	90	100

The fact that 61% and 90% of the strong 1961 and 1960 year-classes spawned in March/April 1967, was the main reason for the exceptionally good fishing results off West Greenland during the first four months of 1967. Probably this will have been the best winter season off West Greenland for many years to come! If the two successive strong year-classes, the 1961 year-class apart from this rich also off South Greenland (East Greenlandic origin), had not been fished so hard as small immature fish, the 1966/67 winter season would probably have broken all previous catch records for the cod fishery off West Greenland.

c. Age and size of cod in commercial stock off East Greenland. Since 1959 the output of cod fishery off East Greenland has never been as small as in 1966 (Table 1). Since most of the East Greenland cod spawn at 8 years of age, the 1958 year-class (Fig. 4) was, as expected, predominant (by weight) in 1966. The average length in late winter of 1966 was 77.2 cm off Southeast Greenland and 83.5 cm on Dohrn Bank. Compared with the exceptionally rich East Greenland 1956 year-class, the 1958 year-class was, at best, moderate. On Dohrn Bank the 10-year-old cod of the 1956 year-class were - owing to its weight and length of 90 cm - still of great commercial importance. Off Southeast Greenland, the 1961 year-class, still immature, was predominant numerically.

2. Redfish. No special studies on redfish were carried out. When possible, small redfish were collected for age studies.

III. Studies on Selectivity

Again studies on selectivity - in 1966 by R/V *Anton Dohrn* were carried out. For reports of these studies see:

Res.Doc.67/31, H. Bohl: Selection of cod by bottom trawl codends in Southwest Greenland waters;
Res.Doc.67/32, H. Bohl: Selection experiments with a large-meshed topside chafer.

B. Subareas 2-5
by J. Messtorff

General Remarks

Nominal catches and catch per day fished of German trawlers are given in Table 4 (Subarea 2), Table 5 (Subarea 3) and Table 6 (Subarea 4 and 5). For the first time the quantities of fish converted to fish meal on board are included in the nominal catches. For comparison with the preceding years the corresponding statistical data since 1962 have been recalculated in the same way as for 1966. Not included are the quantities of fish discarded at sea which are given separately in Table 7.

It has to be stressed, however, that the calculated amounts of industrial cod contained in the given nominal catches are suspected to be higher to some extent in practice because quantities of fish converted to fish meal on board are sometimes not specified and reported as "other fish". The given percentages of industrial fish should therefore be regarded as minimum values.

Subarea 2

A. Status of the Fisheries

The increase of German fishing activity off Labrador as stated for 1965 continued in 1966 and resulted in an increase of the total catch by 22,000 tons (about 50% of the 1965 total catch). But in spite of a considerable increase of fishing effort in 1966 the average total catch per day fished did not drop very significantly.

As in 1965 the main fishing operations took place at the beginning of the year from January to the middle of March. During this time the bulk of the German stern trawler fleet was concentrated off Labrador. For the following time of the year until the end of November only occasional visits of single vessels were paid to Subarea 2 and trawlers often changed fishing grounds several times during one trip between Labrador and Greenland. There was scarcely one vessel which landed an entire catch from Subarea 2 during this period.

Table 4: Subarea 2, nominal catches in tons 1962 - 1966 (including industrial fish = fish converted to fish meal on board)

year	days fished	COD catch	COD catch per day fished	COD % industrial	REDFISH catch	REDFISH catch per day fished	REDFISH % indust.	OTHER FISH catch	OTHER FISH catch per day fished	OTHER FISH % indust.	TOTAL catch	TOTAL catch per day fished	TOTAL % indust.
1962	93	882	9.5	4.1	1939	20.8	15.9	68	0.7	0	2889	31.1	11.9
1963	76	1050	13.8	12.3	941	12.4	12.0	59	0.8	67.8	2050	27.0	13.8
1964	495	3559	7.2	14.4	5079	10.3	10.5	1029	2.1	91.3	9667	19.5	20.5
1965	1323	41556	31.4	13.3	2891	2.2	1.2	1151	0.9	60.0	45598	34.5	13.8
1966	2132	63610	29.8	7.8	2750	1.3	13.2	1541	0.7	46.4	67901	31.8	8.9

Table 5: Subarea 3, nominal catches in tons 1962 - 1966 (including industrial fish = fish converted to fish meal on board)

year	days fished	COD catch	COD catch per day fished	COD % industrial	REDFISH catch	REDFISH catch per day fished	REDFISH % indust.	Haddock* catch	Pollock* catch	OTHER FISH catch	OTHER FISH catch per day fished	OTHER FISH % indust.	TOTAL catch	TOTAL catch per day fished	TOTAL % indust.
1962	85	779	9.2	37.6	2124	25.0	15.2	-	-	62	0.7	30.6	2965	34.9	21.4
1963	113	1822	16.1	3.5	757	6.7	7.8	13	-	133	1.2	84.2	2725	24.1	8.6
1964	282	2344	8.3	**	2495	8.8	**	8	7	702	2.5	93.0	5556	19.7	11.8
1965	724	8147	11.3	3.1	1057	1.5	4.2	44	6	1420	2.0	53.4	10674	14.7	9.9
1966	572	8806	15.4	15.6	305	0.5	36.7	-	-	268	0.5	80.2	9379	16.4	18.1

*) Catch per day fished not calculated, because days fished not splitted into Divisions where Haddock and Pollock are abundant. - Industrial fish not known.

**) Included in "Other Fish".

Table 6: Subarea 4 + 5*, nominal catches in tons 1962 - 1966 (including industrial fish = fish converted to fish meal on board)

year	days fished	COD catch	COD catch per day fished	COD % indust.	REDFISH catch	REDFISH catch per day fished	REDFISH % indust.	HADDOCK** catch	HADDOCK** catch p.day fished	POLLOCK** catch	POLLOCK** catch p.day fished	OTHER FISH catch	OTHER FISH catch p.day fished	OTHER FISH % indust.	TOTAL catch	TOTAL catch p.day fished	TOTAL indust.
1962	No fishing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1963	65	329	5.1	31.9	13	0.2	76.9	1049	16.1	113	1.7	89	1.4	84.3	1593	24.5	11.9
1964	178	954	5.4	2.6	69	0.4	18.8	2004	11.3	439	2.5	110	0.6	68.1	3576	20.1	3.2
1965	33	276	8.4	25.0	10	0.3	0	140	4.2	275	8.3	33	1.0	30.3	734	22.2	10.8
1966	No fishing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*) Subarea 5 only occasionally visited by single trawlers chiefly fishing in Subarea 4.

**) Industrial fish not known.

Table 7: Subarea 2 - 5, discarded fish in tons 1962 - 1966 (not included in nominal catches of tables 1 - 3!)

year	Subarea 2 COD	Subarea 2 REDFISH	Subarea 2 OTHER FISH	Subarea 2 TOTAL	Subarea 3 COD	Subarea 3 REDFISH	Subarea 3 OTHER FISH	Subarea 3 TOTAL	Subarea 4 + 5 COD	Subarea 4 + 5 REDFISH	Subarea 4 + 5 OTHER FISH	Subarea 4 + 5 TOTAL
1962	160	49	11	220	-	60	-	60	-	-	-	-
1963	90	65	-	155	-	-	-	-	-	-	-	-
1964	217	434	-	651	-	-	-	-	-	-	-	-
1965	2288	13	55	2356	22	-	26	48	30	-	-	30
1966	564	32	110	706	16	-	6	22	-	-	-	-

Div.				Div.			
2 G	40	-	8	48	3 K	5	-	2	7
2 H	200	-	39	239	3 L	11	-	4	15
2 J	324	32	63	419	3 M	-	-	-	-

Discards per Division only for 1966.

The Labrador season of the German fleet started again in December 1966.

I. Cod

As in 1965 the increased fishing activity in the subarea was due to a pure offshore cod fishery (94% of the total catch) which took place during the season mentioned above and in Div.2H and 2J along the edge of the Continental Shelf between Cape Mugford and Hamilton Inlet Bank. Favoured by very good fishing conditions especially during the early months of the year, the fishing effort as well as the nominal catch for cod increased by more than 50% of 1965 values, whereas the average catch per day fished decreased only slightly by 1.6 tons (Table 4 and Fig.7.).

The quantity of cod discarded at sea (Table 7) decreased from 5.5% in 1965 to 0.9% of the nominal catch in 1966.

II. Redfish

No special redfish fishery was carried out by German trawlers in Subarea 2. The redfish catches reported in Table 4 have been taken entirely as by-catch of the offshore cod fishery in Div.2J and amounted to only 4% of the total catch from the subarea. In spite of the increased fishing effort a further decrease of the nominal catch of redfish as well as of the catch per day fished was observed (Table 4, Fig. 7).

B. Special Research Studies

I. Environmental Studies

During the successful commercial fishery on dense pre-spawning concentration of cod off Labrador, R/V *Walther Herwig* visited the fishing area (Div.2H-J) in January 1966. Experimental fishing combined with an echo sounder survey and hydrographic observations showed that the formation of catchworthy cod concentrations were restricted to areas along the slope of the Continental Shelf where near-bottom temperatures of at least 3.5°C could be observed. During the survey the best echo traces as well as the most successful catches have been obtained at the northeastern slope of Hamilton Inlet Bank between 290 to 450 m depth and near-bottom temperatures of about 4°C. At 250 m temperatures measured just only 2.5°C and no more fish traces could be observed. Water temperatures around 0°C reached the bottom at a depth of 175 m.

II. Biological Studies

Market sampling of commercial catches have been continued as far as possible. Because of the decreasing number of trawlers catching for fresh fish in the subarea steps have been taken to develop the sampling of factory trawlers at sea. Research vessel investigations were restricted to one cruise of R/V *Walther Herwig* in January 1966.

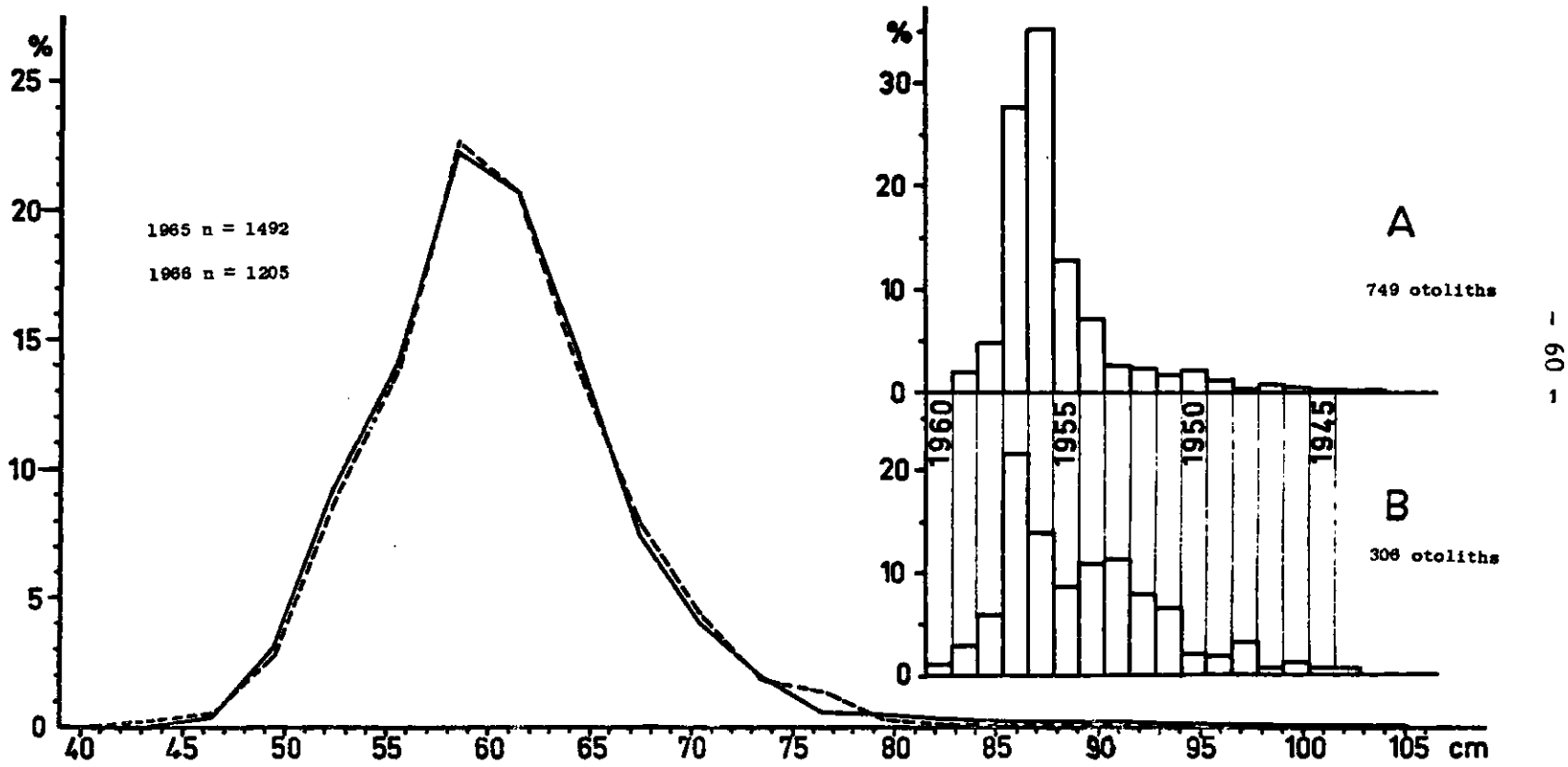

Fig. 6. Cod length and age frequencies of German trawler catches off Labrador (Div.2H and 2J) from January-March 1965 (solid line and A) and 1966 (broken line and B).

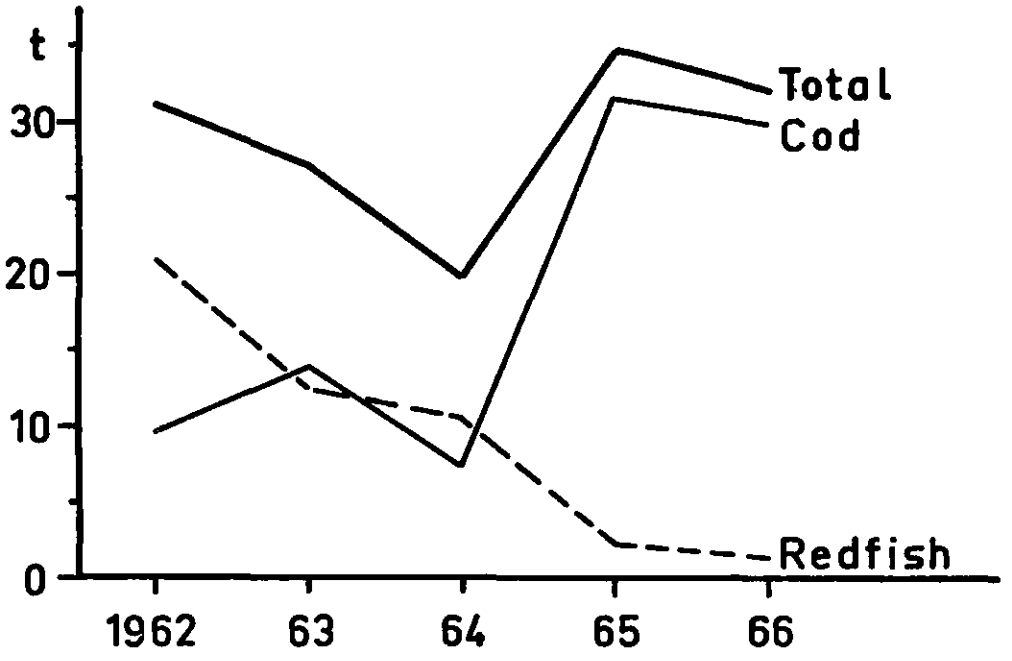

Fig. 7. Average nominal catch per day fished by German trawlers off Labrador (Subarea 2) 1962-1966.

As shown in Fig. 6 cod length frequencies ascertained by market sampling of commercial catches taken off Labrador during the main fishing period from January until March 1965 and 1966 proved to be almost exactly the same in both years. The corresponding age compositions, however, were evidently different. In 1965 75.5% of the commercial catches consisted of only three year-classes (1955, 1956 and 1957) respectively 10- - 8-year-old fish, whereas in 1966 these year-classes contributed to barely 44% of the catches. As no strong new year-class had entered the fishery the yield could only be maintained or increased by further exploitation of the older age groups. If stock recruitment fails it may well be that this tendency will result in a significant decrease of the catch per unit effort in the very near future.

Subarea 3

A. Status of the Fisheries

Fishing activity of German trawlers was restricted to Div.3K and mainly 3L. As in the preceding year the major part of the total catch was taken in summer (June-August). The total nominal catch decreased somewhat in comparison with 1965 and reached only 14% of the Labrador catches. However, a slight increase of the average catch per day fished was recorded.

I. Cod

The cod fishery yielded 94% of the total catch from the subarea against 75% in 1965 and only 41% in 1964. In spite of reduced fishing effort against 1965 the nominal catch as well as the average catch per day fished increased significantly.

II. Redfish

Redfish catches decreased very sharply and amounted to just only 3% of the total catch from the subarea. The average catch per day fished dropped from 25 tons in 1962 to 0.5 tons in 1966. Both, less availability of redfish concentrations and a shift of fishing effort on cod will have caused this remarkable decrease.

B. Special Research Studies

As already reported in the 1965 Research Report (Res.Doc.66/33b), environmental and biological studies were carried out by R/V *Walther Herwig* only in January 1966 and to a limited scale in all divisions of the subarea. No further field work was carried out later in the year. Market sampling was not possible because the entire commercial catches were processed at sea.

Subarea 4 and 5

A. Status of the Fisheries

No commercial fishery was carried out in 1966. The nominal catches taken from the subareas since 1962 by German trawlers are given in Table 6.

B. Special Research Studies

As already reported in the 1965 Research Report (Res.Doc.66/33b) environmental and biological studies were carried out by R/V *Walther Herwig* only in January/February 1966 and were restricted to Div.4V and 4W. No further field work was carried out later in the year.

Of 99 cod tagged 27 January 1966 in Div.4Vn 7 recaptures have been reported by Canadian fishermen. The first recapture was taken within a few days after tagging near the release position. The second tag was recovered in May 1966 at Cape St.George (4R). Later in August/September 1966, 3 tagged cod were recaptured in the northwestern Gulf of St. Lawrence off Gaspe (4T). The hitherto latest recaptures were recovered in October 1966 and January 1967 not far from the release position (4Vn). These results confirm Canadian tagging experiments during which tagged cod were released in the northern Gulf in autumn and recaptured in the Cabot Strait area in winter and prove the migration of cod back into the Gulf in spring and summer.

Of 12 cod tagged 3 February 1966 in Div.4Vs near Sable Island one fish was recovered in inshore waters of Nova Scotia near Cape LaHave (4X) in October 1966.

V. Icelandic Research Report, 1966

by Jón Jónsson

Subareas 1, 2 and 3

A. Status of the Fisheries

In 1966 Icelandic trawlers fished mainly in Div.1D, 1E and 3K.

Table 1 shows the landings by divisions, fishing effort (number of trawling hours) and species. As in previous years, the most important species caught were redfish and cod. The most important division for redfish was 3K, whereas cod were caught principally in Div.1D.

Table 2 shows the fishing effort and catch per unit effort of cod and redfish in Subareas 1, 2 and 3 in the years 1964, 1965 and 1966. As a whole, the fishing effort was substantially lower in 1966 than in the two previous years and the main reduction was in Subarea 1. This was also reflected in the landings of cod and redfish from this area, especially the cod landings. In this area the catch per unit effort of redfish in 1966 was about the average of the two years before and the same goes for the cod landings. There were no landings of redfish reported from Subarea 2 and the landings of cod from this area were also quite small.

Fishing effort in Subarea 3 was somewhat lower than in 1965. Landings of redfish from this area were higher than in the year before. Cod landings from this area were on the same level as in 1965 and there was a slight increase in the catch per unit effort.

B. Sampling of cod from commercial trawlers

Two samples for length and age were taken in Div.1D, one at the end of April and the other at the end of May. They both show a very strong dominance of the 1961 year-class. In the first sample this year-class constituted 75.1% of the landed fish and in the second its share was 63.2%. Other year-classes of some importance were those from 1960 and 1957 which is in agreement with last year's samples.

Three samples are available from East Greenland in May and June. The sample from May shows a dominance of the 1956 and 1958 year-classes and is therefore in good agreement with the age distribution on the Icelandic spawning grounds at that time. The two June samples from East Greenland showed a clear-cut dominance of the 1961 year-class (50.3% and 69.2%) and the 1958 year-class (25.1% and 14.1%).

Table 1. Fishing effort and landings in tons by Icelandic trawlers by divisions and species in the ICNAF Area in 1966.

Div.	Hrs Fished	Cod	Redfish	Hali-but	Cat-fish	Greenland Shark	Haddock	Saithe	Unsorted	Total
1B	117	124.4			8.1				35.0	167.5
1C	27	14.0	69.0		2.0	1.9			3.5	90.4
1D	755	1,202.7	467.1	1.5	69.7	6.5			22.6	1,770.1
1E	323	490.9	332.8	0.3	13.0	3.8			42.1	882.9
1F	49	132.9	99.5	0.4	3.5	1.9				238.2
Total	1,271	1,964.9	968.4	2.2	96.3	14.1			103.2	3,149.1
2H	69	172.8			2.2					175.0
2J	127	208.3			14.8					223.1
Total	196	381.1			17.0					398.1
3K	1,291	623.0	1,899.5	4.2	9.5		0.3		4.6	2,541.1
3L	271	113.4	291.8						1.1	406.3
30	8	11.1								11.1
3P	322	448.0		5.2	2.7		5.3	5.8	0.2	467.2
Total	1,892	1,195.5	2,191.3	9.4	12.2		5.6	5.8	5.9	3,425.7

Table 2. Fishing effort and landings in tons of redfish and cod by Icelandic trawlers in Subareas 1, 2 and 3 in the years 1964, 1965 and 1966.

Subareas	1			2			3			Total		
Years	1964	1965	1966	1964	1965	1966	1964	1965	1966	1964	1965	1966
Hours fished	2,314	1,918	1,271	111	368	196	1,709	2,117	1,892	4,580	4,403	3,359
Redfish (tons)	1,954	1,253	968	379			1,999	1,942	2,191	4,341	3,195	3,159
Redfish tons/100 hours	84	65	76	341			117	92	116	95	73	94
Cod (tons)	3,091	3,376	1,965	114	598	381	887	1,235	1,196	4,274	5,209	3,542
Cod tons/100 hours	134	176	155	103	163	194	52	58	63	93	118	105

VI. Norwegian Research Report, 1966

by Erling Bratberg and Johan Blindheim

Subarea 1

In 1966 the Norwegian R/V *Johan Hjort* worked off West Greenland from 29 March to 4 May. As in previous years, the main area investigated was between Nunarsuit and the Holsteinsborg Deep. During the cruise 18 localities were fished with bottom longline, and 16 hauls with trawl were carried out (Fig. 1).

A. Status of the Fisheries

I. Cod

1. Age and length composition of the commercial stock. In 1966 the 1960 year-class still dominates in the total catch on bottom longline. It has increased a little in importance, from 40.2% in 1965 to 42.0% in 1966 (Fig. 2 and 3). The 1957 year-class plays about the same part in the total bottom longline catch as in 1965 when it constituted 11.6% of the total catch. But compared to the total catch in 1964, the 1957 year-class has decreased considerably from 32.2% in 1964 to 10.0% in 1966. On the other hand, the proportion of cod 7 or more years old has been approximately the same for the last two years, about 37% and compared with 1964 this proportion has increased by 6.7%. The 1961 year-class, which entered into the bottom longline catches in 1965, is also of importance in 1966 as it constitutes 19.5% of the total catch on bottom longline.

In the total trawl catches in 1966, the 1960 and 1961 year-classes play the same part, as they both constitute about 41%. This is a marked change from 1965 when the 1960 year-class constituted 54% and the 1961 year-class 15.8% of the catch (Fig. 4 and 5). Also in the trawl catch, the proportion of 7 or more year-old cod has been almost constant in 1965 and 1966 but compared with the catch in 1964 this proportion has decreased from more than 29% in 1964 to only 14.7% in 1966.

The age distribution in the catches from covered hauls in 1966 (codend + cover) (Fig. 6) shows, to some degree, the same features as the age distribution from the codend only. The 1960 and 1961 year-classes which are also predominant in the covered hauls, together constituting 72.8% of the catch. On the other hand the proportion of cod 7 or more years old is lower while the proportion of small cod is much higher than in the not covered hauls. The 1963 year-class especially shows a marked difference.

The length distribution in the total bottom longline catch was approximately the same in 1966 as in 1965 (Fig. 7 and 8) and the overall mean length was 68.6 cm in 1965 and 68.5 cm in 1966. However, the mean length varied

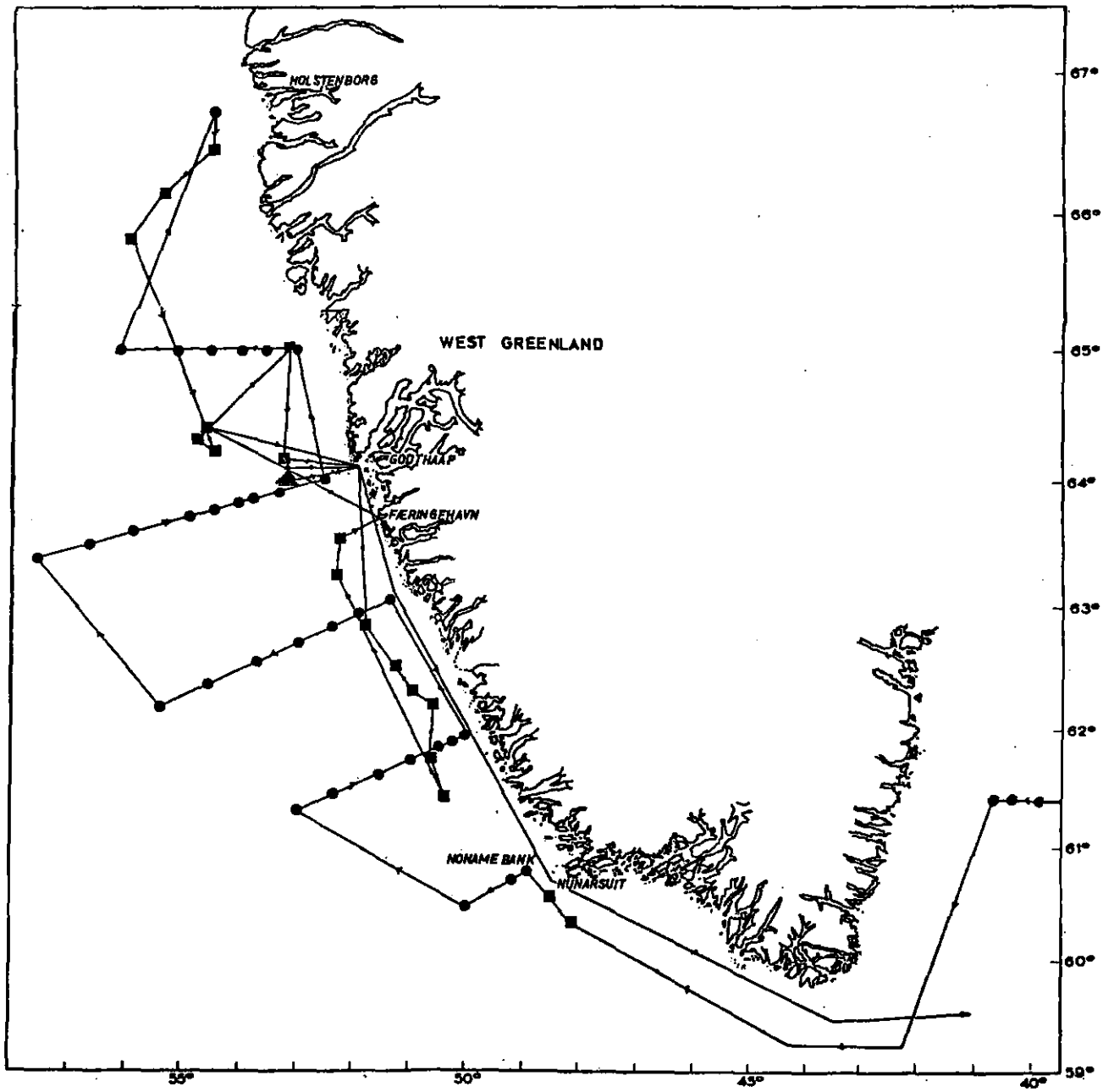

Fig. 1. *Johan Hjort*, West Greenland, March-May 1966. Part of route and net of stations.
● : hydrographical station; ■ : bottom longline station;
▲ : trawl station.

