REDBOOK 1971 PART II

REPORTS ON RESEARCHES IN THE ICNAF AREA IN 1970

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Note

REDBOOK 1971 appears in 3 books. The first book contains Part I, Proceedings of the Standing Committee on Research and Statistics. The second book contains Part II, Reports on Researches in the ICNAF Area in 1970. The third book contains Part III, Selected Papers from the 1971 Annual Meeting.

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PART II. REPORTS ON RESEARCHES IN THE ICNAF AREA IN 1970

CONTENTS

PART II. REPORTS ON RESEARCHES IN THE ICNAF AREA IN 1970

I. Canadian Research Report, 1970

A. Subareas 1, 2 and 3

by W. Templeman

The St. John's Biological Station of the Fisheries Research Board of Canada engaged in fisheries and oceanographic researches in Subareas 1, 2 and 3. The Atlantic Oceanographic Laboratory of the Bedford Institute of the Department of Energy, Mines and Resources at Dartmouth carried out oceanographical researches in Subarea 1. The Arctic Biological Station of the Fisheries Research Board of Canada in Ste. Anne de Bellevue studied the harp and hood seals and whales in Subareas 2 and 3.

Data on Canadian landings from the ICNAF area were not available when this document was prepared and any landings data used are preliminary, usually for Newfoundland only, and are only approximately similar to the data which will be reported to ICNAF in May-June.

Subarea 1

A. Status of the Fisheries

As far as I know at the present time, there was no Canadian fishery in this subarea.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic Studies. Combined hydrographic and geophysical surveys were carried out in Baffin Bay with the *R/V Hudson*.

II. Biological Studies

1. Atlantic salmon, *Salmo salar* L. Work at Greenland and on the high seas was continued during two *R/V A. T. Cameron* cruises. From 6 to 23 April drift nets and longlines were fished in the Labrador Sea, resulting in a catch of 52 salmon of which 27 were tagged. A further 322 salmon were taken and 147 tagged in the Davis Strait and Labrador Sea in September and early October. On both cruises, material was collected for morphometric and meristic studies, blood chemistry, parasite investigations and food studies. At West Greenland, comparative fishing was undertaken with the Danish *R/V Adolf Jensen*.

Of 385 salmon tagged from drift nets by the *R/V A. T. Cameron* in the West Greenland and Labrador Sea areas (mostly from Disko Bay) in September to early October 1969, 15 fish were recaptured in 1969, 14 in West Greenland and 1 in Newfoundland. In 1970, 12 recaptures were reported from this tagging, 2 from West Greenland, 5 from Canada, 2 from England, 1 from Scotland and 2 from Ireland. Overall returns from this experiment amount to 7.0% of the fish tagged. However, if returns are grouped by condition of the fish when tagged, they are as follows: fair condition - 0, good condition - 5.0%,

excellent condition - 12.7%.

Fishing was carried out with drift nets and longlines by the *R/V A. T. Cameron* in the Labrador Sea in April and in the Labrador Sea and Davis Strait in September-October 1970. The results of fishing on these and previous cruises allow some generalizations concerning seasonal distribution of salmon in the sea between Canada and Greenland. In spring, salmon are present outside the pack ice off Labrador, at least as far north as Cape Chidley (about 60°N), as far south as the southern tip of the Grand Bank (about 43°N), and in the Labrador Sea extending more than halfway between the coasts of Labrador and West Greenland. Almost all the fish taken in these areas in spring exhibit 2 sea winters on the scales. In late summer and autumn, salmon are present along the West Greenland coast between Cape Farewell (about 60°N) and Umanak (about 70°N), and are also found in small numbers in the Davis Striat as far west as 80 nautical miles from the coast of Baffin Island and also in the Labrador Sea about halfway between southwest Greenland and Labrador. These fish are almost all of age 1+ sea years. Since salmon have been taken by research vessel in the mid-Labrador Sea in spring, summer and autumn, it is possible that a number of salmon remain in this area during their seagoing phase, without migrating to or from the Greenland coast.