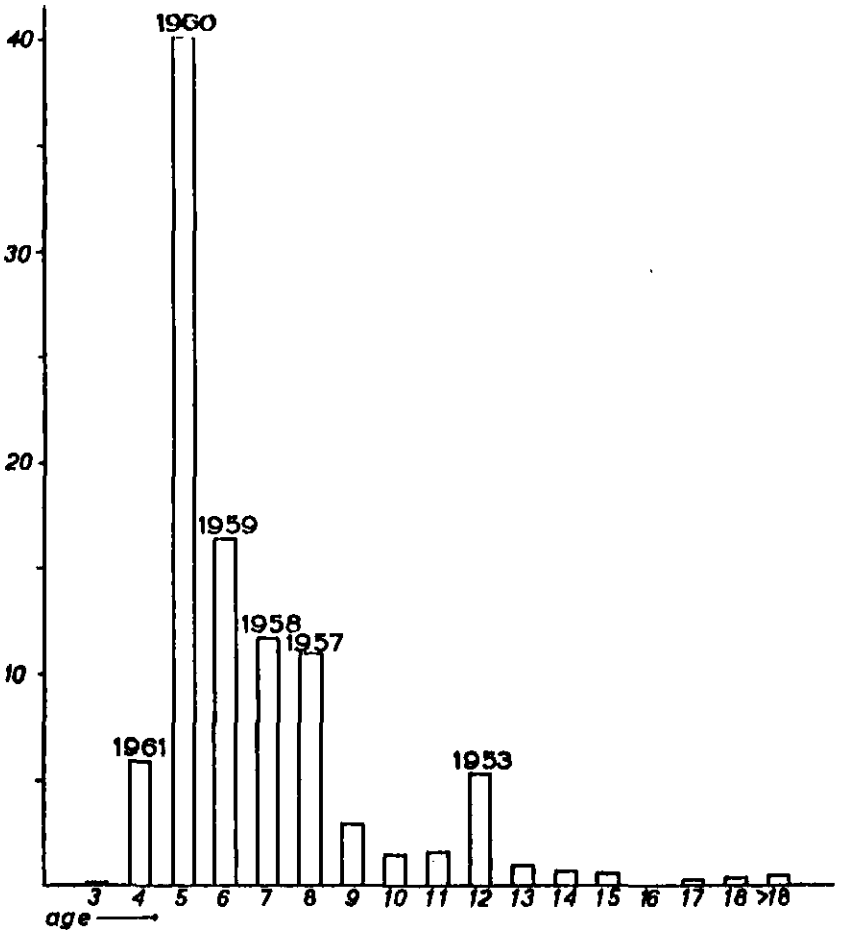

Fig. 2. *Johan Hjort*, West Greenland, April-May 1965. Cod. Age distribution. Total bottom longline catch.

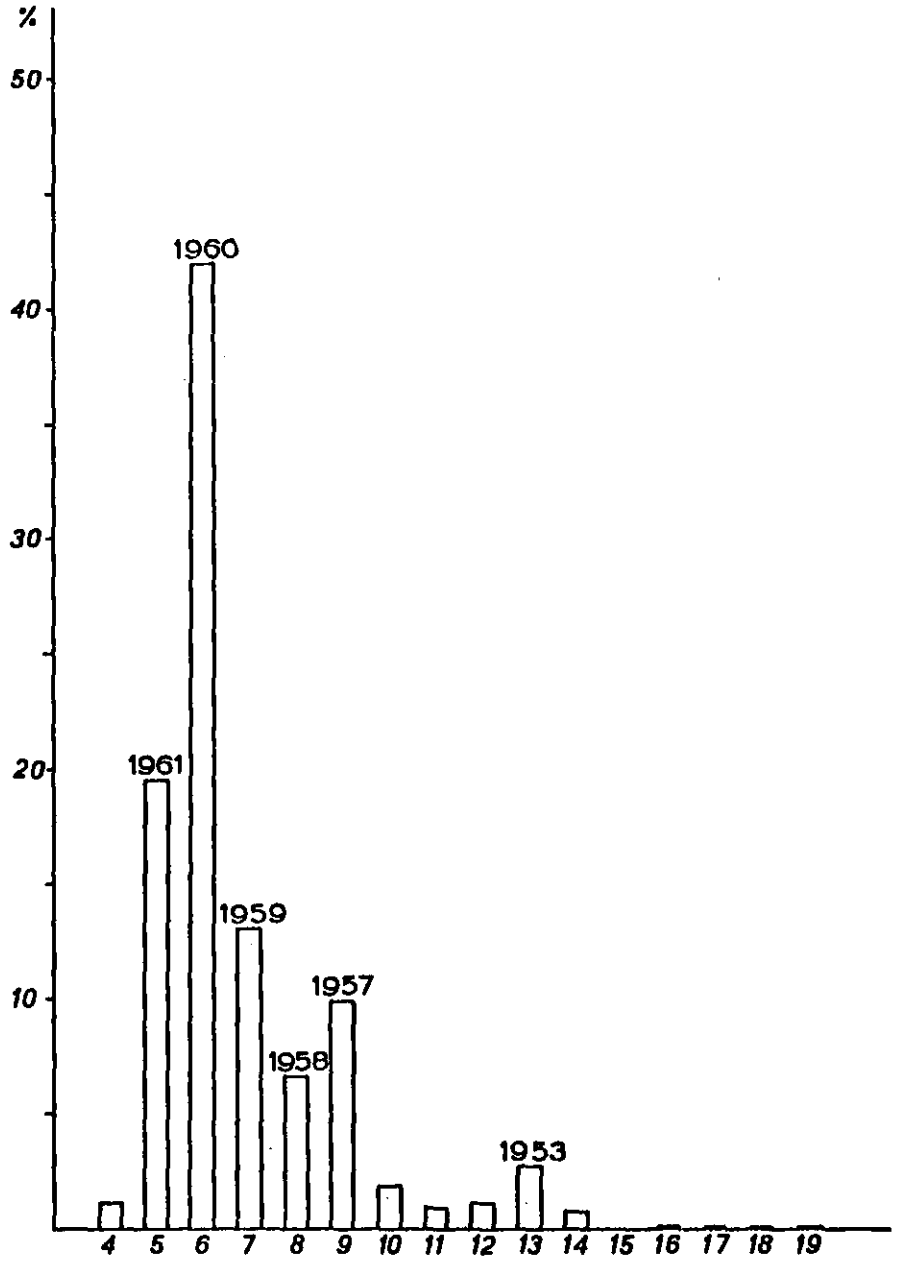

Fig. 3. *Johan Hjort*, West Greenland, March-May 1966. Cod. Age distribution. Total bottom longline catch.

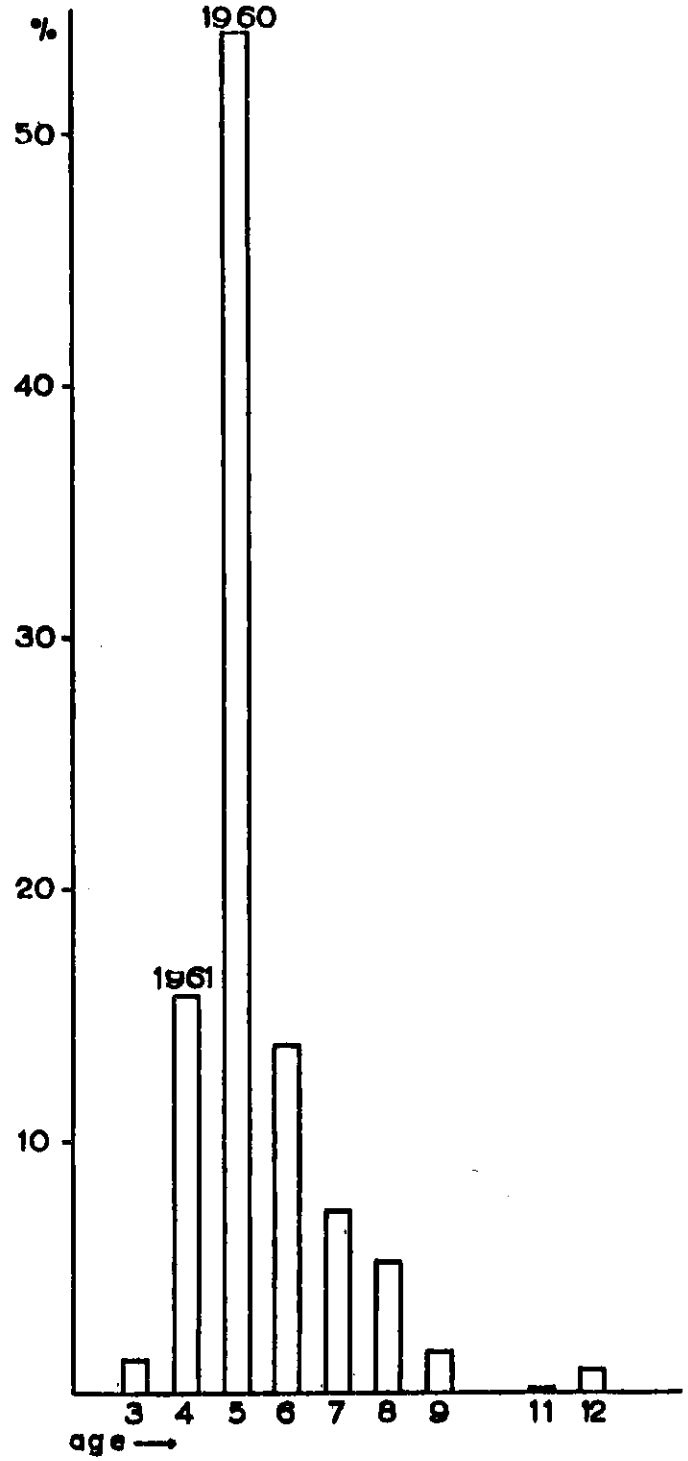

Fig. 4. *Johan Hjort*, West Greenland, April-May 1965. Cod. Age distribution. Total trawl catch.

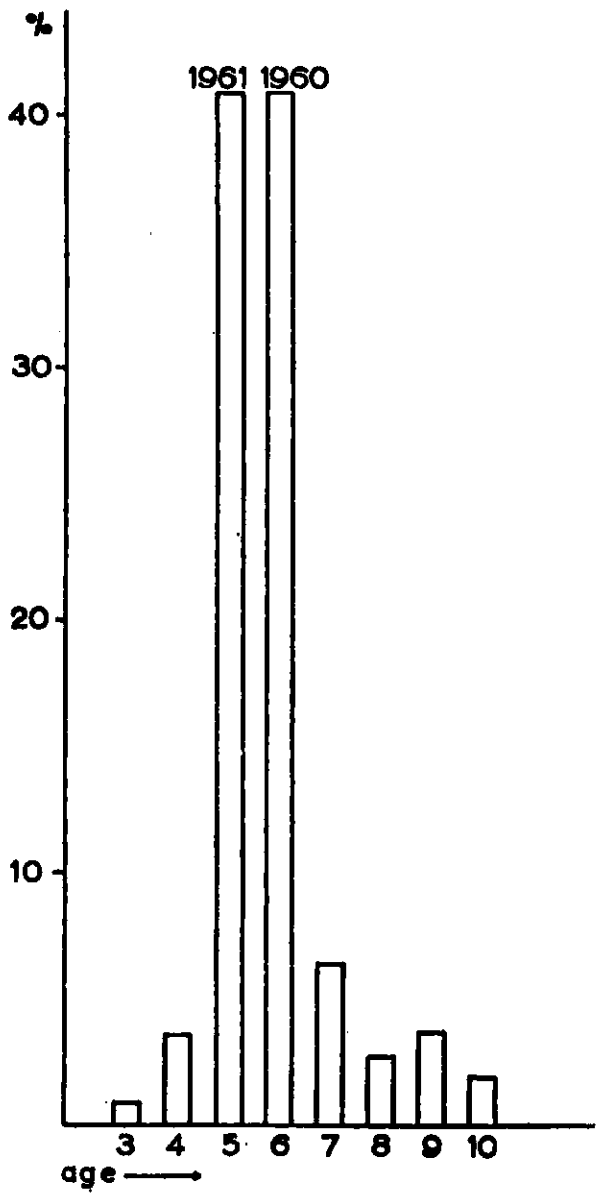

Fig. 5. *Johan Hjort*, West Greenland, Total trawl catch. March-May 1966. Cod. Age distribution.

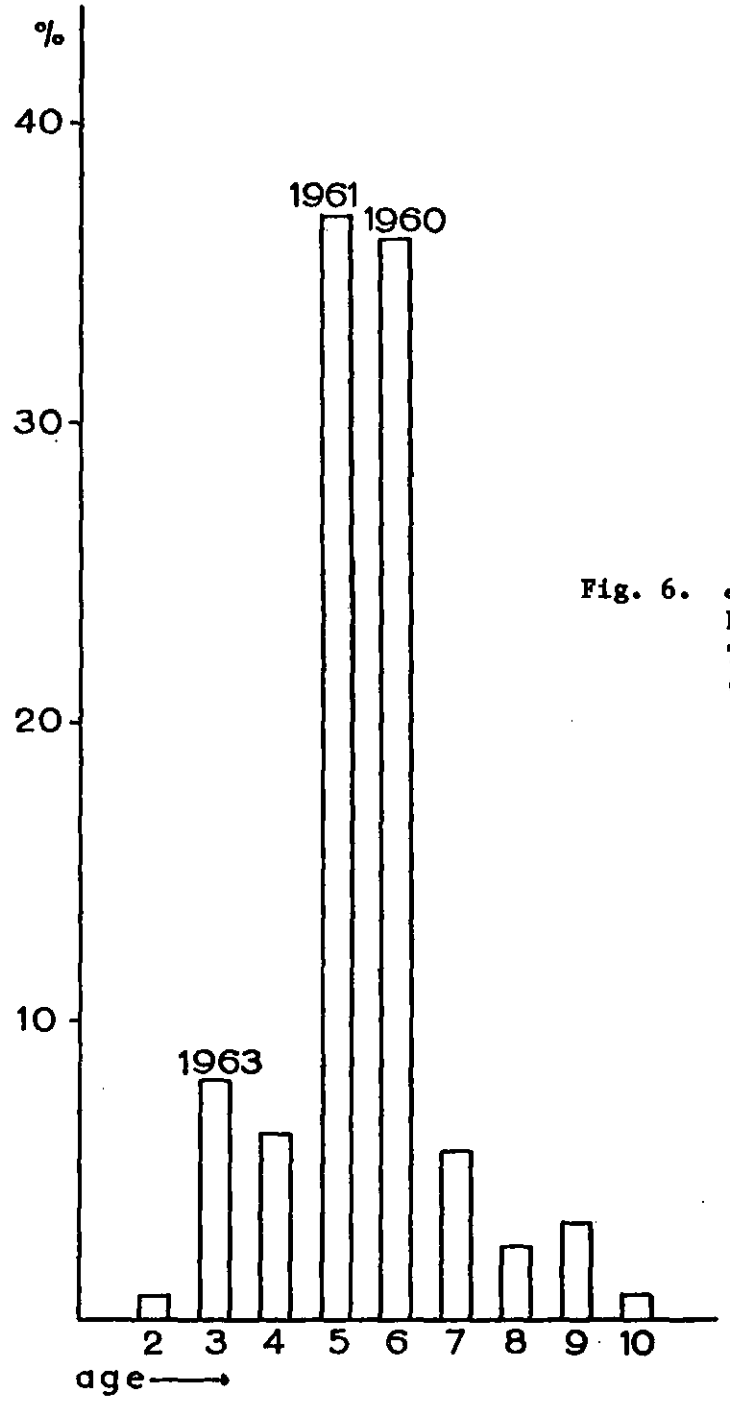

Fig. 6. *Johan Hjort*, West Greenland, March-May 1966. Cod. Age distribution. Total catch in covered trawl hauls (codend + cover).

Fig. 7. *Johan Hjort*, West Greenland, April-May 1965. Cod. Length distribution. Total bottom longline catch.

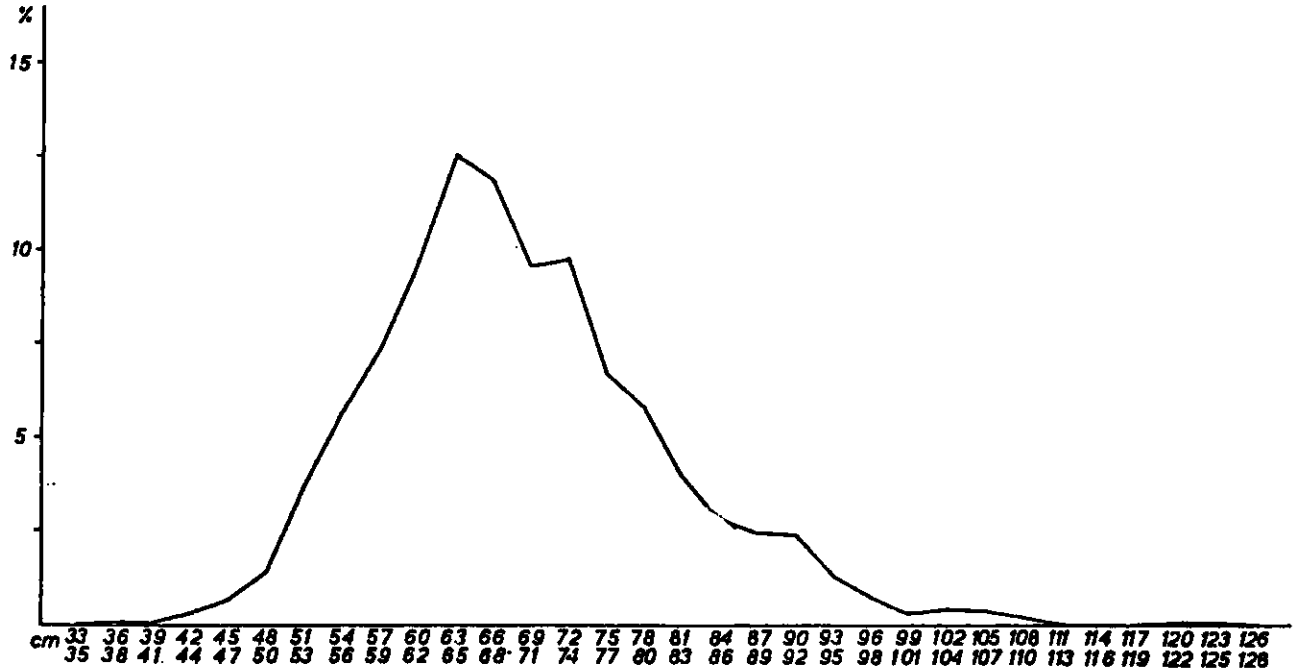

Fig. 8. *Johan Hjort*, West Greenland, March-May 1966. Cod. Length distribution. Total bottom longline catch.

greatly from one locality to another (Table 1). The smallest fish were found on the Fylla Bank, mean length 58.7 cm and on the northwestern part of Lille Hellefiske Bank, mean length 63.3 cm. Taking only the southern banks into account, the mean length has increased considerably, from 65.3 cm in 1965 to 70.3 cm in 1966. On the northern banks the mean length seems to have decreased but this decrease may not be real as there were only two samples from the same area in 1965 and the samples were probably not representative for the cod in this area.

Table 1. R/V *Johan Hjort*, West Greenland 1965 and 1966. Mean length of cod at different fishing stations.

Station			Position			Mean length (cm)	
1965	1966	Bank	1965	1966	Gear	1965	1966
1	1	Off Nunarsuit	60°34'N,48°49'W	60°20'N,48°10'W	Bottom	65.5	71.8
2	2	Off Nunarsuit	60°34'N,48°49'W	60°36'N,48°32'W	longline	64.1	68.7
3	14	Noname Bank	61°22'N,50°07'W	61°46'N,50°40'W	"	66.9	76.0
	15	Noname Bank		61°26'N,50°24'W	"		73.1
	12	Frederikshaab Bank		62°18'N,50°57'W	"		70.3
	13	Frederikshaab Bank		62°11'N,50°36'W	"		64.4
5	11	Dana Bank	62°34'N,51°18'W	62°30'N,51°15'W	"	67.3	68.7
6	10	Dana Bank	62°31'N,51°20'W	62°50'N,51°46'W	"	68.2	69.7
4	16	Fiskenaes Bank	62°59'N,51°55'W	63°15'N,52°17'W	"	62.2	73.0
8		Fiskenaes Bank	63°29'N,52°13'W		"	63.8	
7		Fiskenaes Bank	62°55'N,51°30'W		"	61.8	
14	17	Fiskenaes/Fylla Bank	63°30'N,52°05'W	63°31'N,52°14'W	"	67.9	67.5
		Total Southern Banks			"	65.3	70.3
	9	Fylla Bank		64°10'N,53°14'W	"		58.7
	7	Lille Hellefiske Bank		64°18'N,54°44'W	"		65.1
	6	Lille Hellefiske Bank		64°13'N,54°25'W	"		66.3
11	18	West of Banana Bank	64°26'N,54°24'W	64°23'N,54°37'W	"	88.7	84.9
10	8	Lille Hellefiske Bank	65°00'N,54°30'W	65°00'N,53°06'W	"	66.5	66.9
	3	Lille Hellefiske Bank		66°29'N,54°26'W	"		65.1
	4	Lille Hellefiske Bank		66°05'N,55°17'W	"		63.3
		Total Northern Banks	(St.11/1965 and 18/1966 excluded)		"	66.5	64.2
		Total Northern Banks	(St.11/1965 and 18/1966 included)		"	77.6	67.2
		Total			"	68.6	68.5

The station (18/1966) west of Banana Bank is interesting. The depth of this station is 500-600 m while all the other stations are 180-300 m deep. This locality is the only one where cod are found at such a depth at this time of the year. The cod are very big, mean length 84.9 cm in 1966, and do not seem to mix with the cod in shallower water.

The mean length of the cod in the trawl catches was 63.0 cm in 1966. This mean length is based only on samples from one locality but compared to 1965 the mean length was almost the same at this locality.

2. Forecast for the cod fisheries. For the Norwegian bottom longline fishery off West Greenland it is expected that the 1960 year-class will

dominate in the catches, but compared to 1966 it will probably decrease in strength. The older year-classes will be of decreasing importance while the 1961 year-class will play a more important part. Due to the growth of the 1960 year-class, there may be a small increase in the overall mean length in the catches.

In 1967, the 1960 and 1961 year-classes will dominate the trawl catches. These two year-classes will be of approximately the same importance. However, compared to the catches in 1966, the 1960 year-class will show a decreasing tendency while the 1961 year-class will be of growing importance. The 1963 year-class seems to be promising but for the trawl fishery in 1967 it most probably will be of minor importance. The overall mean length in the trawl catches will be almost the same as in 1966.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. This year the hydrographic program comprised one section off East Greenland and 5 sections in the waters off West Greenland. The observations in West Greenland waters were made between 29 March and 3 April. The whole section across Noname Bank could not be worked due to heavy weather conditions, but the remaining sections were worked in accordance with the program as shown in Fig. 1.

Temperature observations were made at all fishing stations by means of bathythermograph. At depths greater than 250 m reversing thermometer observations were made in addition.

The Irminger component of the West Greenland Current was very well developed at this time, and the greater part of its water masses was of temperatures significantly in excess of 5.0°C with corresponding salinities above 34.95‰ (Fig. 9 and 10). Off Frederikshaab salinities of 35.00‰ were observed at 300 to 400 m depth, and off Fylla Bank one salinity of practically 35.00‰ was observed at 600 m at some distance from the slope. Compared with the years since 1959 when the investigations started in this season, these are the highest salinities which have been observed in the Irminger component of the West Greenland Current. The extent of the Irminger component was also great in relation to the previous years as temperatures above 5.0°C were observed between approximately 300 and 800 m depth off Fylla Bank. Off Lille Hellefiske Bank temperatures above 5.5°C were observed between about 250 and 600 m with a maximum of 5.86 at 300 m. The salinities here were between 34.95 and 34.99‰.

The surface layer was cold in relation to the preceding years. South of about 62°30'N its temperatures were below 0°C as far as approximately 20 nautical miles off the coast. North of the mentioned latitude no temperatures above 0°C were observed except at the most western station in the section across Fylla Bank. In the greater part of this section, the temperatures were

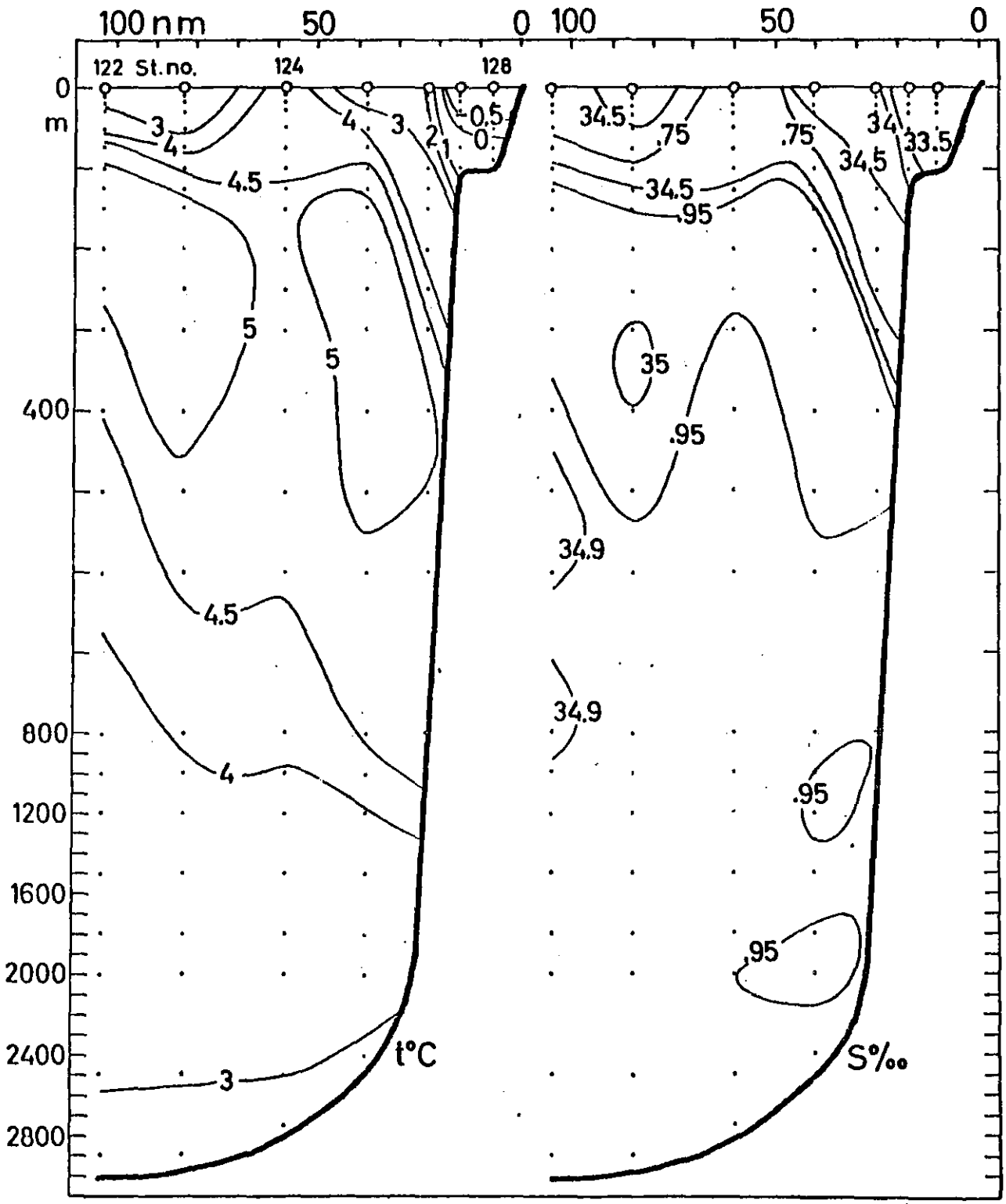

Fig. 9. *Johan Hjort*, West Greenland, 30-31 March 1966. Hydrographical section off Frederikshaab.

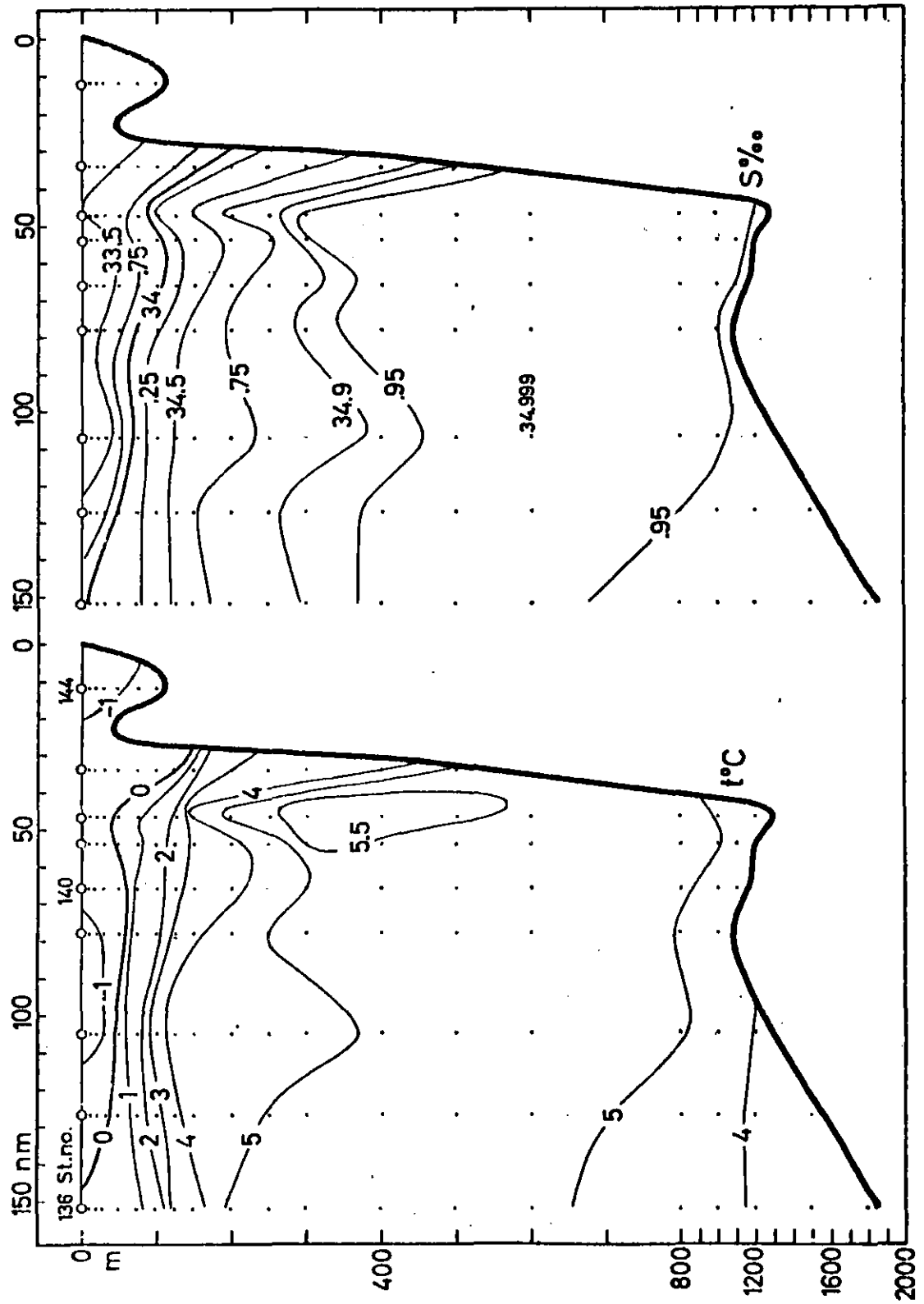

Fig. 10. *Johan Hjort*, West Greenland, 2-3 April 1966. Hydrographical section across Fylla Bank.

below 0°C at depths less than 50 m. There were also temperatures below -1.0°C close to the coast and also at some distance from the shelf (Fig. 10). The low temperatures in the upper layers were seemingly connected with a very stable stratification. This was due to relatively low salinities in the upper layers, resulting in great vertical density gradients. The convection because of the winter cooling was therefore limited to the upper layers.

South of 62°N the surface layer seemed to be influenced by the great Atlantic inflow of the West Greenland Current. Here a sharp front was found along the coast, and outside this the temperatures were rather high.

The ice conditions were favourable. Along the east coast between Cape Tordenskjold and Cape Farewell, the ice extended to about 40 nautical miles off the coast. This ice belt continued around Cape Farewell. North of Julianehaab Bay only a few icebergs were observed. Off Fylla Bank and Lille Hellefiske Bank, the ice border has not been found so far to the west since 1962.

2. Particle recordings. The particle distribution was recorded continuously at 5 m level with Berge's transparency meter. A further study of the sampled material will be prepared.

II. Biological Studies

1. Cod eggs. Sampling of cod eggs was carried out on all the hydrographical and fishing stations. A standard Hensen net was used in vertical hauls 100-0 m, in shallower water from bottom to surface. The sampled material has not been worked up in detail but the preliminary results seem to indicate that very few cod eggs were found even though most of the cod had completed spawning.

2. Cod distribution. The survey with the echo sounder and the bottom longline fishing showed that shoals of cod were present in the whole area investigated. Most of the cod were found on the western slopes of the banks in depths from about 200 to 300 m. Pelagic concentrations of cod were found on Fylla Bank, on the southeastern part of Lille Hellefiske Bank and in the southern part of the Holsteinsborg Deep.

VII. Polish Research Report, 1966

by F. Chrzan
Sea Fisheries Institute
Gdynia

The total Polish catch increased to 72,034 metric tons in 1966 from 56,630 tons taken in 1965. This may be attributed both to an increase in fishing effort and the efficiency of the fishery. On different fishing grounds, mainly in Subareas 2 and 3, 17 Polish factory trawlers fished principally for cod and then for redfish. These vessels made 39 trips to the ICNAF Area compared with 26 trips made by 13 factory trawlers in 1965. In addition, 4 stern freezer trawlers (4 trips) operated in Subarea 5, mainly for herring. Comparison of the 1966 and 1965 catches by major species and groups of species is shown in Table 1.

Table 1.

	1966		1965	
Species	tons	%	tons	%
Redfish	14,962	20.8	24,709	43.6
Cod	36,448	50.6	21,719	38.4
Flatfish	3,334	4.6	6,341	11.2
Greenland halibut	1,119	1.6	591	1.0
Halibut	168	0.2	443	0.8
Other fish and groundfish	1,334	1.8	1,379	2.4
Herring	14,663	20.4	1,447	2.6
Mackerel	6	-	1	-
Total	72,034	100.0	56,630	100.0

The above data show a decrease in catches of redfish and flatfish and an increase of cod and herring.

Subarea 1

A. Status of the Fisheries

In January and March in Subarea 1 only 2 factory vessels scouted occasionally for fish concentrations. Results of catch and effort of these ships are shown in Table 2.

The scouting vessels found almost exlusively cod and rarely redfish, with a poor yield of both species. The poor catches and the rough bottom which caused rapid and excess wear to the nets made the captains give up further scouting for fish on these fishing grounds.

No research work was carried out in Subarea 1.

Table 2.

ICNAF Div.	Catch in metric tons			Hours fished	Days fished
	Redfish	Cod	Flatfish		
1B	6	468	-	137	13
1C	31	196	1	144	16
1D	-	6	-	17	1
1E	9	129	-	109	14
Total	46	799	1	407	44

Subarea 2

A. Status of the Fisheries

In Subarea 2 a number of factory trawlers operated for 9 months of the year. From July to September there was a period of poor yield and no catches were made in these fishing grounds. Catches and fishing effort in Subarea 2 are shown in Table 3.

Table 3.

ICNAF Div.	Catch in metric tons				Hours Fished	Days fished
	Redfish	Cod	Flatfish	Other fish		
2H	474	11,884	290	1	4,312	413
2J	679	17,866	659	-	7,715	655
Total	1,153	29,750	949	1	12,027	1,068

The catch per effort of the factory trawlers in Subarea 2 varied from 10 tons (November in Div.2G) to 44.4 tons daily (January in Div.2J). In the first 5 months of the year, the yield per day was about 30 tons, while in the other months it amounted to about 17 tons. The largest catches were made in Div.2J in the winter months.

B. Research Work

Samples of fish for biological study were obtained in Div.2J in April and May from on board two factory trawlers.

1. Redfish. In May 1,831 redfish (*mentella*-type) 25 to 44 cm in length were measured. The mean length of males made 33.5 cm, females 35 cm and the mean length of both sexes was 34.2 cm. Examination of these fish showed that 93% of the females had gonads in the resting stage.

2. Cod. In April 3,854 cod were measured. The length of these fish varied from 25 to 93 cm with most in the 45-65 cm range. The mean length was 53.6 cm. Cod caught by the Polish trawlers were mainly 5-8 years of age. Over 85% of the fish caught were immature (Stage I and II), 6.2% had running gonads (Stages VI and VII) and 5.9% were spent fish (Stage VIII). In May measurements made on 3,724 specimens have shown that in Div.2J the fish were considerably

smaller than in April. The bulk of the catches consisted of cod 30-50 cm in length and 4-7 years of age. The mean length of cod caught in May was 41.4 cm. Over 95% of these fish were in Stages I and II of maturity. The remaining 4.5% were spent males.

3. Flatfish. On Hamilton Inlet Bank (Div.2J), in May, 3,538 American plaice were measured. The fish were 28-36 cm in length, mean length 34.7 cm. At this time the yield of American plaice, as a bycatch in the cod catches, amounted to about 1,500 kg per day.

At the end of May on the same ground there were good catches of Greenland halibut. The yield amounted to 12-15 tons daily, average 1,200 kg per hour. The 999 fish measured ranged from 32-95 cm in length and their mean length was 60.7 cm.

Subarea 3

A. Status of the Fisheries

In Subarea 3 some factory trawlers were operating throughout the year, though their number was changing. The greatest number of vessels operated in Div.3K, the fewest in Div.3N.

The yield changed depending on the season. In Div.3K, the lowest yield (10 tons per day) was obtained in October, the highest (32 tons per day) in February. In Div.3N, the mean yield fluctuated from 10 tons in April to 25 tons in August. The best catches were made in Div.3K from March to May. The catches and the yield per unit in Subarea 3 are shown in Table 4.

Table 4.

ICNAF	Catch in metric tons			Hours	Days
Div.	Redfish	Cod	Flatfish	fished	fished
3K	10,490	4,454	2,563	9,710	765
3L	234	305	947	1,405	112
3M	105	93	20	275	23
3N	2,476	613	78	1,850	159
3O	452	152	47	395	35
3P	-	9	-	38	4
Total	13,757	5,626	3,655	13,673	1,098

B. Research Work

The most important species were sampled mainly in Div.3K on board the factory trawler *Feniks* during her trip from 15 March to 8 June 1966. From 5 May to 23 August 1966, samples were taken on board the factory trawler *Andromeda*.

1. Redfish. The results of measuring redfish are shown in Table 5.

Table 5.

Species	Month	No. fish measured	Percentage ♂	Percentage ♀	Length in cm Range	Length in cm Mean
S. mentella	March	1,831	50.6	49.4	27-46	35.0
	April	2,437	43.4	56.6	28-46	36.5
	May	3,997	39.8	60.2	28-45	36.0
S. marinus	April	962	22.0	78.0	40-60	48.9

As the above data show, redfish (*mentella*-type) were the same length range from March to May. A greater number of females was noted. In addition, 49.4% of the females of redfish (*mentella*-type) were in the running stage and 20.3% were spent.

Observations on the maturity of redfish (*marinus*-type) have shown that in April in Div.3K 67.1% of the females were in the running stage and 31.0% were spent. These observations indicate that in Div.3K from March to May redfish (*mentella*-type) as well as redfish (*marinus*-type) were producing larvae.

2. Cod. From 9 to 23 May in Div.3K, 5,681 cod were measured. These fish were 19 to 117 cm in length. Fish 35-65 cm in length and 4 to 8 years old predominated in the catches. Mean length was 52.7 cm. The examination of the gonads showed that in May 87.2% of the fish were in the juvenile (I) and resting (II) stage of maturity. In addition there were 4.2% in the running stage (VII and VI) and 3.9% spent.

3. Flatfish. On Ritu Bank (Div.3K) the bycatch was made up of flatfish. There were American plaice, witch flounder and Greenland halibut. Measurements of 1,350 of American plaice showed that these fish were 28 to 45 cm in length (average length 38.2 cm). Witch flounder were caught in much smaller quantities and the measurements of 386 specimens showed the length range to be 32-65 cm (average 50.2 cm).

In May and June on Ritu Bank the yield of Greenland halibut was 800-1,000 kg per hour. The 1,455 fish measured ranged in length from 25 to 95 cm. The mean length of these fish was 55.2 cm.

In the beginning of July on Woolfall Bank (Div.3L) there was the yield of 800 kg per hour of American plaice. The length range of these fish was 18 to 64 cm (mean length 34.5 cm).

In July, when scouting for cod on Green Bank-St.Pierre Bank (Div.3Ps) a rather small quantity of American plaice, witch flounder and yellowtail were caught. Results of measurement made on these fish are as follows:

American plaice : 18-61 cm, mean length 34.5 cm
Witch flounder : 22-55 cm, " " 33.9 cm
Yellowtail : 22-54 cm, " " 39.7 cm.

Subarea 4

A. Status of the Fisheries

In Subarea 4 from June to August the factory trawlers occasionally scouted for fish concentrations. The very small catches are shown in Table 6.

Table 6.

ICNAF Div.	Catch in metric tons		Hours fished	Days fished
	Cod	Herring		
4X	7	190	8	5

B. Research Work

I. Environmental Studies

During the cruise of R/V *Wieczno* in November-December 1966, hydrographic studies were carried out in Subarea 4. The results of temperature measurements are given in Table 7.

Table 7. Temperature cross sections in Subarea 4.

Depth (m) / Position	Temperatures (°C)						
	0	25	50	75	100	150	Bottom
Southeast from Halifax, 19-20 November 1966							
44°12'N 63°29'W	8.40	8.38	4.02	2.08	-	-	2.90 (90 m)
43°47'N 63°08'W	9.51	9.51	3.62	2.32	3.15	-	3.85 (140 m)
43°31'N 63°05'W	9.52	9.55	9.25	3.65	3.12	5.21	5.30 (205 m)
43°24'N 62°49'W	9.28	9.29	4.04	2.69	2.77	-	2.77 (100 m)
42°51'N 62°36'W	9.14	9.10	6.28	5.96	7.42	7.44	5.56 (230 m)
Along the 65°W geogr. Length, 26-27 November 1966							
43°12'N 65°00'W	6.60	6.40	5.41	3.21	3.23	-	3.08 (162 m)
42°48'N 65°00'W	7.58	7.53	5.78	3.76	-	-	3.78 (95 m)
42°36'N 65°00'W	7.99	7.38	5.34	3.70	-	-	2.91 (110 m)
42°20'N 65°02'W	8.61	8.58	3.26	3.16	3.04	3.96	4.77 (500 m)
Along the 61°W geogr. Length, 12 November 1966							
44°41'N 60°58'W	7.34	7.30	7.44	3.95	2.53	-	1.61 (140 m)
44°20'N 61°00'W	7.78	8.10	7.61	4.52	-	-	4.31 (85 m)
44°05'N 61°00'W	7.73	7.72	-	-	-	-	7.17 (56 m)

Observations show an increase of surface salinity from the shore toward the open sea: from 30.66‰ (position 44°12'N to 63°29'W) to 32.01‰ (position 42°20'N to 65°02'W). It was also found that the salinity increases along the coast of Nova Scotia from the northeast (30.90‰) toward the southwest (31.83‰).

Salinity of the bottom layer varies with the geographical position and depth: from north to south and from the shallow to the deeper waters. Near the Nova Scotia coast the salinity was 32.99‰ and on the slopes of the Shelf it increased to 34.56‰ and 34.61‰.

Oxygen content in the surface water layer varied from 92 to 101% of saturation. Over the shallows (*e.g.* on the northwestern part of Sable Bank) saturation was 86 to 93%, while in the deeper layers near the slopes of the Shelf the saturation decreased to 55 and 71%.

Phosphate content expressed as P_2O_5 was estimated on the Scotian Shelf along the 65° meridian and from the Halifax light vessel to Sambro Bank. At the end of November the surface waters contained only traces of P_2O_5 and only exceptionally amounted to 5 mg/m^3. But, at station 44°12'N, 63°29'W, the content of P_2O_5 amounted to 10 mg/m^3. At the bottom, phosphate content amounted to 30-60 mg/m^3, and in once case even 90 mg/m^3.

II. Biological Studies

Fishing survey by R/V *Wieczno* in Subarea 4, Browns Bank (Div.4X). In November catches varied from 20 to 1,000 kg per hour (average 300 kg per hour) in depths of 115 to 320 m. The catch composition included 80% argentine and about 10% cod. Rather good results were obtained at 250 to 300 m depths.

Argentines were found to be concentrated by sizes. In shallower waters (to 260 m) smaller (mean length 26.2 cm) fish were found. In deeper waters (about 300 m) the mean length of argentine was 34.6 cm. On Browns Bank argentine were 18 to 48 cm in length.

Sambro Bank (Div.4W). In mid-November yields were very low, being from 10 to 90 kg per hour (average 50 kg per hour) at fishing depths of 110-240 m. Haddock made up about 50% of the fish landed. Results were similar in mid-December.

Emerald Bank (Div.4W). At the end of November, yields were poor varying from 5-45 kg per hour (average 25 kg per hour). American plaice and yellowtail were the main species caught at depths of 115-160 m. The lengths of 113 American plaice ranged from 10 to 48 cm (average 23.9 cm).

Sable Island Bank (Div.4W). At the end of November on the southern slopes down to 40-50 m, the average yield was 45 kg per hour. In mid-December down to 60-90 m, the yield was 20-240 kg per hour (average 130 kg per hour).

American plaice made up the main bulk of the catches in November and December. The length of these fish was 17 to 50 cm (average 27.9 cm).

On the northern slopes of Sable Island Bank at the end of November and about mid-December, the average catch was 60 kg per hour of cod, flatfish and alewife. The lengths of 328 American plaice varied from 9 to 40 cm (average 23.9 cm). There were also 147 alewives which ranged in length from 25 to 33 cm (average 29.8 cm).

On the southwestern slopes of Sable Island Bank at 60-100 m in December, the yield was 290-1,400 kg per hour (average 760 kg per hour). Composition of the catch was haddock (70%), mackerel (12.6%), American plaice (7.8%) and other fish (9.6%). The lengths of 509 haddock varied from 17 to 73 cm (mean length 36.6 cm).

Banquereau Bank (Div.4V). On this fishing ground in December a few hauls were made at 60-100 m. The yield was from 20 to 175 kg per hour (average 70 kg per hour). More than 70% of catch was haddock and only 7% cod. The length of haddock ranged from 15 to 75 cm (mean length 39.3 cm) and the length of cod from 17 to 49 cm (mean length 28.9 cm).

Subarea 5

A. Status of the Fisheries

Catches and catch per unit effort of Polish factory trawlers and freezer trawlers are given in Table 8.

Table 8.

ICNAF Div.	Catch in metric tons			Hours fished	Days fished
	Cod	Herring	Other fish & groundfish		
	Factory trawlers				
5Z	171	11,564	82	2,728	335
	Freezer trawlers				
5Z	98	2,909	1,279	1,022	132

The fishing season for trawlers of both types commenced in May. The operations of the freezer trawlers were completed in September, and of the factory trawlers in October. The catches of the factory trawlers oscillated from 21 tons per day in May to 47 tons per day in September. The catches of the freezer trawlers fluctuated from 24 tons per day in May to 36 tons in September. The best catches by both types of vessels were obtained from July to September.

B. Research Work

I. Environmental Studies

From 4 November to 7 December 1966, R/V *Wieczno*, 9 hydrographic sections were completed. The temperatures are shown in Table 9. During the course of these observations catches were made in order to find out in which temperature the greatest concentration of fish occurred. Good catches (2,600 kg per hour) were obtained on 10 November northwest of Cultivator Shoal in bottom water temperatures of 5°C to 6°C.

Table 9. Temperature cross sections in Subarea 5.

Position \ Depth (m)	Temperatures (°C) 0	25	50	75	100	150	Bottom
Section along 67° meridian - 4-5 November 1966							
40°05'N 67°00'W	10.51	10.26	9.40	-	-	-	9.09 (73 m)
40°48'N 67°00'W	10.42	10.31	5.83	5.80	-	-	6.16 (90 m)
40°39'N 67°05'W	10.16	10.18	8.36	6.05	5.20	7.89	7.22 (200 m)
40°35'N 67°04'W	10.00	10.00	8.10	5.10	5.14	8.40	5.55 (300 m)
Section along 68° meridian - 6 November 1966							
40°50'N 68°00'W	10.34	11.05	-	-	-	-	11.01 (50 m)
40°32'N 68°00'W	10.58	10.62	10.02	8.70	-	-	8.31 (94 m)
40°20'N 68°00'W	10.70	10.58	9.62	6.07	6.74	8.01	7.55 (200 m)
40°16'N 68°00'W	11.13	12.08	8.74	9.45	7.22	7.94	4.84 (500 m)
Section along 69° meridian - 6-8 November 1966							
40°04'N 68°59'W	12.84	12.82	9.88	8.48	8.62	8.85	7.34 (230 m)
40°19'N 69°00'W	12.32	12.30	9.14	7.32	-	-	7.35 (95 m)
40°40'N 69°00'W	10.44	10.40	10.34	-	-	-	10.20 (63 m)
41°00'N 69°00'W	11.54	11.48	9.85	-	-	-	7.50 (58 m)
41°18'N 69°00'W	10.19	9.52	4.88	4.46	4.44	4.25	-
41°44'N 69°00'W	10.06	10.11	7.32	3.32	4.27	4.46	4.45 (167 m)
42°06'N 69°00'W	9.58	8.92	8.63	3.94	3.96	4.62	4.62 (182 m)
42°23'N 69°02'W	8.84	8.80	8.60	6.60	5.56	4.38	5.80 (230 m)

(continued)

Table 9. (continued)

Position \ Depth (m)	Temperature (°C) 0	25	50	75	100	150	Bottom
Section along 68° meridian - 9-10 November 1966							
41°50'N 68°00'W	11.58	11.44	-	-	-	-	11.43 (45 m)
41°54'N 68°00'W	11.06	10.94	10.26	9.24	5.00	-	5.80 (140 m)
42°06'N 67°58'W	9.42	9.14	8.74	7.42	5.20	4.76	6.27 (217 m)
42°28'N 67°55'W	8.65	8.42	8.18	6.32	5.84	5.96	6.00 (180 m)
Section NW off Cultivator Shoal - 10 November 1966							
41°47'N 68°40'W	11.48	10.27	9.93	9.07	7.48	4.62	5.40 (200 m)
41°37'N 68°28'W	12.24	11.60	10.98	4.72	5.16	-	4.96 (120 m)
41°32'N 68°21'W	12.07	12.04	-	-	-	-	12.00 (40 m)
Section Browns Bank-Georges Bank, 27-30 November 1966							
42°25'N 66°35'W	8.86	7.62	7.00	6.45	5.78	6.16	5.93 (250 m)
42°46'N 66°14'W	6.60	6.58	-	-	-	-	6.56 (35 m)
42°51'N 66°06'W	6.94	6.46	6.38	6.22	6.04	-	5.94 (140 m)
43°00'N 66°03'W	7.90	7.80	7.00	6.50	6.30	-	6.30 (106 m)
42°13'N 66°34'W	10.06	10.03	9.24	7.92	7.88	5.22	4.88 (230 m)
41°50'N 66°50'W	9.32	9.28	-	-	-	-	9.25 (60 m)
Section along 67° meridian - 2-3 December 1966							
40°39'N 67°05'W	9.47	9.43	8.45	6.04	-	-	4.12 (105 m)
40°32'N 67°03'W	10.44	10.45	6.15	5.72	5.68	4.24	4.42 (500 m)
41°02'N 67°08'W	8.78	-	-	-	-	-	8.84 (60 m)
Section along 68° meridian - 5-6 December 1966							
40°16'N 68°00'W	14.48	14.54	14.46	14.46	9.78	13.46	4.76 (450 m)
40°19'N 68°00'W	13.71	13.79	14.82	14.98	12.00	8.93	7.89 (190 m)
40°32'N 68°00'W	9.36	9.42	11.56	15.78	-	-	13.93 (110 m)
40°55N 68°06'W	9.45	9.48	-	-	-	-	9.49 (50 m)

(continued)

Table 9. (continued)

Depth (m) / Position	Temperature (°C) 0	25	50	75	100	150	Bottom
Section along 69° meridian - 6-7 December 1966							
40°02'N 69°02'W	11.14	11.90	13.42	13.18	8.60	8.57	5.77 (500 m)
40°17'N 69°00'W	8.54	8.56	8.64	8.72	-	-	10.32 (95 m)
40°41'N 69°00'W	8.88	8.95	-	-	-	-	8.98 (56 m)
40°59'N 69°00'W	9.05	9.06	8.87	-	-	-	8.65 (80 m)
41°18'N 69°00'W	8.84	8.84	8.24	6.07	5.10	-	4.42 (140 m)

A large herring concentration yielded 1,700 kg per hour at 70 m in temperatures shown in Table 9 for the section along the 67° meridian on 3 December.

Investigations from 4 to 12 November on the southwestern part of Georges Bank have shown the surface salinity to be from 31.8‰ to 33.1‰ (mainly 32.5‰). From 27 November to 7 December on the southern edge of Georges Bank, the surface salinity was 32.6 to 34.8‰. During this same period in the region of Browns Bank the surface salinity was from 32.2 to 32.6‰.

Salinity of the bottom layers was somewhat higher than that of the surface water. From the surface to 100 m, it was from 31.8 to 33.8‰. At 200 to 500 m the salinity was from 34.43 to 34.90‰.

The oxygen content in the surface layers of Georges Bank from 4 to 12 November amounted to 97-105% of saturation. In December the saturation decreased somewhat (89-100%). Oxygen content decreased with depth. On the deep slopes of Georges Bank, the saturation decreased to 70%.

On the shallow part of Georges Bank in surface waters in November, the phosphate content was 15 to 25 mg/m^3. Over the deeper slopes the phosphate content decreased to 10 mg/m^3. In the bottom layers the phosphate content amounted to 90-120 mg/m^3.

II. Biological Studies

Herring. On the southeastern slopes of Georges Bank from 80 to 180 m in December the R/V *Wieczno* obtained yields of from 120 - 3,200 kg per hour of pure herring (average 1,880 kg per hour). The lengths of 1,899 herring ranged from 26 to 35 cm (mean length 31.2 cm).

On southwestern slopes of Georges Bank from 60 to 160 m during the first half of November, yields of herring were 200 to 2,520 kg per hour (average 920 kg per hour). The lengths of 1,276 herring were 26-34 cm (mean length 30.4 cm). In the beginning of December on these fishing grounds the yield of herring oscillated from 450 to 3,320 kg per hour, but the average yield decreased somewhat from the November yield (840 kg per hour). The lengths of the fish were a little smaller, varying from 23-34 cm (average 29.1 cm).

On the northwestern slopes of Georges Bank, from 55 to 110 m, in the beginning of November, the yield of herring was from 45 to 1,120 kg per hour (average 300 kg per hour). Herring ranged from 23 to 35 cm in length (average 29.9 cm).

On other parts of Georges Bank the yield of herring was considerably smaller. The size of fish was, however, similar. Only in one case, in the region of northwestern slopes of Georges Bank, were smaller herring (mean length 22 cm) caught.

In November a considerable number of the herring taken were in the spent stage. In December, the majority of the fish were in the resting stage.

Examination of stomach contents indicated a more intensive feeding by herring on the western and northwestern than on the eastern and southeastern slopes of Georges Bank.

Mackerel were caught in small numbers as a bycatch on nearly all the fishing grounds down to 120 m.

Three size groups were distinguished. The larger fish were found on the southwestern and northwestern slopes of Georges Bank (29-42 cm in length, average about 37 cm). The medium-size fish were found on the southwestern slopes of Georges Bank (25-35 cm in length, mean length about 28 cm). The smallest fish (17-24 cm in length, average 21 cm) were found in various places, mostly on southwestern slopes of Georges Bank.

Alewife was caught on the southwestern slopes of Georges Bank as well as on the southern slopes of Sable Island Bank. On Georges Bank these fish were a bycatch (0.5-2.4% of the catch). The lengths of the fish varied from 22 to 33 cm (average 28 cm).

Haddock. Survey cruises for haddock carried out in November-December 1966 showed that on Georges Bank the fish were larger on the deeper fishing grounds (to 140 m) than in the shallower water (to 80 m). On deeper grounds, the lengths of the fish were from 42 to 80 cm (average 66.8 cm), on the shallower grounds, 33-60 cm (average 50 cm).

An analysis of haddock stomach contents from Georges Bank showed that in November and December the stomachs varied from nearly empty to full. Polychaetes and crustaceans were the chief food organisms found.

Silver hake were caught mainly on the southwestern and northwestern slopes of Georges Bank. The size of fish was similar on the different fishing grounds. Sizes ranged from 17 to 48 cm (mean length 28.0 to 31.2 cm). Smaller silver hake (mean length 25.7 cm) were caught only on the northwestern slopes of Georges Bank.

Squirrel hake were caught chiefly on the western slopes of Georges Bank at from 65 to 160 m. The length of these fish was 20 to 52 cm (average 35 cm).

The stomach contents of 200 fish were examined during the cruises in November and December. Mainly Gammarid-like crustaceans were found.

American plaice were caught in considerable numbers on the southwestern slopes of Georges Bank. These fish were of 23-33 cm in length (average 30.3 cm). On other fishing grounds, American plaice were caught in smaller numbers and had a mean length of 23.9-27.9 cm.

Butterfish were caught in December only on the southern slopes of Georges Bank at about 100 m. The length of these fish was 15 to 24 cm (average about 21 cm).

Spiny dogfish were caught in considerable numbers in December on the southwestern slopes of Georges Bank. They were from 37 to 63 cm in length with the 50 cm length predominating in the catch. The stomachs of the spiny dogfish contained mainly mackerel.

VIII. Portuguese Research Report, 1966

by Manuel Lima Dias

During 1966 the Portuguese otter trawl and dory vessel fleets caught a total of 199,395 tons of cod in the ICNAF Area as shown below:

Subareas	1	2	3	4	Total
Otter Trawl	2,053	44,446	60,616	10,830	117,945
Line Trawl (dory vessel)	73,357	-	8,093	-	81,450
Total	75,410	44,446	68,709	10,830	199,395

The otter trawl fishery was carried out in all four subareas and amounted to almost twice that of the line fishery which was carried out mainly in Subarea 1. The total catch in 1966 shows a slight increase of 2,238 tons over that in 1965.

This report presents the status of the fisheries in the four subareas where the Portuguese fleet fished and includes observations made in commercial trawlers in Subareas 2, 3 and 4. Data on lengths, ages, stage of maturity and probable age at first maturity are presented. All samples were taken at random before discarding the undersized fish; for the age/length keys the same procedure is followed as in our previous report (Res.Doc.66/37). Detailed information on the samples will be included in the *Sampling Yearbook* for 1966.