Preliminary analysis of scale characters, specifically measurements of annuli and counts of circuli of scales of Atlantic salmon smolts, indicate that it may be feasible to distinguish some stocks of Atlantic salmon by this method using a discriminant function analysis. By applying the method to samples of smolt scales from Sand Hill River, Labrador and River Almond (Tay System), Scotland, it was possible, using the width of each of the first two river zones and the number of circuli in each zone, to separate 85% of the smolts from these areas ($P > 0.50$). Seventy-eight percent of the Almond River smolts and 74% of the Sand Hill River smolts were identified with a probability greater than 0.80. However, when the method was applied to 220 scale samples of Atlantic salmon caught in West Greenland during *R/V A. T. Cameron* cruise 164, 1969 and separated initially on the basis of electrophoretic studies, only 63% of the American and 76% of the European salmon were identified.

Preliminary analysis of stomach contents of Atlantic salmon suggests that salmon were feeding heavily and almost continuously during August-October in the Labrador Sea, Davis Strait and coastal areas of West Greenland and during May-July in Newfoundland and Labrador coastal areas. Salmon examined from Chaleur Bay, the Miramichi estuary and Saint John estuary, New Brunswick, during 1970 had all ceased feeding except for about 5% of the fish which had taken such items as smelt, herring, alewives, three-spined sticklebacks and had some partly-digested fish material in their stomachs. The main items of diet (in terms of volume) in the coastal areas of West Greenland, Newfoundland and Labrador were capelin, launce, amphipods and euphausiids. Other items of incidental importance were redfish fry, Greenland halibut fry, herring, Arctic cod, Atlantic cod, polar sculpin, Arctic squid and alligatorfish. In the Labrador Sea and Davis Strait the main items of diet were Arctic squid and paralepids, plus some unidentified fish remains.

Studies to determine whether parasites are useful in separating stocks of salmon caught on the high seas continued in 1970. Emphasis was placed on a comparison of the abundance of the larval nematode *Anisakis* sp. and the adult tapeworm *Eubothrium crassum* in 2-sea-winter salmon caught in

home waters in 1970 with 1-sea-winter salmon caught in Greenland in 1969. In 1969, biochemically-identified North American salmon caught in West Greenland contained an average of 4.5 *Anisakis* larvae per host while European salmon in the same area contained 7.1 larvae. Thus, parasitological evidence supported the biochemical separations. In 1970 the mean number of *Anisakis* in 665 2-sea-winter salmon (tentative age assignments) from eight sampling stations in Canada was 4.5; that of 40 Irish salmon was 6.3. These data lend further support to biochemical identifications of North American and European salmon in Greenland. However, available evidence indicates that the difference in abundance of *Anisakis* in salmon from both sides of the Atlantic may be too small to be of value as a primary means of stock separation.

The variation in abundance of *Anisakis* in different Canadian samples in 1970 was much less than in 1969. Practically all samples (except Bay of Fundy) in 1970 had means (range 4.2-4.9) very similar to the mean observed in North American salmon in Greenland the previous autumn. The Bay of Fundy (Saint John area) had only 2.9 larvae per host.

When the abundance of *Anisakis* in Canadian salmon (caught in 1969) was compared with the hosts' sea ages, the mean number of *Anisakis* present was found to increase during the salmon's first three years at sea (1st = 2.5, 2nd = 3.8, 3rd = 6.9). Also the similarity of means for salmon caught in home waters (in 1970) to those for salmon caught in Greenland the previous autumn suggests that few if any *Anisakis* larvae are acquired by the salmon during the winter and spring feeding activities. Means for samples of 1-sea-winter salmon showed most variability; they ranged from 1.4 (East Shore, Bay of Fundy) to 8.2 (Labrador) and were sometimes higher than those of older fish in the same samples. This variation may be related to more restricted movements and different feeding habits of the grilse. The mean total length of *Anisakis* specimens also increased with the sea age of the salmon. This is related to the permanent nature of these worms and indicates that they continue to grow over an extended period in the salmon.