Subarea 1

A. Status of the Fisheries

I. Cod

In this subarea the dory vessel fleet took 73,357 tons of a total of 75,410 tons of cod caught. The best trawler catches in Subarea 1 were made in Div.1B (1,438 tons between June and September), while the lowest catches were in Div.1C (345 tons in June), 1E (214 tons from March to May), 1D (40 tons in May and June) and 1F (16 tons in May). For the dory vessels, the largest catches were made in Div.1B (39,082 tons from June to September), 1D (22,194 tons between May and August) and 1C (12,081 tons from May to September).

Subarea 2

A. Status of the Fisheries

I. Cod

As in previous years, only the otter trawlers fished in this subarea. The total catch (44,446 tons) is lower by 28,390 tons than in 1965. Catches

in Div.2G, 2H and 2J were 611 tons, 7,380 tons and 36,455 tons respectively from March to November.

Samples for biological study were obtained in Div.2G, 2H and 2J from 14 March to 5 June as follows:

Sample Group	Sample numbers	Date	Depth (m)	No Lengths	No Aged
Div.2G					
A	8-9-10-11-12-13	13-18 April	295-320	983	364
Div.2H					
B	4-5	17-18 March	270-340	150	83
C	14-15-16-18-19-20	19-27 April	395-460	861	342
D	22	2 May	310-350	125	70
Div.2J					
E	1-2-3	14-16 March	270-350	375	62
F	6-21	10-30 April	230-380	225	175
G	23-24-25-26-27-28-29-30	3-30 May	200-470	1,559	486
H	32-33-34-35-36	1-5 June	180-220	900	350

a. Lengths (Fig. 1). Lengths ranged from 22 to 106 cm classes. Mean lengths were A - 58.7, B - 53.3, C - 55.0, D - 57.4 and E - 54.6.

b. Ages (Fig. 1). In March the most important age-groups were VI, VII and VIII (1960, 1959 and 1958 year-classes), in Div.2H and 2J.

In April, May and June, in Div.2G and 2H, the VIII, IX and X age-groups (1958, 1957 and 1956 year-classes) were the most representative, while in Div.2J in May and June, age-group V (1961 year-class) was the most important. Age-group II (1964 year-class) appeared for the first time in May and June in Div.2J. The oldest age-group, XXII (1944 year-class) appeared twice in April Div.2G, and June Div.2J.

Mean ages are as follows: A - 10.3; B - 7.4; C - 8.6; D - 9.2; E - 6.9; F - 7.6; G - 6.6; H - 6.3.

c. Growth is shown in the following table of average lengths (figures in brackets are numbers of fishes for each quarter of the year):

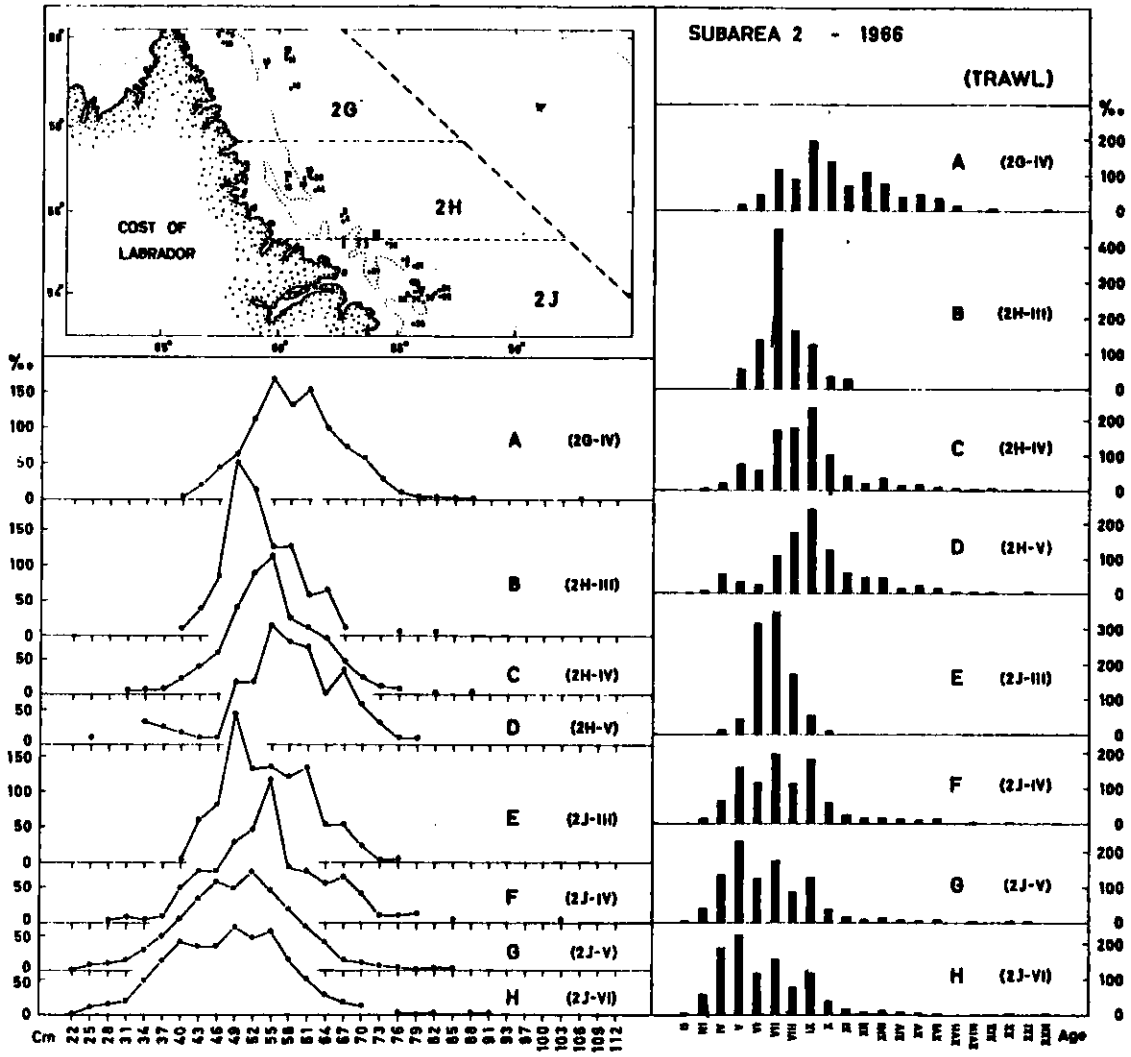

Fig. 1. Cod. Subarea 2. Length and age composition, March-June 1966.

Div.2G

Year-Class	Age-Group	2nd Quarter April
1961	V	45.2 (4)
1960	VI	47.3 (13)
1959	VII	50.5 (44)
1958	VIII	56.0 (35)
1957	IX	57.8 (75)
1956	X	59.7 (50)
1955	XI	62.8 (26)
1954	XII	62.3 (39)
1953	XIII	67.1 (27)
1952	XIV	62.5 (14)
1951	XV	67.7 (18)
1950	XVI	66.2 (13)
1949	XVII	70.0 (4)
1948	XVIII	-
1947	XIX	82.0 (1)
1946	XX	-
1945	XXI	-
1944	XXII	106.0 (1)

Div.2H

Year-class	Age-group	1st Quarter March	2nd Quarter April	2nd Quarter May
1963	III	-	31.8	34.4 (7)
1962	IV	-	37.8	34.7 (7)
1961	V	44.4 (6)	43.4	41.0 (19)
1960	VI	48.5 (12)	48.9	50.7 (21)
1959	VII	51.6 (29)	51.5	52.9 (70)
1958	VIII	56.8 (16)	55.6	58.1 (77)
1957	IX	58.0 (12)	56.8	58.3(102)
1956	X	59.6 (4)	59.4	61.6 (43)
1955	XI	70.5 (4)	61.9	63.7 (19)
1954	XII	-	64.2	68.4 (13)
1953	XIII	-	62.7	61.6 (16)
1952	XIV	-	59.0	59.1 (6)
1951	XV	-	64.6	66.1 (7)
1950	XVI	-	66.9	68.8 (5)
1949	XVII	-	67.0	67.0 (1)
1948	XVIII	-	70.0	70.0 (1)
1947	XIX	-	76.0	76.0 (1)
1946	XX	-	-	-
1945	XXI	-	65.5	76.6 (1)

2J

Year-class	Age-group	1st Quarter March	2nd Quarter April	May	June	
1964	II	-	-	25.0	25.0	(1)
1963	III	-	31.3	29.8	29.1	(36)
1962	IV	43.0 (1)	40.4	38.8	38.3	(117)
1961	V	45.5 (4)	45.4	45.1	44.2	(204)
1960	VI	51.5 (19)	50.3	49.6	49.2	(120)
1959	VII	55.6 (23)	54.0	53.2	53.1	(180)
1958	VIII	54.5 (10)	58.2	56.7	56.7	(92)
1957	IX	64.5 (4)	59.7	58.3	58.0	(146)
1956	X	70.0 (1)	62.7	59.7	61.4	(45)
1955	XI	-	67.7	64.5	64.6	(19)
1954	XII	-	72.1	60.4	59.2	(11)
1953	XIII	-	63.8	62.3	62.6	(14)
1952	XIV	-	69.3	64.1	64.7	(9)
1951	XV	-	67.1	66.3	65.4	(7)
1950	XVI	-	69.4	63.2	63.8	(7)
1949	XVII	-	-	-	-	
1948	XVIII	-	73.0	73.0	1	(1)
1947	XIX	-	-	-	-	
1946	XX	-	67.0	67.0	67.0	(1)
1945	XXI	-	-	-	-	
1944	XXII	-	-	82.0	82.0	(1)

d. Stage of maturity (Fig. 2). In Div.2G in April, about 30% of the males and 20% of females were in the spawning stage. About 20% of the males and 50% of the females were in the post-spawning stage. Yet about 30% of the males and 20% of the females were in the developing stage.

In Div.2H in March, 60% of the males and 24% of the females were in the spawning stage, and 40% of the males and 76% of the females in the developing stage. But in April only about 2% of the females were in the spawning stage and almost all the females were in the post-spawning (75%) and in the recovering (23%) stages. Of the males, almost 70% belong to the developing stage and about 20% and 10% to the recovering and post-spawning stages respectively. In May, about 10% of the males were now in the spawning stage.

In Div.2J in March, about 50% of the males and 10% of the females were in the spawning stage and 50% of the males and 90% of the females in the developing stage. In April about 40% males and 10% females were in the spawning stage. In May and June, the majority of fish were in the recovering and developing stages with some in the post-spawning stage in June.

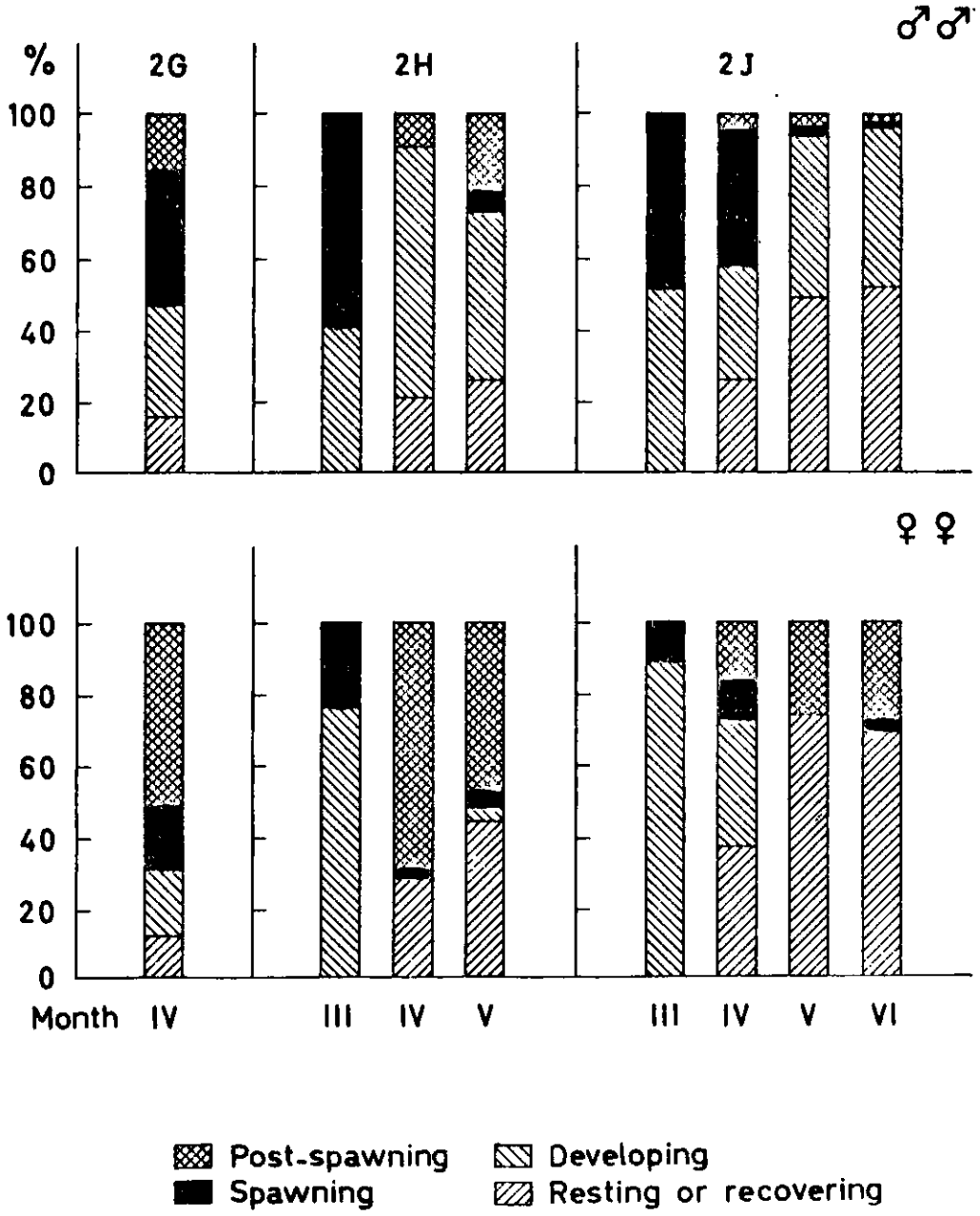

Fig. 2. Cod. Subarea 2. Stages of maturity, 1966.

e. Age at first maturity

Div.2G

1st spawn. / Age-group	♂♂ VI	VII	VIII	IX	θ	?	Total	♀♀ VI	VII	VIII	θ	?	Total
V	-	-	-	-	4	-	4	-	-	-	-	-	-
VI	-	-	-	-	13	-	13	-	-	-	-	-	-
VII	-	1	-	-	35	-	36	-	-	-	8	-	8
VIII	-	-	-	-	26	-	26	-	-	-	9	-	9
IX	-	7	1	-	48	1	57	-	-	-	18	-	18
X	-	4	2	1	28	-	35	-	-	2	12	1	15
XI	1	2	1	-	12	2	18	-	-	-	7	1	8
XII	2	3	3	1	19	2	30	1	-	1	7	-	9
XIII	-	2	4	-	14	1	21	1	1	-	4	-	6
XIV	-	1	1	-	6	2	10	-	-	1	2	1	4
XV	1	1	1	-	8	-	11	-	2	2	2	1	7
XVI	1	2	3	-	3	-	9	-	2	-	1	1	4
XVII	-	-	2	-	-	-	2	-	-	1	1	-	2
XVIII	-	-	-	-	-	-	-	-	-	-	-	-	-
XIX	-	-	-	-	-	-	-	-	-	-	1	-	1
XX	-	-	-	-	-	-	-	-	-	-	-	-	-
XXI	-	-	-	-	-	-	-	-	-	-	-	-	-
XXII	-	-	-	-	-	-	-	-	1	-	-	-	1
No. observed							272						92

Div.2H

1st spawn. / Age-group	♂♂ VI	VII	VIII	IX	θ	?	Total	♀♀ VI	VII	VIII	IX	θ	?	Total
III	-	-	-	-	1	-	1	-	-	-	-	1	-	1
IV	-	-	-	-	5	-	5	-	-	-	-	2	-	2
V	-	-	-	-	21	-	21	-	-	-	-	4	-	4
VI	-	-	-	-	28	-	28	-	-	-	-	5	-	5
VII	-	1	-	-	67	-	68	-	3	-	-	28	-	31
VIII	-	3	-	-	56	-	59	-	2	1	-	30	1	34
IX	1	5	3	1	59	3	72	1	2	2	-	36	1	42
X	2	2	2	-	20	2	28	2	1	1	-	13	2	19
XI	-	3	1	-	8	-	12	-	1	-	1	8	1	11
XII	-	-	-	-	6	1	7	-	-	1	1	3	1	6
XIII	-	3	1	-	1	-	5	1	3	4	1	2	-	11
XIV	-	1	-	1	2	1	5	-	-	-	-	-	1	1
XV	-	3	-	-	-	1	4	-	1	-	-	1	1	3
XVI	-	-	-	1	1	-	2	-	-	3	-	-	-	3
XVII	-	-	1	-	-	-	1	-	-	-	-	-	-	-
XVIII	-	-	-	-	-	-	-	-	-	-	1	-	-	1
XIX	-	-	-	-	-	-	-	-	-	-	1	-	-	1
XX	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XXI	-	-	-	-	-	-	-	-	-	-	1	1	-	2
No. observed							318							177

Div.2J

1st spawn. / Age-group	♂♂ VI	VII	VIII	IX	θ	?	Total	♀♀ VI	VII	VIII	IX	θ	?	Total
II	-	-	-	-	-	-	-	-	-	-	-	1	-	1
III	-	-	-	-	16	-	16	-	-	-	-	20	-	20
IV	-	-	-	-	69	-	69	-	-	-	-	49	-	49
V	-	-	-	-	115	-	115	-	-	-	-	93	-	93
VI	-	-	-	-	67	-	67	-	-	-	-	72	-	72
VII	3	5	-	-	99	3	110	2	7	-	-	83	1	93
VIII	1	1	2	-	41	5	50	1	5	3	-	42	1	52
IX	3	22	2	-	32	10	69	6	15	11	-	39	10	81
X	-	7	1	-	12	4	24	1	2	6	1	7	4	21
XI	-	2	2	-	3	1	8	1	4	3	-	2	1	11
XII	1	-	2	-	3	1	7	-	2	-	-	-	2	4
XIII	-	1	4	1	-	1	7	-	3	3	-	-	1	7
XIV	-	3	1	-	-	-	4	-	2	3	-	-	-	5
XV	-	-	1	-	-	-	1	-	2	3	1	-	-	6
XVI	-	2	2	-	-	1	5	-	1	1	-	-	-	2
XVII	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XVIII	-	-	-	-	-	-	-	-	-	1	-	-	-	1
XIX	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XX	-	-	-	-	-	1	1	-	-	-	-	-	-	-
XXI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XXII	-	-	-	-	-	-	-	-	-	-	1	-	-	1
No. observed							553							519

Subarea 3

A. Status of the Fisheries

I. Cod

Catches in this subarea totalled 68,709 tons, a considerable increase over 1965 catches. The principal reason for this increase was the otter trawler fishery with 60,616 tons (34,649 tons in 1965), while the dory vessels caught only 8,093 tons (14,324 tons in 1965).

The trawlers operated mainly in Div.3K, 3L, 3M, 3N, 3O, 3Pn and 3Ps. Best results were obtained in Div.3L (37,419 tons from March to November) and 3K (12,196 tons from March to October). The dory vessels fished in Div.3L, 3N, 3O and 3P with best results in 3L (5,620 tons from April to September).

Samples for biological study were obtained in Div.3K, 3L and 3M from 20 March to 28 November as follows:

Sample Group	Sample numbers	Date	Depth (m)	No lengths	No aged
Div.3K					
A	13-14-15	22-26 May	215-350	340	252
B	16-17-18-19	22-31 August	195-230	350	70
C	20-28-37	1-29 Sept.	195-330	255	48
D	41-42-43-44-46-47-49	10-28 Oct.	200-350	790	123
Div.3L					
E	1-2-3-4	20-23 March	180-210	491	135
F	22-23-24-25-26-29-30-31-32-33-34-35-38	5-30 Sept.	210-320	1,410	152
G	39-40-48-50-51	7-31 Oct.	230-320	400	47
H	52-54-55-56-57-58-59-61-62-63-64-65-66	1-28 Nov.	220-300	1,430	125
Div.3M					
I	6-7-8-9	25-31 March	420-460	825	275
J	10-12	2-4 April	446-460	225	177

a. Lengths (Fig. 3). Lengths ranged from 19 to 121 cm classes. Mean lengths were A - 50.0, B - 51.1, C - 52.3, D - 56.3, E - 52.2, F - 50.7, G - 51.9, H - 55.8, I - 61.7, J - 60.7.

b. Ages (Fig. 3). In Div.3K and 3L ages ranged from about 2 to 20 years with a marked predominance of the IV, V, VI and VII age-groups (1962, 1961, 1960 and 1959 year-classes). Ages 4, 5 and 6 (1962, 1961 and 1960 year-classes) were abundant in both divisions from March to November.

In Div.3M two samples caught in March and April had ages ranging from 3 to 13 years with a marked predominance of the VI, VII and VIII age-groups (1960, 1959 and 1958 year-classes). Mean ages were as follows: Div.3K: A - 6.0; B - 5.2; C - 5.5; D - 6.0; Div.3L: E - 5.7; F - 5.1; G - 4.8; H - 5.2 and Div.3M: I - 7.5; J - 7.4.

c. Growth is shown in the following tables of average lengths (figures in brackets are number of fish for each quarter of the year):

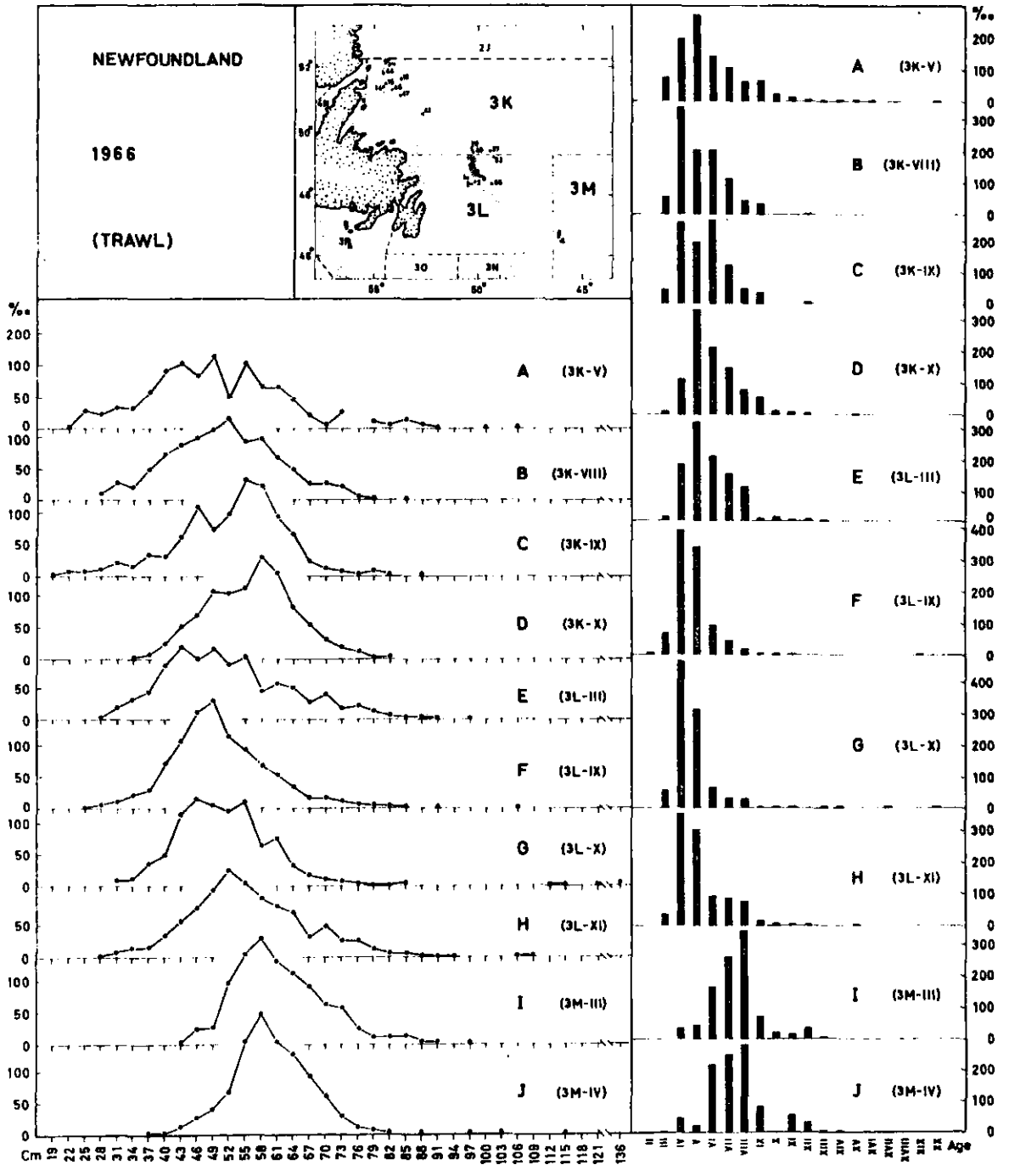

Fig. 3. Cod. Subarea 3. Length and age composition, March-November 1966.

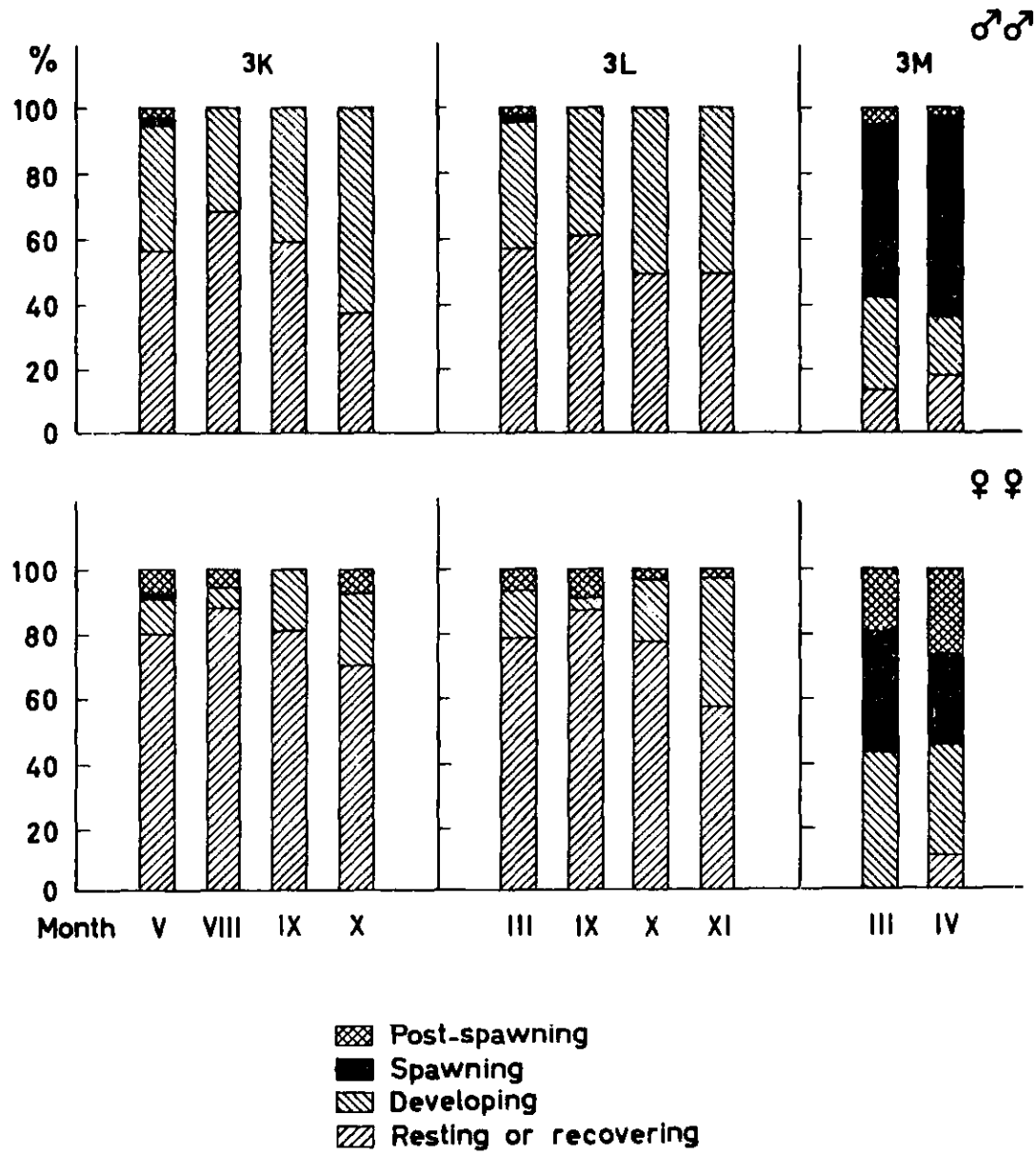

Fig. 4. Cod. Subarea 3. Stages of maturity, 1966.

Div.3K

Year-class	Age-group	2nd Quarter May	3rd Quarter August	3rd Quarter Sept.	4th Quarter October
1963	III	27.8 (14)	34.4	33.7 (8)	38.1 (3)
1962	IV	39.2 (47)	42.6	43.1 (38)	45.1 (18)
1961	V	45.4 (71)	51.4	52.6 (19)	51.4 (33)
1960	VI	53.3 (43)	57.0	57.5 (24)	58.6 (19)
1959	VII	57.1 (23)	62.5	61.6 (14)	62.1 (17)
1958	VIII	63.5 (17)	67.2	68.1 (9)	65.3 (13)
1957	IX	64.1 (17)	64.9	61.7 (5)	64.8 (10)
1956	X	73.3 (7)	-	-	70.1 (5)
1955	XI	76.5 (4)	-	-	71.3 (3)
1954	XII	83.7 (2)	79.0	79.0 (1)	82.0 (1)
1953	XIII	79.0 (1)	-	-	-
1952	XIV	80.2 (2)	-	-	-
1951	XV	79.0 (1)	-	-	115.0 (1)
1950	XVI	98.5 (2)	-	-	-
1949	XVII	-	-	-	-
1948	XVIII	-	-	-	-
1947	XIX	-	-	-	-
1946	XX	100.0 (1)	-	-	-

Div.3L

Year-class	Age-group	1st Quarter March	3rd Quarter September	4th Quarter October	4th Quarter November
1964	II	-	29.2 (4)	-	-
1963	III	30.6 (5)	39.6 (14)	39.6	39.2 (12)
1962	IV	38.7 (23)	45.1 (39)	47.5	48.8 (46)
1961	V	46.5 (36)	53.1 (35)	52.9	54.2 (31)
1960	VI	53.7 (25)	60.2 (20)	61.6	62.7 (14)
1959	VII	61.9 (22)	66.3 (20)	67.6	68.9 (21)
1958	VIII	69.1 (16)	73.2 (13)	71.1	72.2 (27)
1957	IX	80.8 (2)	72.5 (3)	79.9	78.4 (8)
1956	X	80.7 (3)	79.0 (1)	72.3	75.9 (3)
1955	XI	85.0 (1)	82.0 (1)	79.1	82.7 (4)
1954	XII	91.0 (1)	-	-	109.0 (1)
1953	XIII	91.0 (1)	-	115.0	- (1)
1952	XIV	-	-	112.0	- (1)
1951	XV	-	-	-	88.0 (1)
1950	XVI	-	-	-	-
1949	XVII	-	-	121.0	- (1)
1948	XVIII	-	-	-	-
1947	XIX	-	98.6 (2)	-	-
1946	XX	-	-	136.0	- (1)
1945	XXI	-	-	-	-

Div.3M

Year-class	Age-group	1st Quarter March	2nd Quarter April
1963	III	-	37.0 (1)
1962	IV	47.2 (16)	45.6 (11)
1961	V	50.5 (15)	49.0 (5)
1960	VI	56.9 (40)	56.7 (36)
1959	VII	58.6 (64)	57.4 (41)
1958	VIII	63.6 (90)	63.6 (48)
1957	IX	68.7 (23)	64.8 (15)
1956	X	74.7 (9)	-
1955	XI	72.8 (5)	73.0 (11)
1954	XII	79.8 (11)	75.2 (7)
1953	XIII	-	88.0 (1)
1952	XIV	74.3 (2)	115.0 (1)

d. Stage of maturity (Fig. 4). In Div.3K in May about 55% of the males and 80% of the females were in the recovering or resting stage. About 40% of the males were in the developing stage. By August about 70% of the males and 88% of the females were in the recovering stage. Yet in August about 30% of the males and 9% of the females were in the developing stage. In September and October the recovering and developing stages were the most abundant.

In Div.3L in March about 4% of the males only were spawning. During the month as in September, October and November, a large percentage of males and females were in the resting or recovering and developing stages.

In Div.3M in March about 50% of the males and 40% of the females were in the spawning stage and about 30% of the males and 40% of the females in the developing one. By April about 60% of the males and 30% of the females were in the spawning stage and a very low percentage of the males and about 30% of the females were in the recovering and post-spawning stages.

e. Age at first maturity

Div.3K

1st spawn. / Age-group	♂♂ VI	VII	VIII	θ	?	Total	♀♀ VI	VII	VIII	IX	θ	?	Total
III	-	-	-	13	-	13	-	-	-	-	12	-	12
IV	-	-	-	54	-	54	-	-	-	-	49	-	49
V	-	-	-	67	-	67	-	-	-	-	56	-	56
VI	-	-	-	40	-	40	-	-	-	-	46	-	46
VII	1	1	-	18	1	21	1	2	-	-	30	-	33
VIII	1	2	-	15	1	19	1	3	-	-	15	1	20
IX	-	2	2	8	2	14	-	5	-	-	10	2	17
X	-	3	-	4	-	7	-	1	1	-	3	-	5
XI	-	-	-	2	-	2	1	1	1	1	1	-	5
XII	-	-	-	1	-	1	-	1	1	-	1	-	3
XIII	-	-	-	-	-	-	-	-	-	-	1	-	1
XIV	-	-	1	-	-	1	-	-	1	-	-	-	1
XV	-	-	-	-	-	-	-	1	-	-	1	-	2
XVI	-	-	-	2	-	2	-	-	-	-	-	-	-
XVII	-	-	-	-	-	-	-	-	-	-	-	-	-
XVIII	-	-	-	-	-	-	-	-	-	-	-	-	-
XIX	-	-	-	-	-	-	-	-	-	-	-	-	-
XX	-	-	-	-	-	-	-	-	1	-	-	-	1
No. observed						241							251

Div.3L

1st spawn. / Age-group	♂♂ VI	VII	VIII	θ	?	Total	♀♀ VI	VII	VIII	IX	θ	?	Total
II	-	-	-	4	-	4	-	-	-	-	-	-	-
III	-	-	-	17	-	17	-	-	-	-	14	-	14
IV	-	-	-	59	-	59	-	-	-	-	49	-	49
V	-	-	-	40	-	40	-	-	-	-	62	-	62
VI	-	-	-	24	1	25	1	-	-	-	33	-	34
VII	-	-	-	25	-	25	2	6	-	-	28	2	38
VIII	1	11	1	13	-	26	2	2	1	-	23	2	30
IX	-	1	-	1	-	2	-	1	-	-	9	1	11
X	-	1	-	1	-	2	-	-	-	-	4	1	5
XI	-	1	1	2	-	4	1	-	-	-	1	-	2
XII	-	-	1	-	-	1	-	-	-	-	1	-	1
XIII	-	-	1	-	-	1	-	-	-	-	1	-	1
XIV	-	-	-	1	-	1	-	-	-	-	-	-	-
XV	-	-	-	-	-	-	-	1	-	-	-	-	1
XVII	-	-	-	-	-	-	-	-	-	1	-	-	1
XIX	-	-	-	-	-	-	-	-	1	-	-	1	2
XX	-	-	-	-	-	-	-	-	-	-	-	1	1
No. observed						207							252

Div.3M

1st spawn. / Age-group	♂♂ VI	VII	VIII	θ	?	Total	♀♀ VI	VII	VIII	θ	?	Total
III	-	-	-	1	-	1	-	-	-	-	-	-
IV	-	-	-	24	-	24	-	-	-	3	-	3
V	-	-	-	15	-	15	-	-	-	5	-	5
VI	2	-	-	58	-	60	-	-	-	16	-	16
VII	3	5	-	67	-	75	1	2	-	26	1	30
VIII	5	8	-	77	-	90	6	3	1	38	-	48
IX	1	3	-	21	1	26	-	3	-	9	-	12
X	-	1	-	2	-	3	-	2	-	3	1	6
XI	-	-	-	10	-	10	-	3	-	3	-	6
XII	2	5	2	2	3	14	2	1	1	-	-	4
XIII	-	-	-	-	-	-	-	-	-	1	-	1
XIV	-	1	-	-	1	2	-	-	-	1	-	1
No. observed						320						132

Subarea 4

A. Status of the Fisheries

I. Cod

In 1966, as in 1965, only otter trawlers operated in Subarea 4. They caught 10,830 tons, a small decrease from the fishery in 1965 which took 14,665 tons. Catches were taken from January to August in Div.4R (10,361 tons), 4S (331 tons) and 4Vn (138 tons).

Samples for biological study were obtained in Div.4R in August as follows:

Sample Group	Sample numbers	Date	Depth (m)	No Lengths	No Aged
A	1-2-3-4	26-29 Aug.	50-100	255	105

a. Lengths (Fig. 5). Lengths ranged from 28 to 127 cm classes. Mean length was A - 57.0.

b. Ages (Fig. 5). Ages ranged from 3 to 21 years with a marked dominance of the IV, V, VI, VII, VIII and IX age-groups (1962, 1961, 1960, 1959, 1958 and 1957 year-classes). Mean age was A - 6.8.

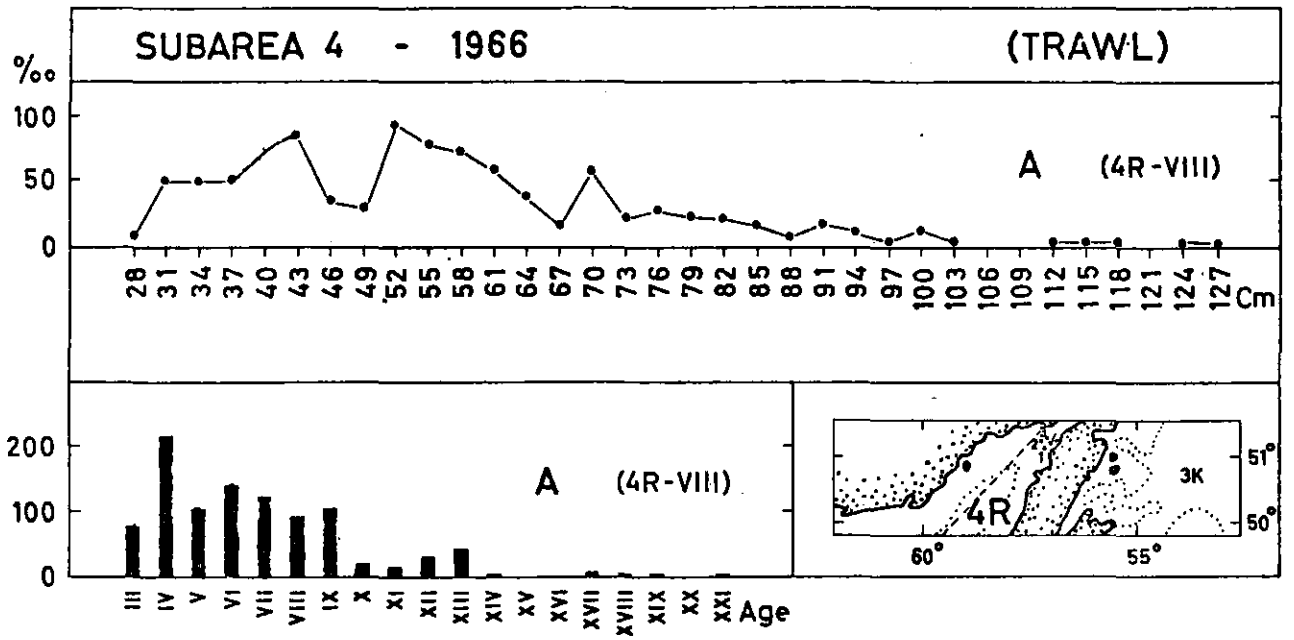

Fig. 5. Cod. Subarea 4. Length and age composition, August 1966.

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

Year-class	Div.4R Age-group	3rd Quarter August
1963	III	32.0 (3)
1962	IV	40.0 (17)
1961	V	47.4 (10)
1960	VI	53.8 (15)
1959	VII	59.8 (14)
1958	VIII	64.2 (11)
1957	IX	73.7 (16)
1956	X	76.8 (4)
1955	XI	81.2 (2)
1954	XII	96.6 (3)
1953	XIII	77.6 (5)
1952	XIV	112.0 (1)
1951	XV	-
1950	XVI	-
1949	XVII	91.0 (1)
1948	XVIII	118.0 (1)
1947	XIX	115.0 (1)
1946	XX	-
1945	XXI	127.0 (1)

d. Stage of maturity (Fig. 6). About 50% of the males and 75% of the females were in the resting or recovering stages. Almost 40% of the males and 5% of the females were also in the developing stage while very few (about 4%) of both were in the spawning stage.

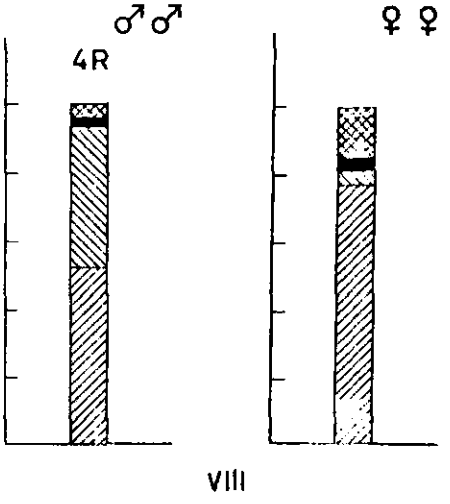

Fig. 6. Cod. Subarea 4. Stages of maturity, 1966.

e. Age at first maturity

Div.4R

1st spawn. / Age-group	♂♂ VII	♂♂ θ	♂♂ Total	♀♀ VII	♀♀ VIII	♀♀ X	♀♀ θ	♀♀ Total
III	-	1	1	-	-	-	2	2
IV	-	13	13	-	-	-	4	4
V	-	7	7	-	-	-	3	3
VI	-	8	8	-	-	-	7	7
VII	-	7	7	-	-	-	7	7
VIII	-	3	3	1	-	-	7	8
IX	1	6	7	-	-	-	9	9
X	-	1	1	-	1	-	2	3
XI	-	1	1	-	-	-	1	1
XII	-	1	1	-	-	-	2	2
XIII	-	2	2	-	-	1	2	3
XIV	-	1	1	-	-	-	-	-
XV	-	-	-	-	-	-	-	-
XVI	-	-	-	-	-	-	-	-
XVII	-	1	1	-	-	-	-	-
XVIII	-	-	-	-	-	-	1	1
XIX	-	-	-	-	-	1	-	1
XX	-	-	-	-	-	-	-	-
XXI	-	1	1	-	-	-	-	-
No. observed			54					51

IX. Spanish Research Report, 1966

by O. Rodriguez Martin

1. Statistical Information

A total of 23 trawlers and 106 pair trawlers (these vessels represent only 53 gears) have operated in the ICNAF Area during the year 1966. Total tonnage of these vessels is about 68,000 tons. About 3,725 fishermen make up the crews. Total catch was 241,000 tons, of which 96% was cod, 2% haddock, and 2% other species (white hake and pollock).

A comparison of the catches of trawlers and pair trawlers from 1952 to 1966 (Fig. 1) shows a consistent and converging increase until 1964 when catches of the pair trawlers equal those of the trawlers. In 1965 and 1966, pair trawler catches showed a steady increase over the trawler catches. The Spanish cod fleet, fishing only for salt and dry cod, requires the best in quality of species and sizes of fish. Cod is the only species sought, other fishes (haddock, pollock, white hake, etc.) being ignored.

2. Discards

Information about discards provided by the masters of the trawlers has been submitted on ICNAF Statistics Form 4.

3. Recaptured Tags (Res.Doc.67/33)

During the present year, information has been received about 93 tags recaptured by Spanish fishermen. Most of them come from Canada, USSR and Germany. All these tags were returned to their countries of origin and reward of 50-Pts. was paid to the fishermen who delivered them.

4. Joint Inspection

During May 1967, two inspection officers, one Portuguese and the other one Spanish, on board a Spanish ship, carried out a joint inspection of the Portuguese and Spanish fishing vessels which operate in ICNAF waters.

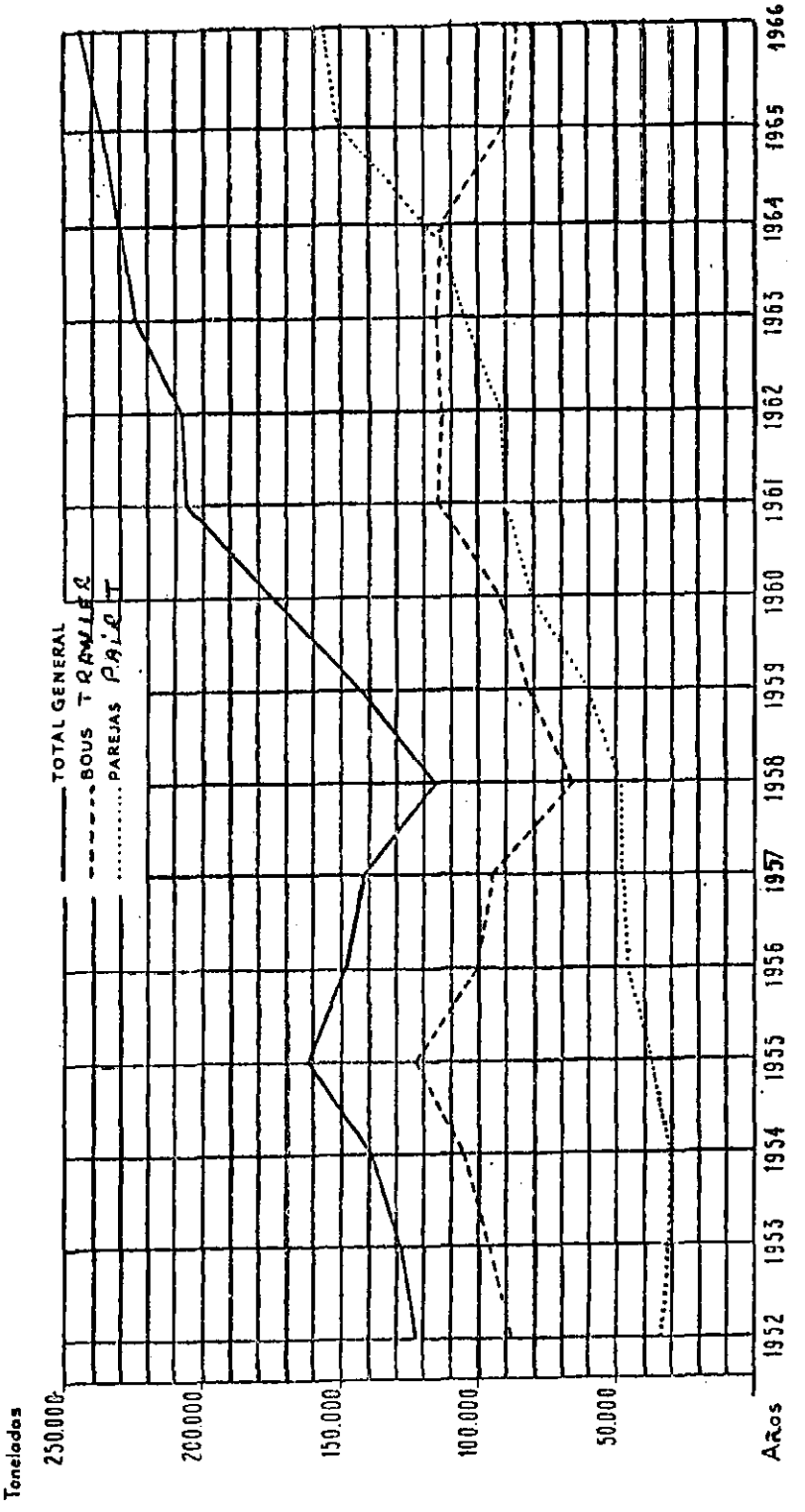

Fig. 1. Catches of the Spanish fleet in the Northwest Atlantic.

Table 1. Catches in tons, 1966.

ICNAF Div.	1965			1966		
	Trawler	Pair Trawler	Total	Trawler	Pair Trawler	Total
1B	622		622		896	896
1C	29		29		507	507
1D					2,190	2,190
1E				43		43
Total Subarea 1	651		651	43	3,593	3,636
2G	832		832	181		181
2H	6,827		6,827	4,600		4,600
2J	51,822		51,822	43,290	550	43,840
Total Subarea 2	59,481		59,481	48,071	550	48,621
3K	9,950		9,950	9,304	8	9,312
3L	11,014	21,076	32,090	20,053	13,164	33,217
3M	1,538		1,538	4,275		4,275
3N	2,111	28,495	30,606	2,765	29,935	32,700
3O	337	35,646	35,983	270	20,838	21,108
3P	2,366	13,496	15,862	2,445	23,684	26,129
Total Subarea 3	27,316	98,713	126,029	39,112	87,629	126,741
4R	219		219	1,060	50	1,110
4T	24	19	43		13	13
4V	1,899	32,579	34,478	40	22,558	22,598
4W		12,891	12,891		27,997	27,997
4X		148	148		961	961
Total Subarea 4	2,142	45,637	47,779	1,100	51,579	52,679
5Z		69	69		9,531	9,531
Total Subarea 5		69	69		9,531	9,531
Total	89,590	144,419	234,009	88,326	152,882	241,208

STATISTICAL ICNAF - 1966

Concepts	Otter Trawlers	Pair Trawlers	Total
No. of vessels	23	106[1]	129
Tons R.B.	29,828.60	38,152.07	67,980.67
Crew	1,318	2,407	3,725
No. Days on Grounds	5,472	11,780	17,252
No. Days Fished	4,643	9,544	14,187
No. Sets	21,381	25,002	46,383
No. Trawl Hours	64,700.25	91,196.35	155,897
Catches			
Cod	88,174.5	143,835	232,009.5
Haddock	93.6	6,274.2	6,367.8
White Hake	18.6	137.4	156
Pollock	36.9	2,630.4	2,667.3
Total Catches	88,323.6	152,877	241,200.6

Applied Conversion Factor: 3

[1]As these vessels are "pair trawlers" they represent only 53 trawl gears

Data supplied by Spanish enterprise PYSBE

Subareas 2 and 3

Fishing Average by Vessel

	Departure Date	Days Absent	Days on Grounds	Landings (tons)	Catch by day on Grounds	(1) a	b	c	d	e	h
1965											
1st Trip (12 vessels)	26 January	151	118	1,000	8.50	1.78	1.48	11.10	80.94	4.48	0.22
2nd Trip (10 vessels)	1 July	162	131	500	3.79	2.45	2.14	16.65	70.59	4.58	3.59
1966											
1st Trip (12 vessels)	19 January	175	144	990	6.88	1.65	1.52	9.62	77.92	9.05	0.24
2nd Trip (10 vessels)	18 July	149	127	614	4.84	1.86	2.60	18.55	62.55	7.89	6.55

(1) a = big cod, b = middling size, c = small size, d = smaller size
e = smallest size, h = haddock

X. USSR Research Report, 1966

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

The total catch obtained by the USSR fleet in the ICNAF Area in 1966 was 711,201 tons (Table 1), which was 141,896 tons less than in 1965.

Table 1. Species composition of USSR catches (in metric tons) in the Convention Area, 1966.

	Subarea					Total Catch	
Species	1	2	3	4	5	tons	%
Herring	-	-	-	2,227	117,346	119,573	16.5
Argentine	-	-	119	14,983	33,938	49,040	6.9
Cod	1,070	32,305	49,325	10,977	16,755	110,432	15.1
Haddock	-	-	4,435	20,566	48,409	73,410	10.7
Pollock (saithe)	-	-	689	7,254	2,611	10,554	1.5
Silver hake	-	-	-	10,323	121,373	131,696	18.5
Red hake	-	-	44	2,173	82,889	85,106	12.0
Flounders	-	1,205	24,318	13,817	938	40,278	5.6
Halibut	12	220	51	130	60	473	0.1
Redfish	74	2,305	31,464	13,943	939	48,725	7.0
Wolffish	-	102	15	77	312	506	0.1
Ocean pout	-	-	-	-	6,231	6,231	0.9
Scup	-	-	-	-	257	257	0.1
Mackerel	-	-	-	1,234	5,446	6,680	0.9
Butterfish	-	-	-	-	3,865	3,865	0.5
Sea robins	-	-	-	-	98	98	0.1
Angler fish	-	-	-	640	692	1,332	0.3
Dogfish and skate	-	-	-	1,534	5,254	6,788	0.9
Squid	-	-	-	104	341	445	0.1
Other and unidentified	17	1,071	4,642	1,378	8,604	15,712	2.2
Total	1,173	37,208	115,102	101,360	456,358	711,201	100.0

The catch of silver hake decreased considerably (331,418 tons or 38.8% of the total catch in 1965, against 131,696 or 18.5% of the total catch in 1966).

Catches of herring, argentine, pollock (saithe), mackerel and flounders increased.

Subarea 1

A. Status of the Fisheries

In July, a large refrigerator trawler fished for a short period in Subarea 1, but catches were poor; the total catch of cod amounted to 224 tons,

the average catch was 0.6 tons per one hour of trawling. Most of the trawl hauls were made in Div.1C. In addition, research vessels took part in the investigations in Subarea 1.

B. Special Research Studies

I. Distribution, feeding, age and sizes of cod

The R/V *Pobeda* made two cruises, one in May-August and the other in September-November.

In May-July, the area lying to the north of 62° was not covered with ice. Oceanographic investigations showed that the water temperature in the near-bottom layers was much higher than that in more southern areas. This resulted in the cod appearing in the shallow areas north of 62°. Thus, in May-June, cod commercial concentrations were observed in Div.1B, 1C and 1D at depths of 80-120 m, whereas cod catches exceeding one ton per trawl haul were taken in Div.1E at depths of 200-350 m.

In September-November, after warming of the shallow waters, cod were in commercial concentrations at depths of 40-120 m also in Div.1E. Throughout their summer-autumn feeding, cod were concentrated mainly in the areas rich with food species, such as Euphausiidae, sand launce, shrimp, the young of redfish in the temperatures of 1.0°-4.5°C in the off-bottom layers.

Thus, in May-June, considerable concentrations of Euphausiidae, and of cod feeding on Euphausiidae, were discovered on the western slopes of banks (from Dana Bank to Store Hellefiske Bank), at the boundary between cold and warm waters in depths from 100-300 m. In September-November, cod feeding on Euphausiidae were found in concentrations in the area of Holsteinsborg Deep and Banana Bank at depths of 120-300 m. It should be noted that during the period of feeding on Euphausiidae, the West Greenland cod usually keep over the bottom. At that time, the Euphausiidae and fish stocks are recorded by the fish finder in water masses. Catches in the bottom trawl were small in number (from several hundred kg up to one or two tons per hour of trawling).

Of the small shoaling fish, the sand launce is the main food of cod. In July, dense concentrations of cod were discovered feeding intensively on sand launce on the fishing grounds in Div.1D and 1E (from Frederikshaab Bank to Fyllas Bank). In September-November, considerable concentrations of cod were found in the sand launce spawning area, mainly on Fyllas Bank at depths 40-80 m, and cod catches were from 0.1 tons to 3-5 tons per hour of trawling.

The young of redfish (4-5 cm long) were a basic food of cod. In autumn, cod concentrations were observed along the course of drift and settlement of the redfish young, *i.e.* in areas of Nanortalik Bank and Banana Bank at depths of 90-180 m.

In May-August, trawl catches consisted mainly of cod of 50-70 cm average length. Small cod of 35-50 cm in length were found mainly to the south, *i.e.* from Cape Farewell to Banana Bank and especially in the area of Frederikshaab Bank. In May, large cod over 70 cm in length made up a considerable part of the catches in Div.1C, 1D and 1E. In June-July and following months, large cod were dispersed throughout the area and their percentage in the catches was not high.

In the first half-year, individuals of the 1961 year-class (5 years old and 52-60 cm average length) persisted in the catches. In all divisions, these individuals made up from 30 to 88% of the total number of specimens caught. Cod (63-70 cm long) of the 1960 year-class made up from 3 to 40%. In May-June, 6-year-old fish were mainly on the Biezymyanaya and Frederikshaab Banks and in July-August in the area from Banana Bank to Store Hellefiske Bank. Four-year-old cod (43-49 cm long) ranked third in numbers in the catches. Sometimes the four-year-olds made up to 40% of all the fish caught, especially on Biezymyanaya and Frederikshaab Banks. It should be noted that the 1962 year-class of cod is very widely distributed. Cod more than 6 years of age were seldom seen. Nine year-olds, representing the rich 1957 year-class, averaged about 12%, 7-8 year-olds from 1 to 11% of the fish caught.

In the second half-year, the age composition in the catches changed considerably. Specimens 6 years and older were dispersed throughout the area and were rarely caught except in Div.1D. Many young specimens of the 1962 and 1963 year-classes were found in catches (mean length of the 4 year olds reached 46-53 cm and that of the 3 year olds, 34-46 cm).

In May-July, 2,000 cod and in September-November 2,500 cod were tagged. Throughout 1966, the number of the specimens recaptured was 1.2% of the fish tagged and released in May-July. Some of the tagged fish were caught immediately in the area of tagging. Thus, many specimens released on Banana and Fylla Banks in May-June remained there during the summer and autumn months. But, some tagged specimens were caught far to the north. Thus, the 72 cm cod tagged on Fyllas Bank on 27 May were caught in September in the eastern part of Store Hellefiske Bank. Specimens tagged in the area of Holsteinsborg Deep and in the central part of Store Hellefiske Bank in May-July were caught in the northern part of Store Hellefiske Bank and in the area of Disko Island in August-September.

Subarea 2

A. Status of the Fisheries

I. General

The annual catch is given in Table 2.

Table 2. Annual catch and catch per one hour of trawling for Subarea 2 (in metric tons).

Divisions	Total catch by all types of trawlers					Average catch per one hour of trawling BMRT
	Cod	Redfish	Flounders	Others	Total	
2G	268	22	5	5	300	-
2H	6,032	438	368	243	7,081	2.96
2J	26,005	1,845	1,052	925	29,827	3.08
Subarea 2	32,305	2,305	1,425	1,173	37,208	3.05

In 1966, the catch in Div.2H increased slightly compared to that for the other divisions of Subarea 2. Catch in Div.2J was as usual the highest. In 1965, the ratio of catches in Div.2J and 2H was 10:1, but in 1966 only 4:1.

II. Cod

The increased commercial importance of Div.2H was caused by the peculiarities in cod distribution in 1966. In the winter of 1965-1966, the water temperature on the Labrador Shelf was considerably higher than that observed for a number of years and, consequently, the first commercial concentrations of cod were found earlier than usual.

In 1966, the average catch per one hour of trawling (BMRT) was 3.05 tons in Subarea 2, while in 1965 it was 3.27 tons. Such a decrease in catch was partially due to the fact that in 1966 the fleet was working in the area where the bottom was unfavourable for trawling (2H). It can also be explained by a decrease in the number of cod of the Labrador stock caused by an intensive fishery in previous years. As shown in Table 3, the average length of the cod in trawl catches is gradually decreasing. For the last five years, the

Table 3. Average length (cm) of cod in Div.2J.

Year	January	February	May	June	October
1960	57.3	57.2	52.1	49.3	55.4
1964	52.2	53.9	51.3	48.8	53.2
1965	51.5	54.2	51.3	48.8	55.4
1966	51.9	52.2	47.7	44.4	50.9

average age and weight of cod has declined due to the almost complete disappearance of the older individuals in the trawl catches (Table 4). The young cod survey carried out by the Soviet ichthyologists in Subareas 2 and 3 showed that the abundance of new year-classes of the Labrador cod fluctuated only slightly. Thus, every year the commercial stock is recruited by approximately an equal amount of the growing fish. Table 5 shows the average catches of

Table 4. Age composition (%) of cod in Div.2J in February 1961 and 1966.

Year	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Avg age	Avg wt (g)
1961	14	47	114	169	143	97	93	70	60	70	53	37	26	6	7	3	9.5	2,197
1966	56	230	200	246	150	96	16	3	3	-	-	-	-	-	-	-	6.6	1,196

Table 5. Average catch (number of individuals) per one hour of cod trawling of different year-classes from 0+ to 3+.

Year-	0+						1+						2+						3+					
Class	3K	3L	3M	3N	3O	3P	3K	3L	3M	3N	3O	3P	3K	3L	3M	3N	3O	3P	3K	3L	3M	3N	3O	3P
1958																			10	10	4	1	-	2
1959													21	11	7	8	1	4	15	10	42	1	1	1
1960							5	2	1	3	-	3	11	8	8	1	2	5	11	8	1	1	-	1
1961	1	1	3	1	1	6	3	4	1	4	3	6	20	28	3	5	1	6	24	11	1	4	1	1
1962	1	1	8	1	7	42	2	5	4	8	2	7	15	40	20	18	2	12	24	13	-	6	1	2
1963	1	2	1	1	1	3	1	8	4	5	1	13	36	31	-	30	1	17						
1964	1	1	1	41	24	31	3	15	-	137	13	22												
1965	1	1	-	1	1	5																		

young cod per one hour of trawling determined by a special fish counting trawl for all the divisions of Subarea 3. Relative abundance of the young of the Labrador cod stock may be determined from the catches of young on the North Newfoundland Bank (3K).

Cod larvae are brought there by the water currents from the main spawning grounds situated in North Labrador. The young cod inhabit the waters of the North Labrador Bank during their first years of life, then migrate gradually to the north and return to the Labrador Shelf. As seen from Table 5, the bulk of cod taken by the fish-counting trawler was age 2+ and 3+; the average catch of such individuals is almost always the same. Unlike the cod stock of the West Greenland or of the Barents Sea, fluctuations are not normal for the Labrador cod stock.

This is caused by relatively stable conditions on the spawning grounds and in the manner of the drift of eggs and larvae of the Labrador cod stock. Eggs and larvae are brought by the current to the south (but not to the north, as is the case with the cod eggs and larvae near West Greenland and in the Barents Sea). Thus, the Labrador cod fingerlings cannot be driven into the zone of Arctic waters where they die immediately. Stable annual recruitment of the Labrador cod stock should result in an almost invariable age-size composition.

But, taking into account some decrease in the average length and age, it can be supposed that fishery has a certain effect on the stock. This effect is still very insignificant, however, and the stocks of the Labrador cod are

in comparatively good condition. Cod is fished intensively by large vessels in the winter-spring months; in the second half of the year cod come to the coastal shallow areas, gulfs and straits. In the first half of the year, cod fishing is impeded by floating ice. Cod spawning near North Labrador seems to be protected by natural conditions. Thus, there are no grounds for expecting a sharp decrease in the abundance of the Labrador cod or in the productivity of their fishery in the near future. In 1968, the average catch per one hour of trawling in Subarea 2 might be expected to be lower in comparison with the level of 1967, but not more than by 10-12%.

III. Flounders

Commercial vessels fished on the spawning grounds of witch flounder *(Glyptocephalus cynoglossus)* in Div.2J, at approximately 53°30'N and 52°15'W. Spawning was observed mainly in March at depths 550-560 m. The mode of the size range of fish was 57 cm.

B. Special Research Studies

I. Environmental Studies

1. Oceanography. Scouting and research vessels conducted observations on the temperature and the chemical composition of water. According to observations made along Section 8A, the water temperature on the Labrador Shelf remained much higher than the average for many years; the cold Labrador Current became weaker. By August, positive temperature anomalies became somewhat lower, but by January they rose again due to slow irradiation in the atmosphere. A detailed characteristic of oceanographic conditions in Subarea 2 is given in a special paper.

II. Tagging

About 5,000 specimens, mainly cod, were tagged by Soviet ichthyologists. The results of tagging for 1960-1966 are also given in a special paper.

III. Experiments on trawl selectivity

Trawl selectivity without chafing gear and with chafing gear of the Polish type was determined by a group of scientists from PINRO in Div.2J, where the commercial trawler *Vitebsk* operated. Eighty experimental trawlings were made, and all the fish caught were measured. Results showed that the chafing gear proposed by the Polish specialists differed in selectivity very slightly from that of the USSR type. Detailed results of the experiments are given in a special paper.

Subarea 3

A. Status of the Fisheries

I. General Outline

The annual catch is given in Table 6.

Table 6. The total catch and the catch per one hour of trawling in Subarea 3 (in metric tons).

Div.	General catch by all types of trawlers					General catch per one hour of trawling BMRT
	Cod	Redfish	Flounders	Others	Total	
3K	3,610	2,951	1,650	465	8,676	2.41
3L	888	282	148	98	1,416	1.78
3M	5,138	6,954	4,003	1,061	17,156	1.07
3N	31,596	5,851	10,091	1,499	49,037	2.19
3O	7,427	14,667	8,059	6,420	36,573	2.52
3P	666	759	418	401	2,244	2.29
Subarea 3	49,325	31,464	24,369	9,944	115,102	2.33

Compared to 1965, the importance of the fishery on the southern slopes of the Grand Bank (3N and 3O) rose considerably, but there was some decrease in catch on Flemish Cap Bank (3M) and in Div.3K and 3L.

II. Cod

The bulk of the commercial trawl catches consisted of individuals 50-60 cm in length. In July 1966, in Div.3N, the mean length of cod was 59.3 cm.

III. Redfish

In 1966, Soviet trawlers caught redfish mainly to the south of the Grand Bank. The fishery has almost ceased on Flemish Cap Bank, where the redfish stock *(Sebastes mentella)* isolated and fished for a long time has decreased considerably in number. It should be noted that the redfish age-size composition does not change despite the intensive and long-time fishing (Table 7). This peculiarity of the redfish is common in all other areas of the North Atlantic.

Table 7. Mean length (cm) of redfish on Flemish Cap Bank in August.

Year	Male	Female
1962	33.37	35.31
1964	33.37	35.14
1966	33.69	36.09

IV. Flounders

American plaice *(Hippoglossoides platessoides)* formed the bulk of flounders caught on the southern slope of the Grand Bank. Of the 1,500 specimens measured in Div.3N in December, 50% were from 40 to 50 cm in length.

B. Special Research Studies

I. Environmental Studies

Research and scouting vessels *Sevastopol, Kreml, Rossia, Pobeda, Novorossijsk* made temperature measurements on standard oceanographic Sections 1A, 2A, 3A and in all the areas where commercial fish concentrations were discovered. On some sections, the oxygen and nitrogen content and salinity rate were also determined. The main results of oceanographic observations are given in a special paper.

II. Biological Studies

In May-June, samples of fish eggs and larvae were taken on the Grand Bank to determine more exactly the area of haddock mass spawning and the areas of dispersion of their developing eggs and larvae. The samples collected are being worked up.

III. Counting of the Young

As in the previous five years, counts of young cod and haddock were made in Subareas 2 and 3. It was found that, during the last few years, poor year-classes of haddock were found on the Grand Bank. Table 5 shows that there was an extremely high abundance of young cod of the 1964 year-class on the south of the Grand Bank and on St. Pierre Bank (Div.3O and 3P and especially 3N). There is no doubt that, upon reaching commercial size in 1968-1969, cod of that extremely abundant year-class should increase the catches on the Grand Bank. At the same time, the mean length of cod in trawl catches will be somewhat less due to a strong recruitment to the stock by the young fish.

Subarea 4

A. Status of the Fisheries

Silver hake

In 1966, the catches of silver hake continued to decrease sharply and were only 10,323 tons (Table 8). The reduction in catches is caused by a decrease in commercial concentrations on the Scotian Shelf during all seasons of the year. As was noted in 1965, that fact can be explained by a decrease in the stock abundance. The decrease in number was caused by the entry into the fishery of a series of poor year-classes of 1961-1964.

Table 8. Catches of silver hake by the USSR commercial fleet in Subarea 4 (in thousand tons).

Year	1962	1963	1964	1965	1966
Catch	8.8	123.0	81.1	50.0	10.3

Silver hake were caught on the slopes of the banks of the Scotian Shelf from May to the end of October, but, as a rule, the catches were not high.

In the near future, hake abundance will, apparently, be at a low level. This fact could be due to poorer conditions for silver hake reproduction and living with the cooling of waters on the Scotian Shelf.

Haddock

In 1966, haddock catches were 20,566 tons (Table 9). Haddock concentrations were less dense and stable than in 1965.

Table 9. Haddock catches by the USSR commercial fleet in Subarea 4 (in thousand tons).

Year	1962	1963	1964	1965	1966
Catch	2.6	3.7	5.5	45.5	20.6

In May-July, haddock were caught with argentine, flounder and pollock on the continental slope. In August-September, haddock were caught in Sable Island shallows, but in considerably less numbers than in 1965.

Argentines

Argentines were caught along the slopes of the shelf from Banquereau to Browns Banks, the bulk being taken on the slopes of Browns Bank. In 1966, argentine catches reached 14,983 tons (Table 10).

Table 10. Argentine catches by the USSR commercial fleet in Subarea 4 (thousand tons).

Year	1963	1964	1965	1966
Catch	8.1	4.9	5.6	15.0

Argentine, from 19 to 45 cm long, were taken in the catches by research-scouting vessels.

B. Special Research Studies

I. Environmental Studies

1. Oceanography. In 1966, 8 cruises were made by research and scouting vessels in Div.4X and 4W for the purpose of studying mid-year and seasonal changes in hydrographic conditions over the Scotian Shelf. Observations were made on standard sections and stations (Fig. 1).

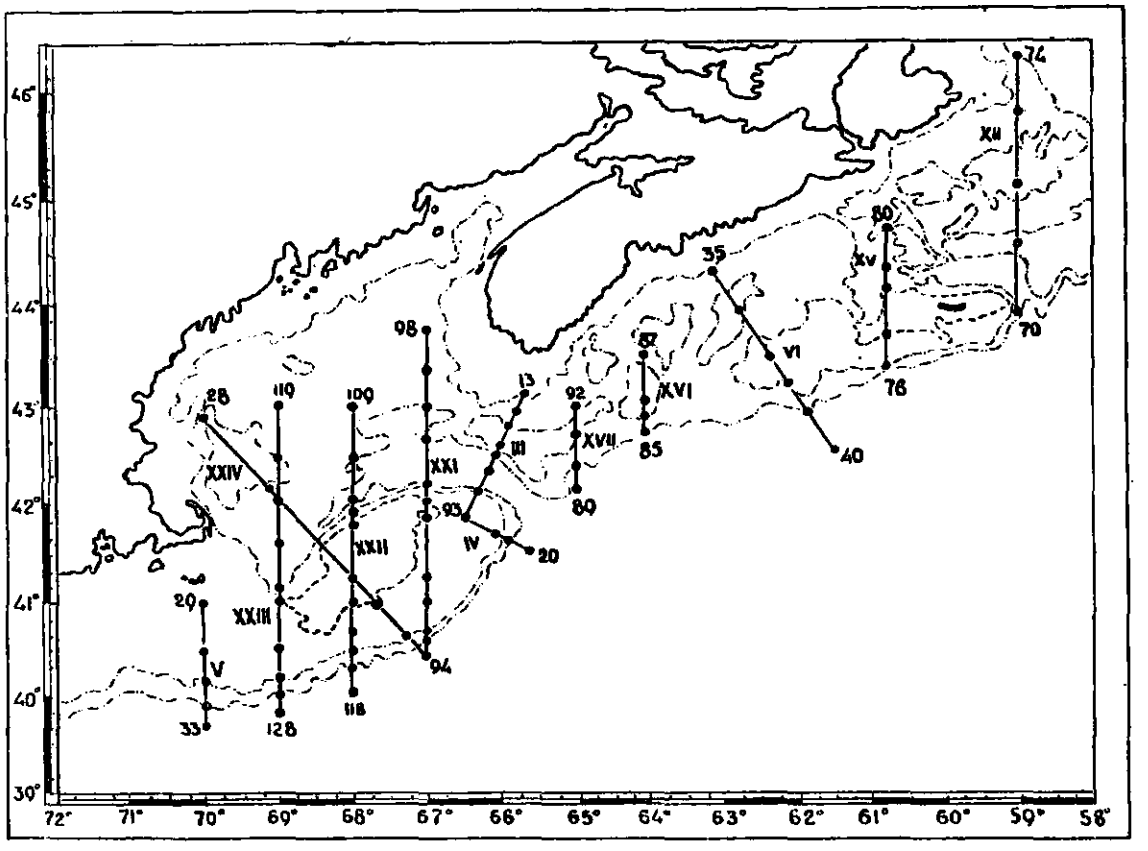

Fig. 1. Location of standard sections.

As in previous years the minimum temperature in the intermediate cold layer, the depth of occurrence of the 5° isotherm and the average temperature in the layer from 100 m to bottom were determined. It was found that the process of cooling begun several years ago continued in 1966.

The Halifax section (Fig. 2) (completed 6 times during the year) shows that, in January, the water temperature in the near bottom layers in the central deep waters of the Scotian Shelf was higher than 5°C and, in other months, was below 5°C.

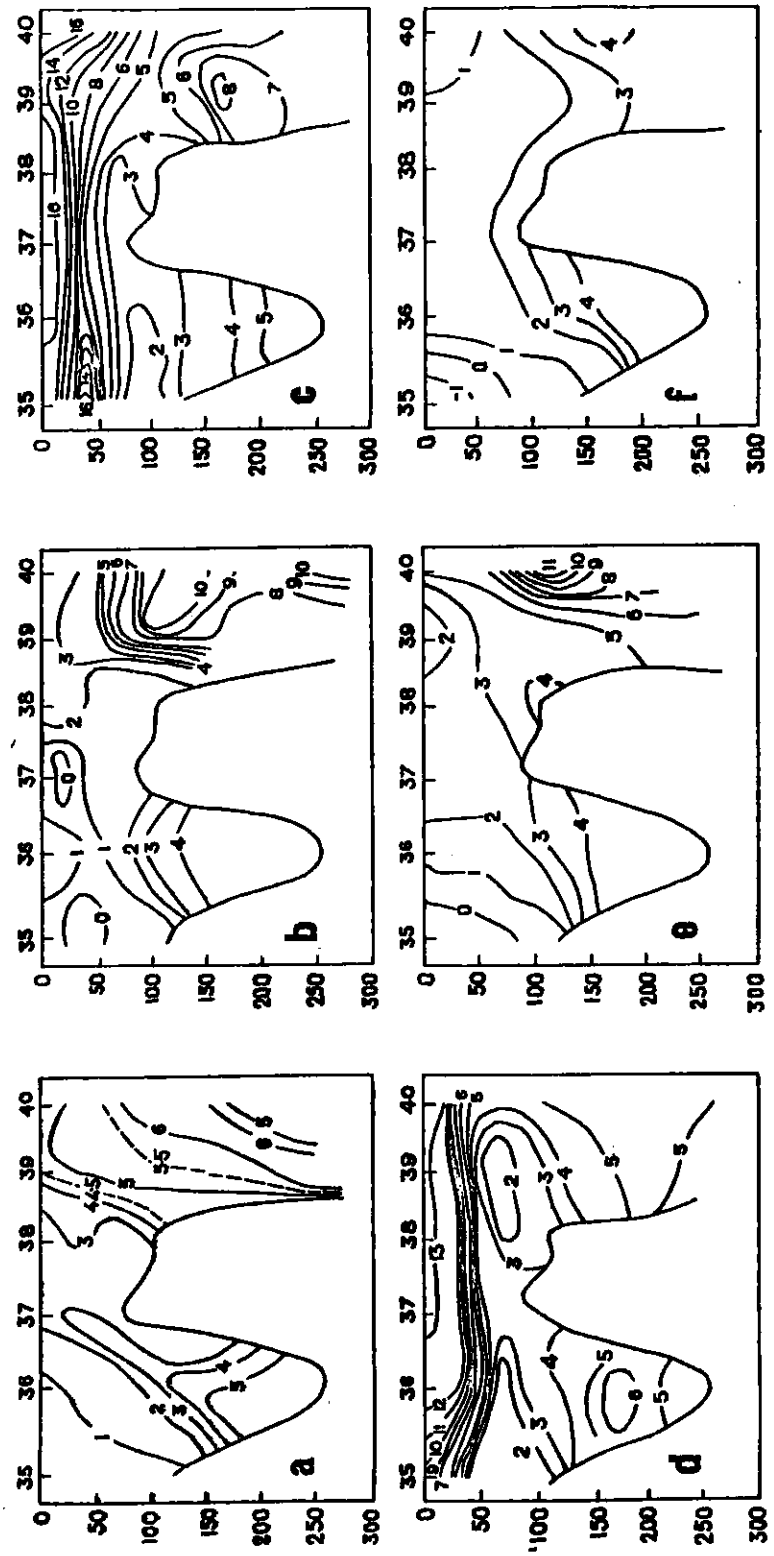

Fig. 2. Distribution of water temperatures in the Halifax section, 1966: (a) 28-30 January, (b) 5-10 April, (c) 4-5 August, (d) 10-11 October, (e) 6-10 February, (f) 24-25 February.

In winter and spring, the water temperature in the off-bottom layer between LaHave and Emerald Bank was 1.3° below that in the winter and spring of 1965.

The average temperature in the 100 m - bottom layer was also considerably lower than in 1965 (in winter, by 2.3°; in spring, by 0.5°; in summer, by 1.3°). In autumn, the difference was not observed.

In February-March, the penetration of waters from the slopes to the shelf was investigated in Subarea 4.

Detailed results of these investigations are given in a special paper.

II. Biological Studies

Silver hake. From June to August in Div.4W the length of hake caught ranged from 20 to 60 cm. Individuals 28-34 cm long were dominant. In July, the mean length was 31.8 cm and in August, 32.5 cm. As in two previous years, the three-year-olds (22.4%), the four-year-olds (41.0%) and the five-year-olds (23.8%) were the most abundant.

Haddock. From June to October, haddock from 28 to 40 cm in length were dominant in the Sable Island area. In July, the mean length of haddock was 37.0 cm, in August - 33.5 cm and in October - 38.9 cm.

From July to September 1966, the otoliths of 793 haddock were collected and studied to determine the age composition. In addition, in November 1965, the age of 100 specimens was determined.

Table 11. Haddock age composition in catches by scouting and commercial vessels in the Sable Island area in 1965-1966 (%).

		Age							No. of
Year	Month	1	2	3	4	5	6	7	specimens
1965	November	-	-	3.0	29.0	42.0	23.0	3.0	100
1966	July-September	2.0	6.5	52.2	25.0	10.3	3.1	0.9	793

The analysis of the age composition of fish caught in 1966 confirmed the conclusions of the Canadian investigators that there was a relatively high abundance of the 1963 year-class.

Subarea 5

A. Status of the Fisheries

I. Silver Hake

Silver hake catches on Georges Bank amounted to 121,373 tons (Table 12).

Table 12. Silver hake catches by the USSR commercial fleet in Div.5Z (thousand tons).

Year	1962	1963	1964	1965	1966
Catch	41.9	107.4	163.3	281.4	121.4

The decrease in commercial silver hake concentrations on Georges Bank has continued since 1964. In the summers of 1962-1963, the most dense concentrations including pre-spawning and spawning ones were observed on the southern slopes. In winter, concentrations were found to the north of Georges Bank in the Gulf of Maine. But, since 1964, hake concentrations have not been seen in winter in the Gulf of Maine, and these concentrations have decreased gradually in the summer on the southern slopes. In 1966, silver hake concentrations were dispersed and unstable in spite of the favourable oceanographic conditions observed in that area.

In 1966, the bulk of silver hake was caught to the southwest of the ICNAF Area in the Hudson Canyon.

In the winter and spring of 1966, silver hake were taken as by-catch in the red hake catches taken on the slopes of Georges Bank to the west of 69°W. In summer, the red hake made up the bulk of fish caught on the southern slopes. From the end of the summer to October, silver hake were fished on the northwestern slopes of Georges Bank and in the Nantucket shallows.

In general, one can say that the stocks of silver hake inhabiting the waters of Georges Bank decreased considerably or that the bulk of the fish shifted to the area of Georges Bank (to its southwestern part). But the latter is less probable, since race investigations show that a separate population of silver hake inhabits the area to the west of Cape Cod peninsula. In 1967, and perhaps in the following years, the stocks and catches of silver hake on Georges Bank will be considerably lower than in 1962-1965.

II. Haddock

In 1966 and especially in the second half of the year, a decrease in the Georges Bank catches was observed (Table 13).

Table 13. Haddock catches taken by the USSR commercial fleet on Georges Bank (thousand tons).

Year	1962	1963	1964	1965	1966
Catch	1.1	2.4	5.5	81.9	48.4

During January to March, the best catches of haddock were made on the southern slopes of Georges Bank and in April, on its southeastern slopes. In January, the catches per one hour of trawling by BMRT averaged 2.8 tons, in February - 3.7 tons, in March - 3.1 tons and in April - 2.8 tons.

During that period, haddock concentrations were found in the areas at depths from 40 to 270 m where the off-bottom temperature was 3-4°C.

In summer and autumn, haddock were caught in small numbers on the northwestern, northern and northeastern slopes of Georges Bank.

III. Herring

In 1966, the commercial fleet fished for herring more intensively than in 1965, and their catches increased (Table 14).

Table 14. Herring catches taken by the USSR commercial fleet on Georges Bank (thousand tons).

Year	1962	1963	1964	1965	1966
Catch	151.1	97.3	130.7	36.3	117.3

Late in May and in June, herring fishing was, as usual, conducted on the southern slopes at depths 50-100 m.

During July to August, herring were fished on the eastern, northern and southern slopes and in September and in the beginning of October in the spawning areas on its northern slopes.

At the end of the first ten-day period, after spawning, the herring dispersed and no more were caught.

IV. Red Hake

In January and February, red hake was the main object of a fishery on the southwestern slopes of Georges Bank at depths 150-250 m where the off-bottom temperature was 6-7°C.

In March, red hake concentrations began to shift to the southwestern slopes of Georges Bank, and catches gradually decreased. From May to July, red hake were fished lightly on the southern slopes of Georges Bank, and from August to September on the northwestern slopes. Red hake lengths ranged from 24 to 57 cm in catches, mean length from 31 to 34 cm. Three- and four-year-olds were the most abundant.

B. Special Research Studies

I. Environmental Studies

1. Oceanography. Four standard surveys were completed on Georges Bank throughout 1966. The sections and stations in the area of the surveys are given in Fig. 1. Data on those surveys showed (Fig. 3, 4, 5) that the time of a temporary warming in 1966 did not correspond to that in 1965. The warm waters of the Gulf Stream had less influence on the southeastern and southern slopes of the bank. Waters of a cold intermediate layer are distributed more widely. In the summer of 1966, the minimum water temperature of this layer was 2-3°C lower than in the corresponding period in 1965. Thus, cooling which had started in previous years continued in 1966.

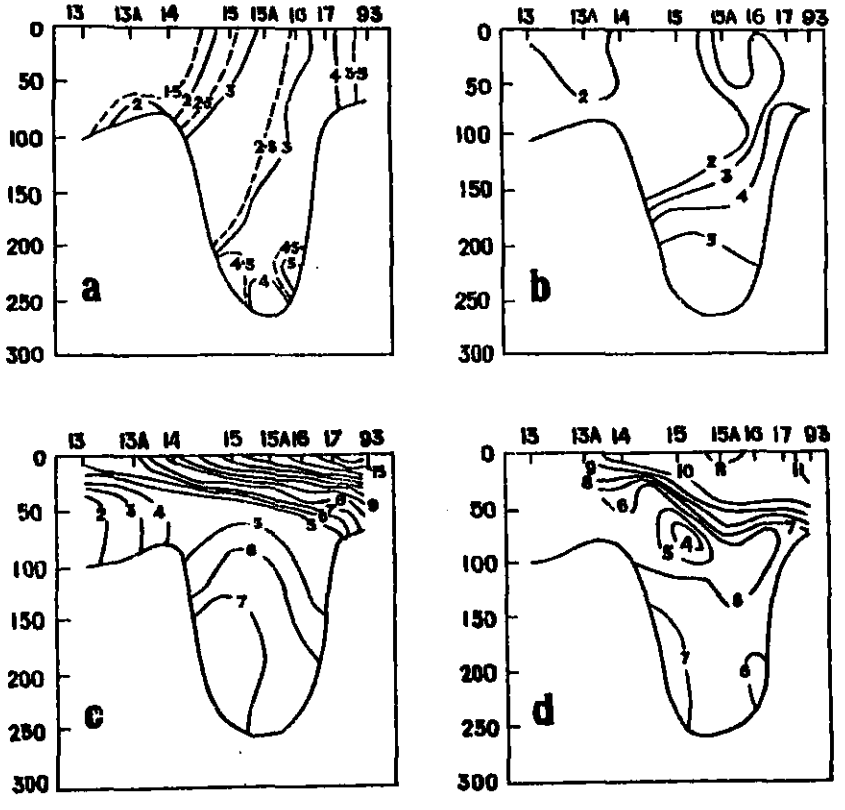

Fig. 3. Distribution of water temperatures in the channel between Browns and Georges Banks in 1966: (a) 29 January, (b) 4 April, (c) 4 August, (d) 10 October.

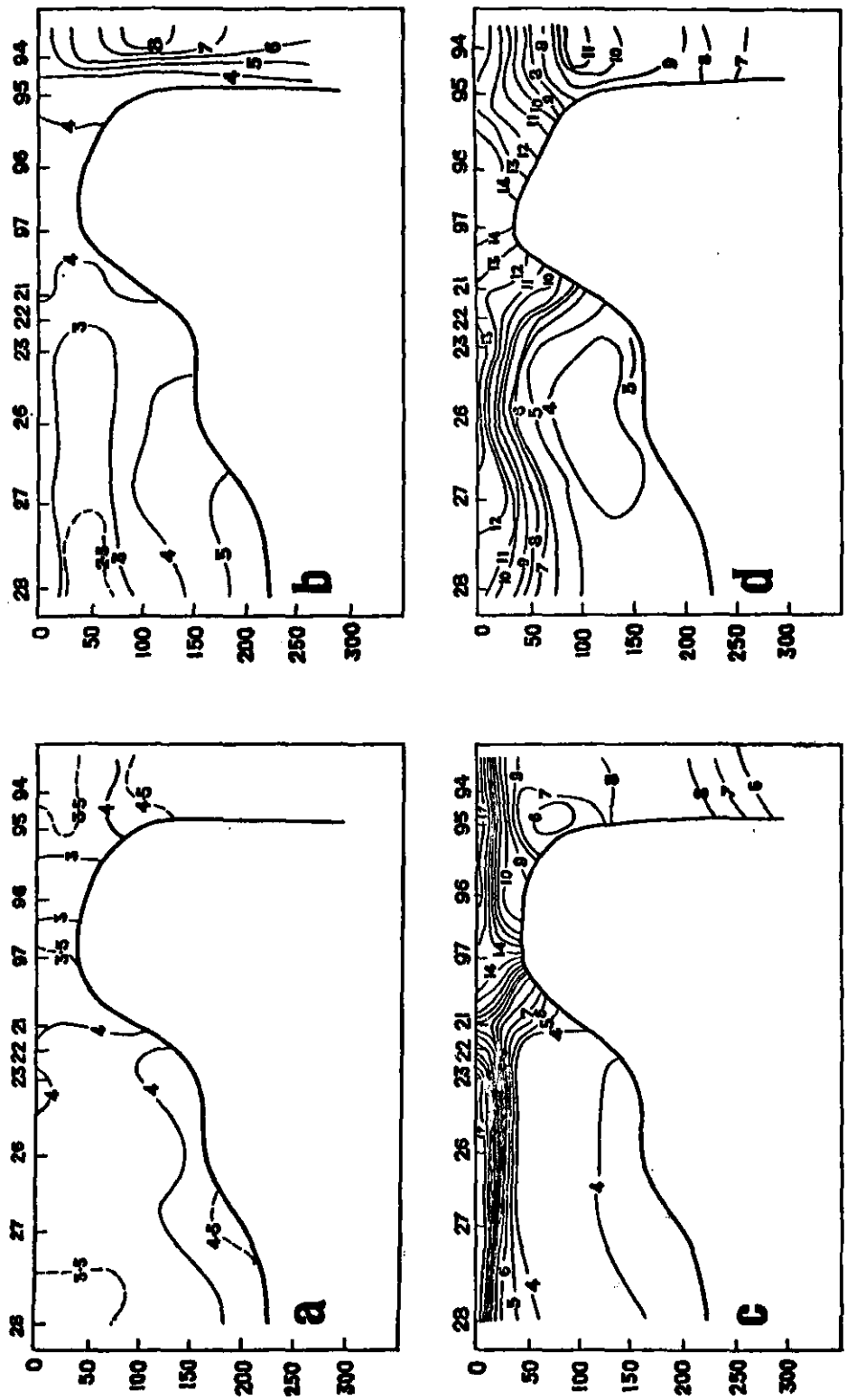

Fig. 4. Temperature distribution in Gulf of Maine-Georges Bank area (Section XXIV) in 1966: (a) 25 January, (b) 2 April, (c) 10 August, (d) 10 October.

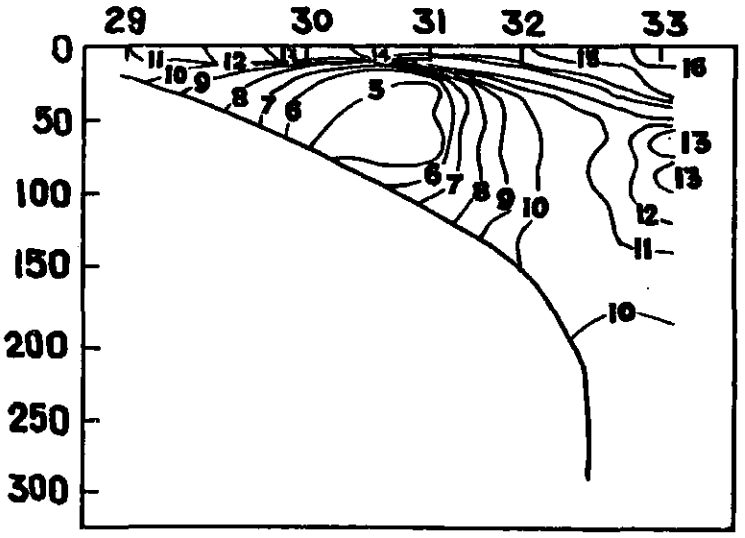

Fig. 5. Distribution of water temperatures over the continental slope to the south of Cape Cod (Section V) on 22 June 1966.

2. Plankton. Zooplankton samples were taken at the standard stations in April, June, July, August and October. A Juday net made of silk bolting cloth, N 38, was used. At present the samples are being analyzed in the laboratory.

In June and July, ichthyoplankton collections were made on the southern slopes of Georges Bank to study silver hake spawning.

In August and October, the ichthyoplankton was sampled in the northern part of Georges Bank to study the distribution of herring larvae in the area of the spawning grounds.

II. Biological Studies

1. Silver hake

a. Studies of the age and size composition in catches. Throughout the year, 113 samples (300 individuals in a sample) were measured and the age in 2,236 specimens was determined by otoliths and scales. Individuals from 24 cm to 32 cm in length were predominant. The mean length of all the fish measured was 28.6 cm.

The mean length of fish caught in Nantucket shallow was 26.2 cm in May, 26.8 cm in June, 30.5 cm in July, 28.4 cm in August; on the southern slopes of Georges Bank it was 26.7 cm in May, 29.2 cm in June, 28.8 cm in July and 28.4 cm in August.

Of the total number of specimens sampled in 1966, on the average 17.3% were 2-year-old fish, 45.5% 3-year-olds, 27.3% 4-year-olds and 4.1% were 5-year-olds.

b. Race investigations. In 1966, morphological and serological studies were continued to identify local stocks of silver hake. The number of vertebrae, gill rakers and branchiostegal rays as well as the relation between otolith weight and length of fish body were analyzed.

Studies of the albumen in the blood serum of silver hake caught in Div.4W and 5Z were made by the electrophoresis method. They showed that the correlation between the albumen components is of specific nature.

From the data available one can conclude that a number of stocks inhabit the areas in question. But, it is difficult to determine the degree of mixing of these stocks. This problem may be solved in further investigations.

c. The estimation of young silver hake abundance. Work on searching for and counting silver hake young was completed by the R/V *Olonets* in October-December 1966. The trawling areas are shown in Fig. 6.

A bottom trawl with a 27.1 m head rope was used. A codend with a mesh size of 10 mm from knot to knot was used. A total of 132 trawl hauls was made. Each haul lasted for one hour.

Estimates of the abundance of all individuals of total length 15-25 cm, those representing mainly the 1965 year-class, were made. In Subarea 1, silver hake young were not observed. In Subarea 2, young were found at depths of 70-120 m. The maximum catch per one hour of trawling was 182 specimens, the average catch was 39 specimens. In Subarea 3, young were observed everywhere in the area from Georges Bank to Hudson Canyon at depths of 70-200 m. The maximum catch per one hour of trawling was 216 specimens, the average was 35 specimens. In Subarea 4, young were found mainly at depths of 150-250 m. The most dense concentrations were discovered in the southern part of the subarea. The maximum catch per one hour of trawling was 526 specimens, the average was 113.

2. Haddock. Observations on size and age composition of haddock caught by research and scouting vessels were made throughout the year. The samples were usually taken by research vessels in haddock fishing areas. Haddock caught were from 28 to 85 cm long. Mean length gradually increased during the year. Thus, in January it was 39.9 cm, in February - 38.0 cm, in June - 46.6 cm, in October - 46.8 cm and in November - 50.9 cm.

The age of 365 specimens caught in May, September and December 1965 and of 1,088 specimens caught from January to December 1966 was determined for age composition studies. Individuals from two to seven years of age were found among the fish sampled. The 1962 year-class dominated the catches in 1965 and 1966 (Table 15).

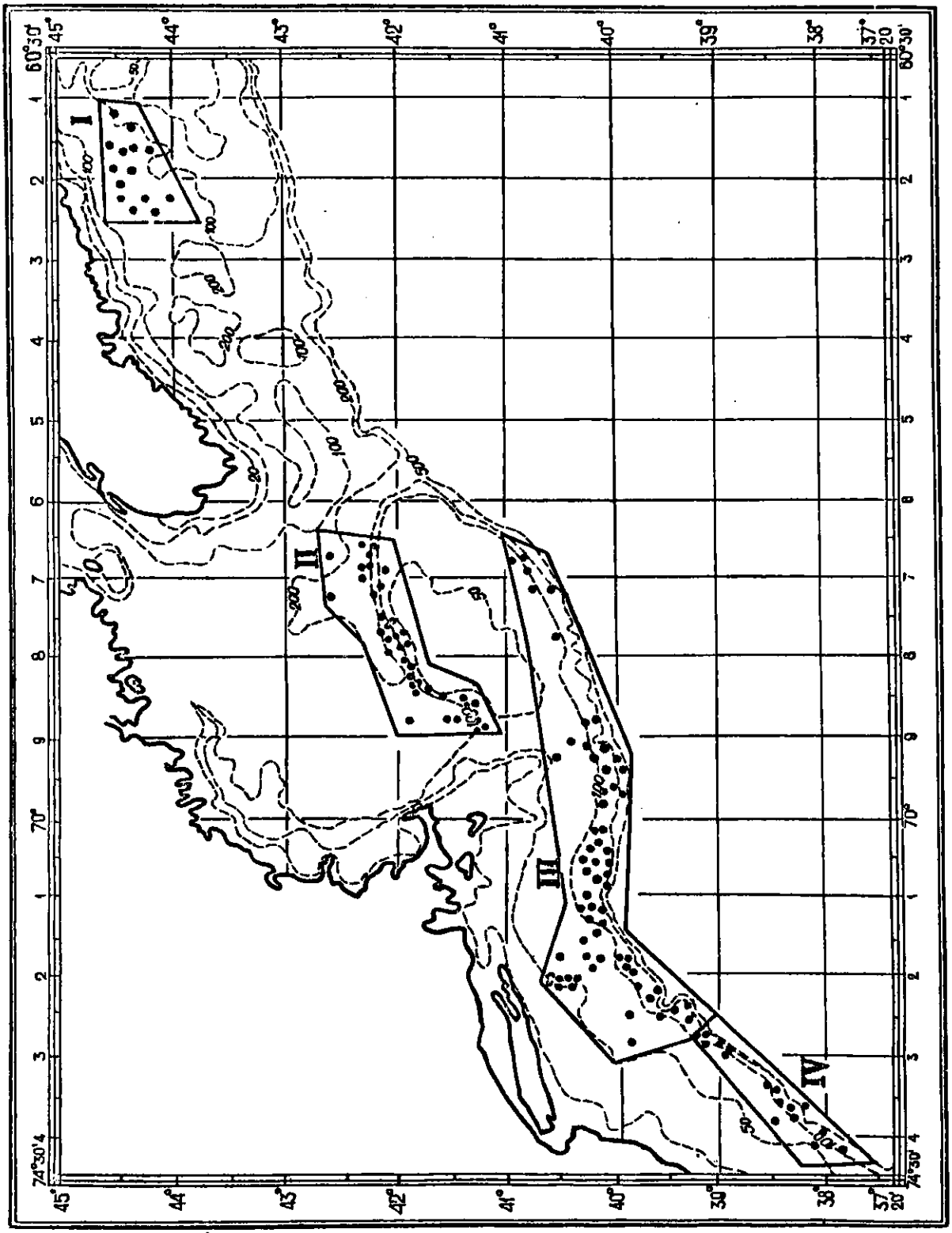

Fig. 6. Scheme of the regions investigated by R/V *Olmets* and location of trawling operations.

Table 15. Haddock age composition on Georges Bank, 1965 and 1966 (%).

Year	Month	Age 2	3	4	5	6	7	No. of Specimens
1965	V	97.0	3.0					68
	IX	11.7	64.5	21.8	1.5	0.5		197
	XII		20.0	64.0	16.0			100
1966	I		46.4	50.5	3.1			194
	III	1.0	84.8	14.2				97
	VIII	0.5	9.5	53.7	34.7	1.5		198
	IX		40.0	59.0	1.0			100
	X		23.4	43.3	29.3	2.0		99
	XI		15.5	57.0	20.3	2.0		400

The relatively high abundance of the 1962 year-class confirms the results of the 1965 US investigations.

3. Herring

a. Research studies on the age and size composition in the catches. In 1966, regular research on the age and size composition of herring catches were made in different areas of Georges Bank. A total of 286 samples (each sample included 300 specimens) were taken for length measurements. Age of 2,898 specimens was determined.

Individuals 28-33 cm long were predominant in the catches. In the first half of the year, mean length ranged from 25.8 cm to 30.5 cm; in July-September - from 29.7 cm to 31.9 cm.

Herring 2 and 3 years of age were found only as single individuals and averaged only 1.5% in the catches for the period. In addition, 5.9% were 4-year-old fish, 31.6% were 5-year-olds (1961 year-class), 47.3% were 6-year-olds (1960 year-class), 11.6% were 7-year-olds and 2.1% were 8-year-olds. Thus, in 1966, as in 1963-1965, the 1960 year-class was dominant in the catches.

This year-class has already been reduced due to natural and fishery mortality. In 1967, its abundance will be still lower. Other year-classes are much poorer compared to the 1960 year-class. Thus, in 1967 the herring stocks of Georges Bank will be considerably reduced.

b. Observations on herring spawning. In September and in early October of 1966, observations on herring spawning were continued on the northern slopes of Georges Bank to estimate the eggs deposited and to determine the abundance of the spawning population. As in 1965, two spawning areas were discovered near the northern slopes of Georges Bank. In one case, the area covered by the eggs was 10.8 km^2, in the other it was 8.3 km^2.

The spawning in the first case was observed on 19-20 September, and that, in the second one, on 28-29 September. The layers of eggs were 5-6 cm thick. Their minimum quantity in the samples was 0.2 kg/m^2, their maximum, 17.8 kg/m^2.

From the total number of the eggs deposited, the average fecundity of fish, the correlation of different sexes and the average weight of one specimen, the total stock of the spawning population was estimated as 150,000 tons.

4. Red hake. Observations on the composition of red hake catches were made by the research vessels. Simultaneously, otoliths were collected for age determination. The most abundant specimens were 28 to 38 cm in length.

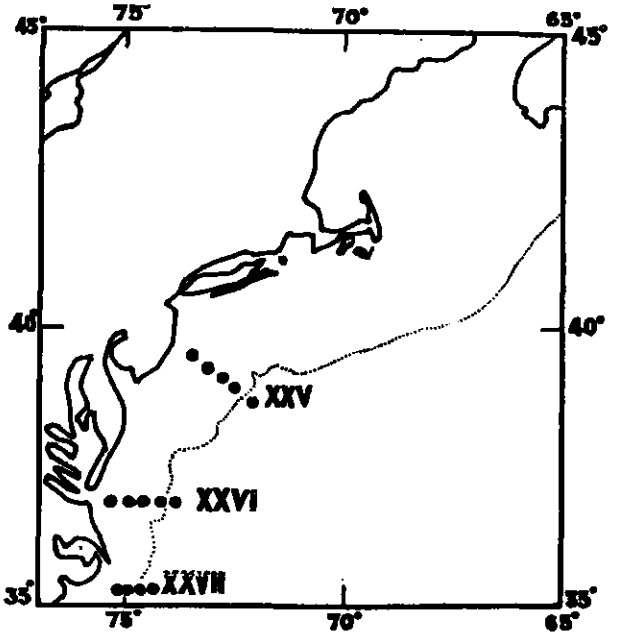

Fig. 7. Location of sections on the shelf along the United States coast of the ICNAF Area.

XI. United Kingdom Research Report, 1966

by B.B.Parrish and A.J.Lee

Subareas 1-5

A. Status of the Fisheries

Provisional figures indicate that United Kingdom landings from the ICNAF Area increased by 7 percent during 1966, from 56,000 tons to 60,000 tons comprised mainly of cod (57,000). The fishing effort increased by rather less, 13 percent. In fact the fishing effort by freezer trawlers expanded by two-thirds its 1965 level as recently built vessels came into service, but this was offset by decreased effort by side trawlers.

This summary conceals more complex fleet movements between the subareas of the ICNAF region. The increase in freezer trawler effort in 1966 took place in Subarea 3, and to some extent in Subarea 2. On the other hand, fishing by side trawlers increased in Subarea 1, reversing the switch from Subarea 1 to Subarea 3 which took place in 1965.

As a result of these changes the greater proportion of the increased catch in 1966 has been taken in Subarea 1 (21,000 tons) with catches in the other subareas remaining almost constant.

As suggested by the movements of the fleet, these preliminary catch and effort statistics indicate an increase in stock abundance in Subarea 1 but a decrease in Subarea 3. Data are not yet available to relate these changes to the age composition of the stocks in question.

B. Special Research Studies

I. Biological Studies

Regular sampling for length and age has continued on the fresh fish markets, at sea on the Fairtry factory vessels, and also in the processing houses for samples of whole frozen fish. Further information on the structure of the cod stocks in Subarea 1 was collected during a cruise of R/V *Ernest Holt* in connection with the United Kingdom research program on North Atlantic salmon (see below). This showed a very marked distinction between the size composition of cod sampled in Subarea 1, Div.1F, and those sampled further north in Div.1A-D where the length composition was relatively uniform.

II. North Atlantic Salmon

During October 1966 R/V *Ernest Holt* carried out a cruise in Subarea 1 as part of a joint program by the marine and freshwater laboratories in the United Kingdom, and in cooperation with the Danish authorities. The main

objects of the cruise were to tag salmon and to collect them for racial studies based on electrophoretic analysis of the blood and parasitic infestation.

Fishing was mainly carried out in Div.1A, B, C and D and in all 26 salmon were caught in the size range 65 cm to 97 cm total length. Only one was suitable for tagging.

In addition to the *Ernest Holt* cruise, a program of salmon tagging and blood characteristics studies was carried out by a party of 10 scientists from the United Kingdom, based at Greenland, during autumn 1966.

The shore-based, coastal tagging operations, which were carried out in the Godthaab area, were much more successful than in 1965; 728 salmon were tagged out of a total of 2,120 salmon caught. To date, records have been received of the recapture of 25 of the tagged salmon in the Greenland fishery, mostly in the Godthaab area. In addition, one salmon, tagged in the Praestefjord on 14 October 1966 was recaptured in the River Tweed on 18 March 1967. It had been at liberty for 155 days, during which it had covered a minimum distance of 2,000 miles at a minimum rate of 13.5 miles per day.

Blood characteristics, including red cell and serum antigens, and blood groups, were investigated both in fish caught at sea and in fish caught in the coastal fishery; some work was done on transferins and some other material, *e.g.* eye lenses and hearts, were collected for further study. Only preliminary results are available from these investigations, and more detailed studies on the blood characteristics of national stocks are now required before further interpretation of the Greenland data is possible.

Attempts were made to extend and increase smolt tagging programs during the spring and, though the number tagged did not always come up to expectations, 12,800 smolts were tagged in England and Wales from three river systems and 23,039 smolts, from five river systems, were tagged in Scotland.

III. Environmental Studies

UK research vessels made no environmental surveys in the ICNAF Area in 1966, but members of the Lowestoft, Aberdeen and Edinburgh laboratories were engaged in completing the report on the NORWESTLANT Surveys.

As in previous years the Continuous Plankton Recorder survey was conducted from the Oceanographic Laboratory, Edinburgh, supported financially by H.M. Treasury, through the Natural Environment Research Council, and by the Department of the United States Navy through Contract N62558-3612 between the Office of Naval Research and the Scottish Marine Biological Association.

During 1966, Continuous Plankton Recorders, sampling at a depth of 10 m, were towed in the ICNAF Area by cutters of the US Coast Guard and by merchant ships from Denmark, Iceland and the United Kingdom. The total mileage

sampled was 28,100 (compared with 25,900 in the previous year) made up of 3,900 miles in Subarea 1, 4,400 in Subarea 2, 16,000 in Subarea 3, 3,000 in Subarea 4 and 800 in Subarea 5.

The material is being analyzed in the Edinburgh Oceanographic Laboratory and the results will be incorporated into a study of the distribution and abundance of the plankton and, especially, analyses of variation in the plankton and the environment. During the year progress has been made in the preparation of an atlas of the plankton of the North Atlantic based on sampling from 1958 to 1965; it is expected that charts of the distribution of about 200 organisms will be published during 1967.

In 1966 the spring outbreak of phytoplankton in most of the ICNAF region was later and less abundant than usual. For example, the spring peak occurred in May instead of April over the Grand Banks and there was a similar delay of about one month in the coastal waters of West Greenland. *Thalassiosira* spp., *Chaetoceros* spp., and *Thalassiothrix longissima* were the most abundant diatoms. *Calanus finmarchicus* and *Thysanoessa longicaudata* were the dominant organisms in the zooplankton. *Calanus* was common throughout the year over the Grand Banks but, in the oceanic waters east of Newfoundland, the increase in numbers of adult *Calanus* did not occur until April, that is, about one month later than usual. Euphausiids were somewhat less numerous than is usual

A preliminary assessment of the numbers of young *Sebastes* suggests that they were somewhat below their average abundance in 1966; this was particularly noticeable in July in the region north of the Grand Banks and extending to the Strait of Belle Isle.

XII. United States Research Report, 1966

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 redfish landings from Subarea 3 came mainly from the Grand Bank, Div.3N and 3P (Table 1).

Table 1. US redfish statistics, Subarea 3, 1966 (metric tons, round fresh).

Year	Landings	Days Fished	Landings/Day Fished
1962	14,257	932	15.3
1963	12,089	882	13.7
1964	4,692	369	12.7
1965	772	51	15.0
1966	346	38	9.1

B. Special Research Studies

I. Environmental Studies

Oceanographic Programs of the United States Coast Guard Oceanographic Unit.

In 1966, the Coast Guard again had two major oceanographic efforts in the ICNAF Area. The long standing program in support of International Ice Patrol[1] was quite different from previous years because of the extremely light ice season and the availability of an icebreaker for studies in the Baffin Bay-Nares Strait area. The Ocean Station program which was begun in 1964 was greatly expanded. The "on station" coverage was expanded to include work at all stations and a pilot program for the occupation of a series of standard sections across the Gulf Stream and Labrador Current was begun.

1966 was the lightest ice season in the history of INTICEPAT, not a single berg was sighted in the Labrador Current south of 48°N, and the requirement for direct oceanographic support was terminated on 25 April 1966. Consequently, only one survey of 43 stations, required by COMINTICEPAT, was to determine the oceanographic conditions in the vicinity of the Grand Banks. In May and June an extensive, 103 station, survey was made of the Gulf Stream, Labrador Current system and the Labrador Sea from a point well south of the

[1] INTICEPAT

Grand Banks north to the INTICEPAT South Wolf Island, Labrador to Cape Farewell, Greenland Section. The purpose was to determine the extent of the unusually warm conditions observed in the Grand Banks area during the spring 1966. As in 1965, the normal post ice season cruise in July was again devoted to an extensive study of the contribution of the outflow of Hudson Strait to the Labrador Current. A total of 194 oceanographic stations were occupied during this program.

During August 1966, the CG icebreaker *Edisto* was utilized to make an oceanographic survey of the Baffin Bay-Nares Strait area between 77°30'N and 82°N. A total of 119 stations were occupied. In addition to serial temperature and salinity data, dissolved oxygen observations were made at 73 stations and 200-meter vertical plankton tows at 24.

The development of the Ocean Station program continued to be hampered by the shortage of reversing thermometers. However, coverage at BRAVO was increased to 9 patrols, which meant that data was taken during alternate three week patrols throughout the year. The program at station CHARLIE was begun in June and data were taken on 6 patrols during the remainder of the year. At station DELTA data were taken on 4 patrols between July and December at station ECHO thermometers were for only one patrol. The program at all stations except BRAVO consist of daily 13-15 bottle Nansen casts to 1,500 m with sampling being extended to as near the bottom as practicable at least once during the patrol. At BRAVO casts were made on alternate days.

The locations of the standard sections are shown on the attached chart, Fig. 1. Sections 1 through 4 are modifications of INTICEPAT sections. It is planned to occupy Sections 2 through 5 on a monthly basis, Sections 6 and 7 on at least seasonal basis and Section 1 monthly whenever ice conditions will permit. Sampling is to 1,500 m with near bottom samples interspaced at about 90 mile intervals. Station spacing is approximately 30 miles offshore and at 10-15 mile intervals in the Labrador Current. In addition to the INTICEPAT coverage in 1966 mentioned above, Section 2 was occupied during March and November, Section 3 - 3 times (February, March and November), and Section 4 twice (October and November). Section 5 was occupied in November and Section 6 in both October and November.

Subarea 4

A. Status of the Fisheries

I. Haddock

United States fishing effort in Subarea 4 was concentrated mainly in Div.4X. Decreased landings were due to decreased abundance and effort (Table 2). No age compositions were available in 1966 because of lack of samples. The 1963 year-class which was so strong on Georges Bank in 1965 and 1966 is expected to make its appearance on Browns Bank in 1967.

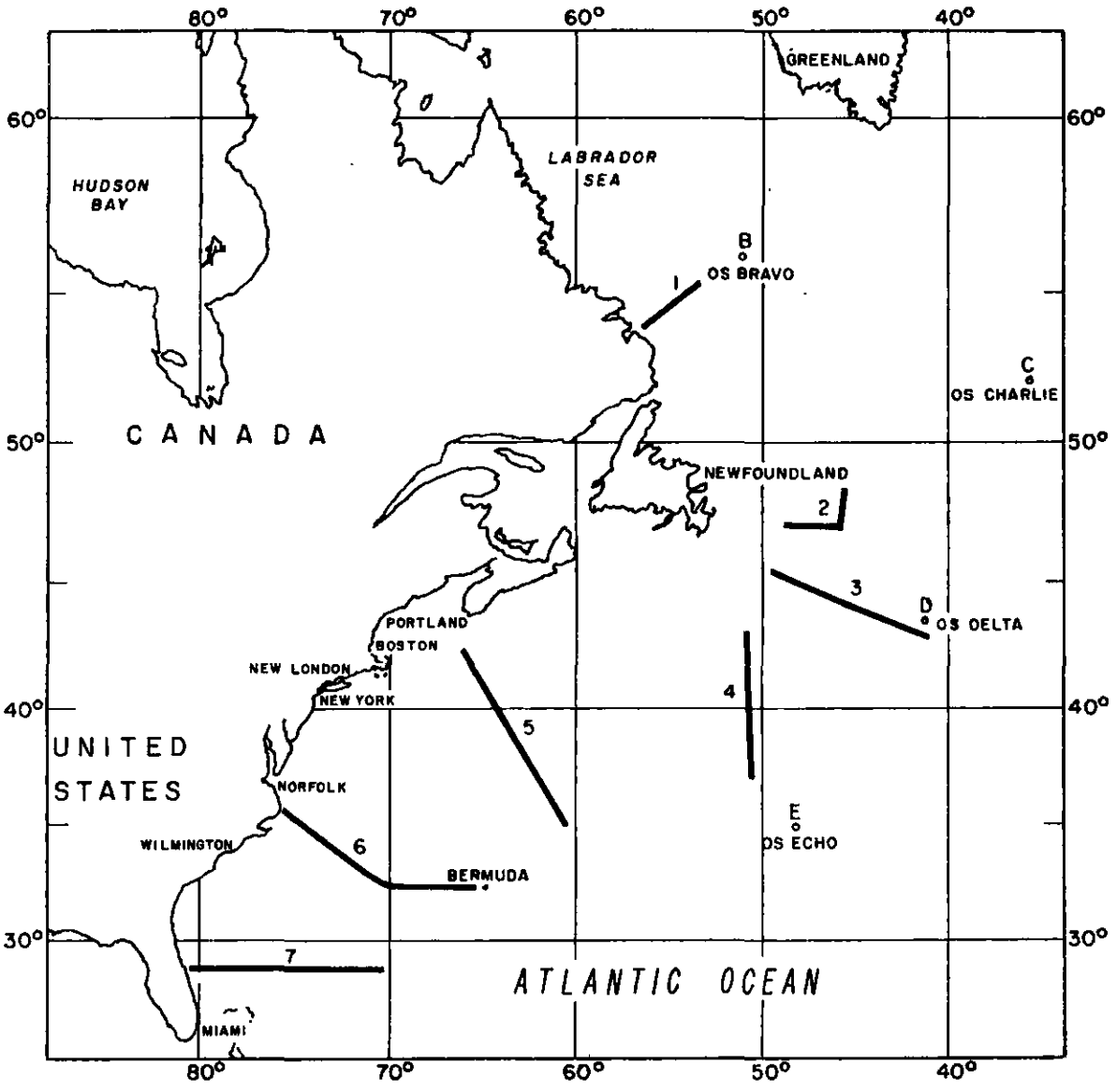

Fig. 1. Standard sections and ocean stations occupied by US Coast Guard.

Table 2. US haddock statistics, Div.4X (metric tons, live weight).

Year	Landings	Days Fished	Landings/Day Fished
1962	6,388	875	7.3
1963	7,223	1,111	6.5
1964	8,488	1,132	7.5
1965	3,685	567	6.5
1966	2,473	526	4.7

II. Cod

US cod landings showed no change from 1965. Less than 1,000 metric tons were landed.

III. Redfish

Gulf of St. Lawrence redfish landings (Div.4R, S, T) by the US in 1966 was less than in 1965 (Table 3). This seems to be a result of decreased effort. Redfish landings from the Scotian Shelf (Div.4V, W, X) on the other hand increased considerably in 1966 apparently the result of increased abundance (Table 4).

Table 3. US redfish statistics, Div.4R, S, T (Gulf of St. Lawrence) (metric tons, round fresh).

Year	Landings	Days Fished	Landings/Day Fished
1962	68	8	8.7
1963	4,879	508	9.6
1964	12,278	735	16.7
1965	17,099	803	21.3
1966	12,766	608	21.0

Table 4. US redfish statistics, Subarea 4, Div.V, W and X (Scotian Shelf) (metric tons, round fresh)

Year	Landings	Days Fished	Landings/Day Fished
1962	29,375	3,376	8.7
1963	23,282	3,104	7.5
1964	15,636	2,369	6.6
1965	13,082	1,246	10.5
1966	16,680	1,183	14.1

B. Special Research Studies

I. Environmental Studies (see under Subarea 3)

II. Biological Studies

1. Haddock. Study comparing ages from scales and otoliths from Div.4X was undertaken to determine feasibility of using scales in place of

otoliths for routine age studies. Agreement of 465 scale-otolith comparisons was 76%. Scale readings were consistently lower than otolith readings and these differences were significant in all age groups beyond about 5 years. Study is being continued to determine reasons for disagreement between scales and otoliths.

The abundance index for haddock in Subarea 4 is normally calculated from boats that fished the entire trip in the subarea. Because haddock abundance on Browns Bank was relatively low, few boats fished the entire trip in the subarea and the abundance index was considered weak. Comparisons were made between indexes based on pure and split trips in Subarea 4 and no significant differences were found. Therefore, catch per day for vessels fishing partial trips as well as those fishing an entire trip on Browns Bank are now used in calculating the index.

Subarea 5

A. Status of the Fisheries

I. Haddock

US landings from Georges Bank in 1966 were the same as in 1965 (Table 5). The abundance index showed a slight decrease but increased effort maintained the same level of landings.

Table 5. US haddock statistics, Georges Bank (metric tons, round weight).

Year	Landings	Days Fished	Landings/Day Fished
1962	49,378	7,838	6.3
1963	44,126	10,029	4.4
1964	46,522	8,778	5.3
1965	52,677	9,407	5.6
1966	52,735	9,948	5.1

Age compositions (Fig. 2) show 3 year olds (1963 year-class) contributing about 60 percent of the catch. *Albatross IV* groundfish surveys show that subsequent year-classes (1964, 1965 and 1966) are weak ones (Fig. 3). For this reason forecasts are for decreased haddock abundance on Georges Bank through 1968 and 1969.

II. Cod

Generally cod abundance and landings (Table 6) remained steady in 1966. The 1966 abundance index, however, indicates slightly higher abundance than in 1965.

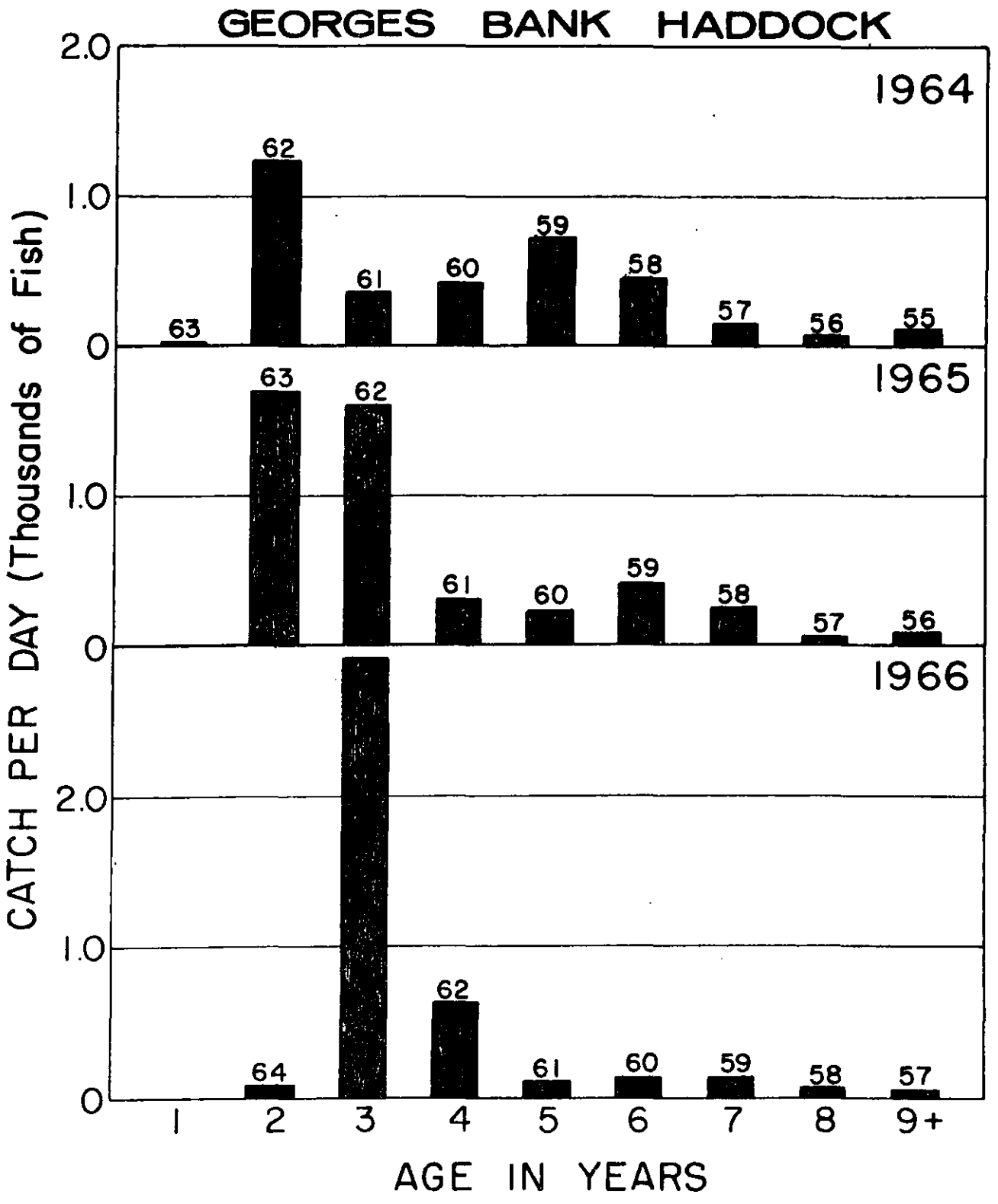

Fig. 2. Age composition of Georges Bank haddock.

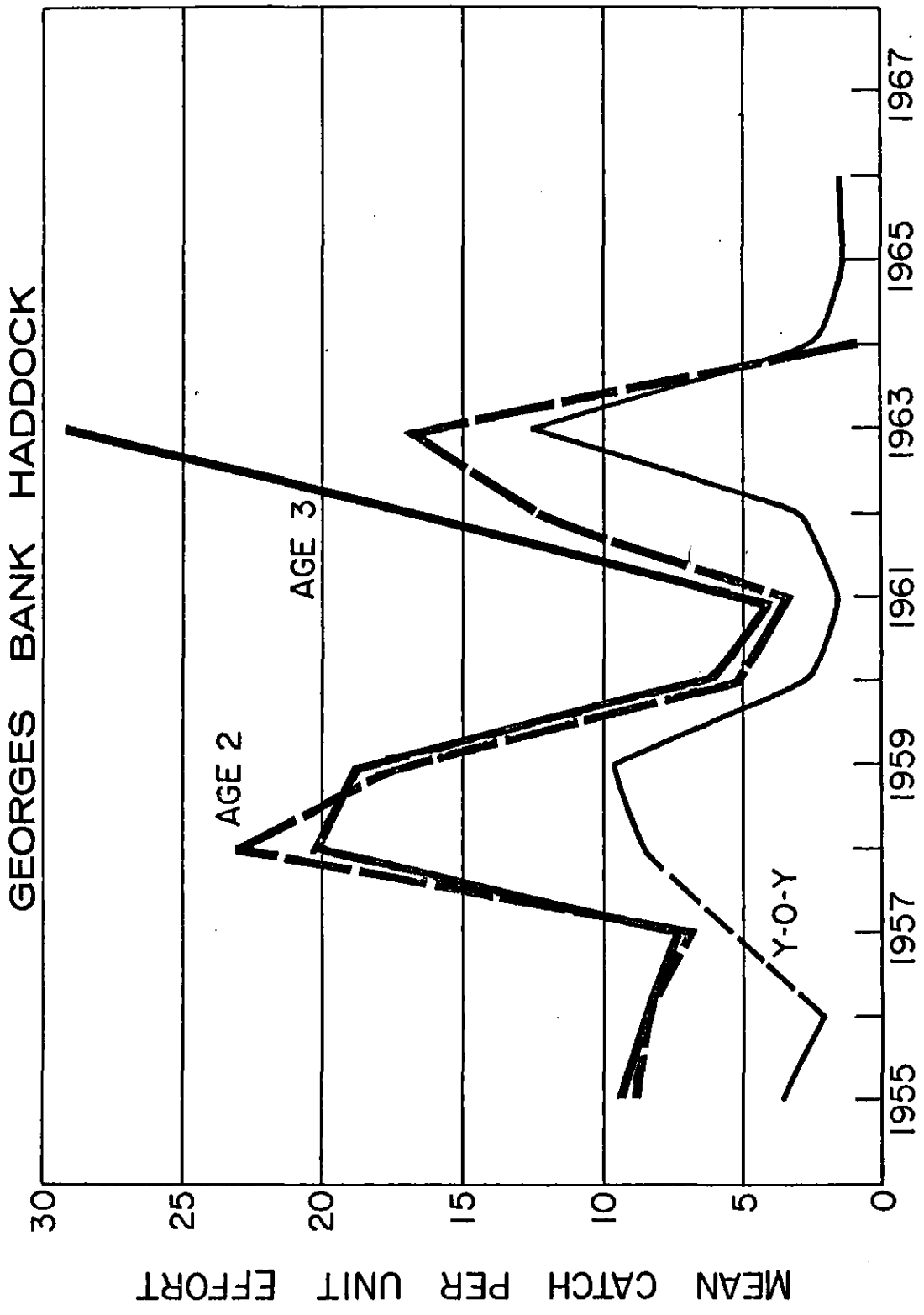

Fig. 3. Relative strength of year-classes - Georges Bank haddock.

Table 6. US cod statistics, Subarea 5 (metric tons, round weight).

Year	Landings	Landings/Day Fished[1]
1962	18,626	1.2
1963	16,734	1.8
1964	15,478	1.0
1965	15,011	0.9
1966	15,343	1.1

[1]Calculated from the amount of cod caught incidentally by Boston haddock study fleet. Most cod landed in the US from Subarea 5 is a by-catch of vessels engaged in other fisheries.

III. Silver Hake

Landings of silver hake by the US (Table 7) have decreased in 1966. This decrease is accounted for in the lower catch of silver hake in industrial landings. Food fish landings actually increased in 1966, but the abundance was unchanged.

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

Year	Landings (Food)	Landings (Industrial)	Days Fished	Landings/Day Fished (food only)
1962	44,271	5,333	2,393	18.5
1963	39,247	8,490	2,256	17.4
1964	39,479	13,666	2,615	15.1
1965	33,774	8,035	2,639	12.8
1966	37,545	2,655	3,004	12.5

[1]Amagansett, Long Island, industrial landings of silver hake included.

IV. Redfish

US redfish landings were about the same in 1966 as in the previous year (Table 8). Landings per day, however, increased for the fourth year indicating that redfish abundance in Subarea 5 (Gulf of Maine) is definitely on the increase.

Table 8. US redfish statistics, Subarea 5 (Gulf of Maine) (metric tons, round weight).

Year	Landings	Days Fished	Landings/Day Fished
1962	12,540	3,135	4.0
1963	8,871	2,164	4.1
1964	7,812	1,817	4.3
1965	6,986	1,027	6.8
1966	7,075	643	11.0

V. Yellowtail

US yellowtail flounder landings in 1966 decreased about 18 percent compared to 1965 (Table 9). Landings per day on both Georges Bank and Southern New England grounds decreased in 1966 showing reduced abundance of yellowtail.

Table 9. US yellowtail statistics, Subarea 5 (metric tons, round weight) (food fish only).

		Southern New England		Georges Bank	
Year	Total Landings	Days Fished	Landings/Day Fished	Days Fished	Landings/Day Fished
1962	25,565	4,748	3.3	2,354	3.3
1963	35,220	5,244	4.1	2,317	4.6
1964	35,930	5,099	3.7	3,535	4.2
1965	34,234	6,010	3.1	4,486	3.2
1966	28,079	7,110	2.1	5,671	2.0

Age compositions of yellowtail landings show about 50 percent of the catch were 3 year olds in 1966 (Fig. 4). The poor showing of 2 year olds in the catch indicates further decreases in yellowtail abundance in 1967.

VI. Industrial Groundfish Fishery

New England industrial landings (Table 10) decreased about 18 percent in 1966. This decrease was due to a marked decrease in red hake and silver hake abundance. Red hake normally make up 40-45 percent of the industrial catch. In 1966 the percentage dropped to 10 percent. Silver hake usually comprise 20 percent of the catch but accounted for only 10 percent of the catch in 1966.

Table 10. New England groundfish landings for industrial purposes (metric tons, round weight)[1].

		Percent		
Year	Landings	Silver Hake	Red Hake	Other[2]
1962	26,666	-	-	-
1963	26,020	19.5	43.7	36.8
1964	27,899	20.0	42.6	37.4
1965	34,049	20.4	38.0	41.6
1966	28,337	9.6	10.2	80.2

[1]Amagansett, Long Island, industrial landings not included.
[2]Each component species less than 7%

VII. Herring

The Maine catch of herring for 1966 was 27,200 metric tons, the second lowest in 20 years. The landings, normally heavier in western Maine, were

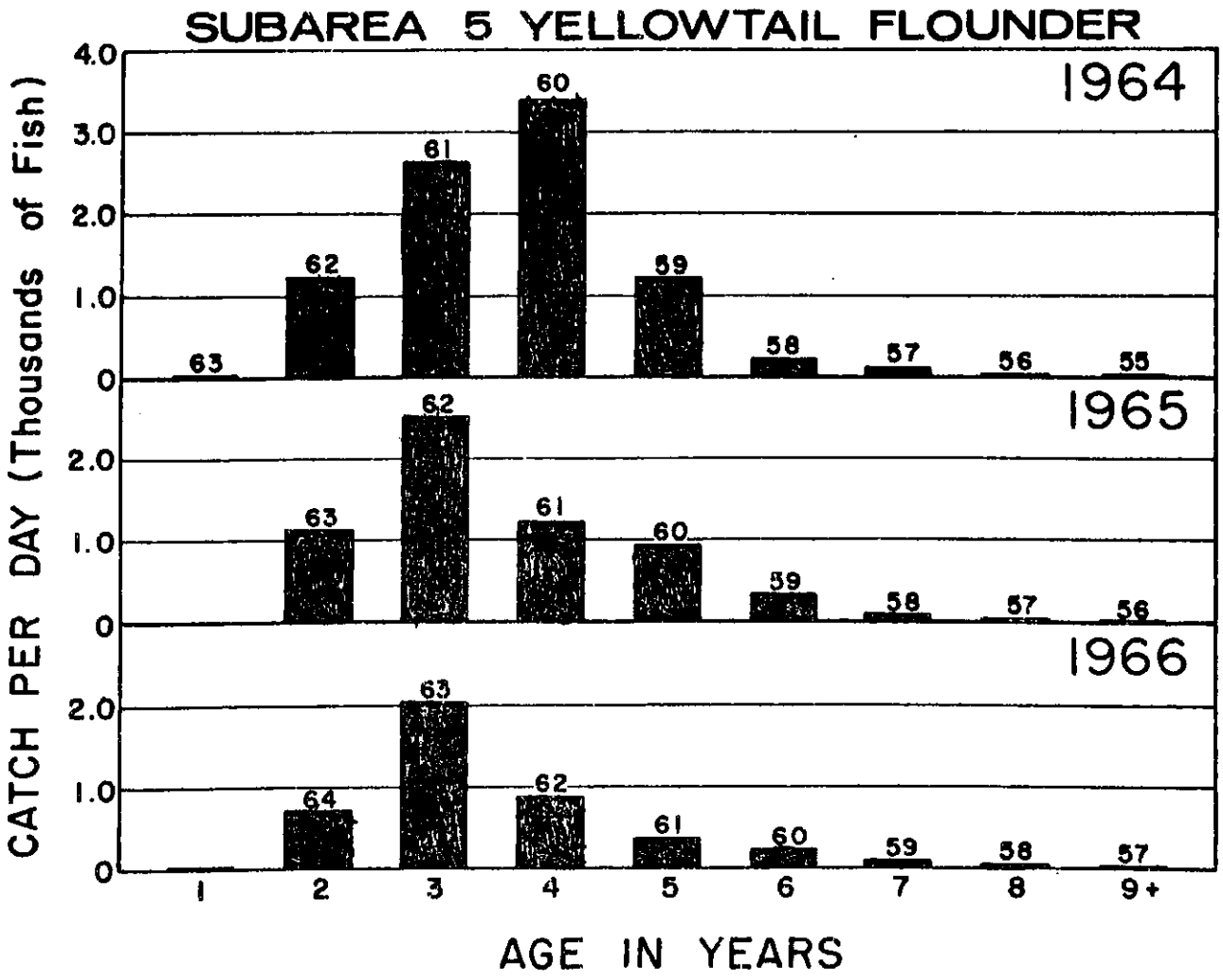

Fig. 4. Age composition of Subarea 5 yellowtail flounder.

heaviest in eastern Maine,which produced, for the second year in a row, the best catches since 1958. There was no indication of an unusually high mortality to account for the lack of fish during the past year. Temperatures, however, were unusually low in the winter of 1965. A possible explanation of non-availability to the inshore fishery is that zooplankton was very high. During August dissolved gases in the water were the highest for the 3-year period that records have been kept and very few fish were caught at this time. In September and October, dissolved gases were the lowest recorded and catches improved measurably. A cursory examination of samples collected along the entire coast in 1966 indicated no unusual occurrence of disease, parasites or reduced growth.

Effort units for 1966 increased slightly in the eastern area (from 67 weirs in 1965 to 76 in 1966) but fell in central and western Maine as herring fishermen turned to other species.

Age composition of the Maine sardine landings (Table 11) show three year old fish most abundandant in 1966, the first year on record in which age-group II has been outnumbered. Age-group I, usually abundant from September onward, was also scarce. Herring were scarce in Central and Western Maine during 1966, and catches in Eastern Maine and Canada accounted for nearly 75 percent of the fishery. Fish of the 1961 year-class dominated the samples from Georges Bank, while fish of the 1960 year-class dominated the samples of coastal Gulf of Maine and Nova Scotia. The contribution of the 1963 year-class was higher on the Banks and coastal Gulf of Maine than in Nova Scotia. The range in length of herring (age-groups III to VIII) from Georges Bank, coastal Gulf of Maine and Nova Scotia was 18.0 to 33.6, 19.7 to 34.2, and 21.3 to 33.9 cm, respectively. The mean lengths of fish from a given year-class for a particular month did not differ between the areas.

Table 11. Age composition of Maine sardine fishery in 1966.

Age-group	Year-class	Percent
I	1965	5.1
II	1964	42.4
III	1963	49.3
IV	1962	1.6
V	1961	1.0
VI	1960	0.6

On Georges Bank in 1966, the onset of spawning was later than in coastal Gulf of Maine and Nova Scotia. Spring spawning (although less than 2 percent) was evident in coastal Gulf of Maine and Nova Scotia and not evident on Georges Bank.

VIII. Other Pelagic Species

Tagging of bluefin tuna, skipjack and white marlin was continued. Of 3,958 tuna tagged in 1966, 531 were recaptured. Of 1,672 tagged in 1965, 59 were recaptured in 1966, 12 of them in the Bay of Biscay. There were no recoveries in 1966 from the 465 releases in 1964.

There were 8 recaptures of 790 skipjack released in 1966 but no recaptures of 438 fish released in 1965. No returns resulted from 64 white marlin releases in the Montauk-Martha's Vineyard area but other taggings south of this area strengthened the concept of a clockwise migratory pattern between Georges Bank and the tropics for this species.

IX. Sea Scallops

US landings of sea scallops from Georges Bank were even less in 1966 than in 1965 which was the lowest on record (Table 12). As in 1965, the drop was caused by diversion of effort to grounds off the Middle Atlantic states outside the Convention Area.

The research abundance index shows an increase after several years of decline. It is somewhat less reliable than in former years, however, since it is based on a smaller sample.

Table 12. US sea scallop statistics, Subarea 5 (metric tons, meat weights).

Year	Landings	Days Fished	Landings/Day Fished	Research Vessel Index
1962	9,687	8,806	1.1	99.1
1963	7,906	7,906	1.0	45.4
1964	6,296	6,296	1.0	40.0
1965	1,509	2,156	0.7	33.5
1966	901	1,001	0.9	48.0

X. Lobsters

The US catch of lobsters in 1966 was about 14,000 tons, approximately the same as in 1965. About 15 percent of the catch was taken in the offshore fishery.

B. Special Research Studies

I. Environmental Studies

Seabed drifters. Seabed drifter recoveries from the Gulf of Maine-Georges Bank area reveal a general parallelism between the near-bottom and surface drift. The Georges Bank gyre appears both at the surface and near the bottom. A westward flowing current south of Cape Sable persists through the spring at the surface and near the bottom. Near-bottom current velocities in these cases were of the same order of magnitude as those at the surface, *i.e.* several miles per day.

Plankton ecology. In a study of the short-term changes which occur as a result of the growth of plankton populations, a September study in the Gulf of Maine by the Woods Hole Oceanographic Institution produced these preliminary results:

little net change in the size of the phytoplankton population
" " " " " distribution of nutrients, oxygen, chlorophyll or particulate organic carbon
carbon fixation of about 700 mg/m^2/day.

If this rate of photosyntheses were reflected in plant growth, the amount of particulate carbon would have doubled in 10 days and of particulate phosphorus in 5-7 days. Since the net changes were small, the population must be maintained at this time of year by rapid recycling of elements *in situ*.

Plankton sampling procedures. Studies of comparisons of different kinds of plankton samplers and plankton sampling design are reported elsewhere.

Hydrographic studies. Three quarterly environmental surveys of Continental Shelf waters between Nova Scotia and Long Island were completed (*Albatross IV* Cruise 66-2, March 2-14, 1966; *Albatross IV* Cruise 66-7, May 24-June 7, 1966; *Albatross IV* Cruise 66-12, September 8-25, 1966). The sampling depths were 1, 10, 20, 30, 40, 50, 75, 100, 150, 200 and 250 m. The properties measured were temperature, salinity, dissolved oxygen and chlorophyll. Laboratory references have been prepared summarizing these data in tabular and graphic form and distributed to interested parties.

A summary of bathythermograph and hydrographic station temperature data collected between 1940 and 1960 in an area bounded by latitude 39°00'N and 45°30'N and longitudes 64°00'W and 72°00'W is nearing completion. The data (comprising some 75,000 observations) have been tabulated on a basis of 30-minute quadrangles at depths of 1, 10, 20, 30, 40, 50, 75, 100, 150, 200 and 250 m. Horizontal plots of monthly mean values at specific depths, profiles of selected sections and temperature anomaly charts are being prepared in an effort to establish temperature norms for specific areas and depths to which specific cruise data may be compared.

Coast Guard hydrographic studies (see under Subarea 3).

Intensive hydrographic studies were continued along the Gulf of Maine in connection with the herring studies carried out in that area. Plankton studies were conducted in the same waters. Copepods were the dominant zooplankters during all seasons. Mean annual volumes were highest in the western area and lowest in the eastern. Zooplankton volumes were generally lower in 1966 than in 1965.

Benthic studies. Studies of the macrobenthic fauna of the New England Continental Shelf and Slope were continued this year. Particular emphasis was devoted to summarizing the distributional relationships of 42 major invertebrate taxa. An analysis of 1,100 samples has revealed interesting relationships between the abundance of these taxa and the water depths and bottom sediments they inhabit.

The bathymetrical analyses indicate that a large proportion of the benthic invertebrate taxa occur in highest densities in shallow water and lowest densities in deep water. The particular pattern of density in relation to water depth, however, varies from group to group. For example, in the coelenterate group, hydroids were most numerous in depths less than 40 m, whereas alcyonarians occurred at depths from 60 to 2,000 m. Priapulids were found only at depths greater than 1,000 m. Sipunculids were rather uniformly distributed; they averaged between 1 and 9 specimens per m^2 at all depths from 2 m to 4,000

m. Amphipods, one of the more abundant invertebrate groups, averaged more than $500/m^2$ from the shoreline out to the edge of the Continental Shelf, but were relatively sparse in deeper waters. Pelecypods were most numerous ($500/m^2$) at depths less than 25 m, and they were moderately common ($175/m^2$ or more) at all depths on the Continental Shelf. Beyond the Continental Shelf their density was greatly reduced and averaged only $25/m^2$ on the continental rise. Pogonophora were generally sparse, deep water inhabitants - none were taken at depths less than 100 m and their highest densities were found on the Continental Slope.

A special study was conducted comparing quantitative estimates obtained from dredge samples and from sea-bottom photographs. Our evidence indicates that density estimates derived from photographs are substantially more accurate than values based on dredge-collected samples from a measured area of sea bottom.

II. Biological Studies

1. Haddock. Haddock abundance (catch per day) is presently being calculated for Div.5Z from "study boats," selected large otter trawlers (OTL) fishing depth zone 2 (30-60 fathoms) on Georges Bank. Since 1940 the number of study vessels has decreased from 29 to 15. Investigations of catch per day for various combinations of vessel classes were initiated in 1966 to determine if the present calculation of abundance index is still valid. Comparisons were made of the study vessels' catch per day for depth zone 2 with catch per day of all OTL's fishing Georges Bank. It was found that all OTL's displayed less variation. Presently, investigations are under way using each vessel class and depth zone as determinant factors.

Predictions of haddock year-class strength using the Grosslein Index continues to be useful. Comparison of indices and abundance of two-year-old and three-year-old fish are given in Fig. 3 for the year-classes 1955 to 1964.

2. Silver hake. Growth studies and validation of age readings have been completed. Silver hake from the Gulf of Maine and from southern New England grounds show different growth patterns during their first year of growth.

3. Scup. Growth rate of young-of-the-year scup and occurrence of the first annulus has been determined. The first year ring on southern New England scup occurs at about 10-12 cm, and the first strong ring observed is the first winter zone. No accessory annulus was noted.

4. Haddock, redfish, silver hake, yellowtail flounder. A study was undertaken to evaluate the differences between calculated average weight from the length-weight formula, and average weights taken from commercial samples. There were significant differences within years and areas for three species - haddock, redfish and silver hake - which suggests that our method of determining the estimated total number of fish landed should be revised to use sample mean weight rather than the calculated mean weight now used in our computer program.

5. Groundfish surveys. Stratified estimates of catch per tow of haddock by age groups for the nine seasonal groundfish survey cruises, 1963-66, have been completed. A preliminary analysis of these data show the effect of heavy fishing by the USSR in 1965. There are, however, several aspects of these data that will require study. First, there are strong seasonal trends which must be adjusted for, and the appearance of upward swings in abundance during the first quarter for even the immature fish indicates that something more than spawning concentrations are involved. Secondly, the overall estimated total mortality rate is about 1/2 that obtained from the commercial data.

6. Herring. Racial studies on herring, using a variety of biochemical and serological methods was continued. Blood typing indicated that adult herring from Nova Scotia, Georges Bank and eastern Gulf of Maine belong to separate subpopulations.

A study of fecundity of herring from Georges Bank, coastal Gulf of Maine and Nova Scotia was initiated in 1966. Preliminary analysis from 440 fish suggests that there is a direct relationship between number of eggs and the length, age and the index of maturity (gonad weight/body weight). The number of eggs is apparently fixed by Stage III of gonadal development. The mean range of fecundity for age groups IV through VII was 40-65,000; 75-85,000; 90-120,000; and 100-125,000 respectively. Our data show that fish (of a given age-group) from weak year-classes (1959) have more eggs than fish from strong year-classes (1960).

The sampling for herring larvae on the western coast of the Gulf of Maine indicated two major periods of spawning, one in early September and another in October. The growth rate of larvae during the winter was well below that observed in previous years.

7. Salmon. Restoration and management of Atlantic salmon resources continued during 1966 with activities centred in the State of Maine. Drought conditions affected the sport catch and delayed ascending migrants. Natural production of the salmon streams was reduced but compensated for by the planting of 439,000 hatchery-reared fish. Over 300,000 of these were smolt-sized. Fin-clipping as a means of later identification of stocks was supplemented by the release of 83,000 tagged smolts in the spring of 1966.

During 1966 ten post-kelt tags were returned from Convention waters with two of these fish taken in the Greenland fishery. Majority of the tags are taken in the shore-based Newfoundland fisheries.

Tagging studies were expanded during 1966 to include the Machias River and over 700 adults were tagged as they ascended the stream. In addition, 82,000 smolts have been tagged for release in the spring of 1967. Tagged smolts are one-year and two-year hatchery-reared fish and this will enable us to compare ages as well as stocks.

8. Lobster. Five lobster cruises were conducted in 1966 and covered the area from Corsair to Hudson Canyons along the edge of the Continental Shelf. Commercial landings also were sampled. Most of the lobsters were taken in depths between 70 and 200 m. The carapace length ranged from 5 to 21 cm and the weight from 0.2 to 13.0 kg. Mean length from the research cruises averaged 13 cm and mean weight almost 3 kg. In contrast, lobster from the inshore fishery average about 9 cm and weighed less than 1 kg.

Over 60% of the offshore lobsters were females; their dominance was greatest during the winter. The sex ratio of lobsters between 5-7 cm was 1:1. The ratio of females increased with size, accounting for 70% in some samples of large lobsters (14-16 cm). The carapace length of the smallest egg-bearing female was 9 cm. Between 12-17 cm, 50% of the females were egg-bearing in summer and autumn samples.

Lobster parasites were identified and enumerated and blood samples were collected to determine the relationship of inshore and offshore stocks.