Previous studies indicated that *E. crassum* is found in a higher proportion of North American salmon in Greenland than in European salmon in the same area. In 1970 50% of more than 550 Canadian salmon were infested. This is considerably higher than the proportion estimated for North American salmon in Greenland in 1969 (24%). Observed infestations are apparently not permanent as are those of *Anisakis*. The absence of *E. crassum* in 40 Irish salmon (caught in fresh water) is not comparable with the high proportion observed in Canadian salmon (caught at sea). There was no relationship between the sea age of the salmon and the rate of infestation with *E. crassum*. Also there is no apparent relationship between the proportion of salmon infested in Greenland and the proportion infested in home waters.

Subarea 2

A. Status of the Fisheries

I. Cod, *Gadus morhua* L.

Tagging experiments have shown that large numbers of cod found offshore in winter and spring move inshore in summer. Since the inshore and offshore fisheries are exploiting the same stock of fish, changes in the abundance of the stock or stocks offshore will be reflected in changes inshore. Since 1960,

the European otter-trawl fleet has fished extensively the pre-spawning, spawning and post-spawning concentrations of cod in winter and spring. The offshore catch increased from 1960 to 1969. The inshore catch has fallen off sharply since 1967, having remained relatively stable until then only because the number of inshore fishermen had increased. The inshore population, however, has been steadily declining since 1954 as shown by a decreasing catch per man per year. It might be expected that a reduction in the abundance of the stock would be reflected more in the inshore than the offshore fishery because the inshore gears are restricted in area fished whereas the offshore fleet is mobile and has efficient fish-finding capabilities. May (ICNAF *Research Bulletin* No. 4: 67-75, 1967) attributes an increase in the growth rate of cod caught by inshore fishermen in Labrador in the period 1955-66 to the reduction of the stock by the intense offshore fishery of recent years. In addition the average sizes of cod taken by trap have decreased in recent years.

Because of lack of research vessel time the usual sampling of the Labrador coastal fishery for lengths and ages was not carried out.

An unusually large catch of 3-year-old cod was taken by the *R/V A. T. Cameron* on the southern part of Hamilton Inlet Bank in May; this is a good indication that the 1967 year-class is strong. These cod averaged about 25-30 cm in length (1,630 kg, 12,500 fish in a 30-minute set with a No. 41 Yankee net with a 24.1 m headline) and will not be of commercial size for several years. No large catches of commercial-sized cod were taken.

II. Harp and hood seals, *Pagophilus groenlandicus* (Erxleben) and *Cystophora cristata* (Erxleben).

The fishery started on 22 March. The Canadian catch of young harp seals in Subareas 2 and 3 consisted of 37,000 whitecoats and ragged jackets and 21,000 beaters, or 58,000 young seals in all. Nine thousand older harp seals were also taken and 2,000 hood seals.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic Studies. The standard section off Seal Island was occupied in early August. See the research document on hydrography of the Newfoundland area for details (Res.Doc. 71/22).

II. Biological Studies

1. Cod. In 1970 the inshore cod fishery was reported to be particularly poor. Biological observers from the Station accompanied the *M.V. Lady Anna* which was sent to the Labrador area by the Industrial Development Branch to obtain information on the fishery. Bottom water temperatures at the usual hydrographic stations were low and in addition capelin were not abundant in the inshore areas. Rapid fouling of nets by "slub" was also a factor which tended to produce low catches. The "slub" was identified by the Biology Department of Memorial University as being composed mostly of the diatom *Chaetoceros socialis*.

The low catch in the inshore cod fishery off Labrador in 1970 is attributed to the reduction of the stock by the intense fishery of recent years,

but may have been made even lower by unfavourable biological and hydrographic conditions inshore.

"Virtual population" analyses on Div. 2J cod indicated that fishing mortality values (F) for ages 4-13 increased from 0.06 in 1959 to 0.35 in 1961 and 0.40 in 1962 and then decreased to a level of 0.28-0.34 during 1963-66 except in 1965 when F increased to 0.52 for one year only because of a high proportion of older fish in the catches. Cod are first recruited to the otter-trawl fishery in this area in significant numbers (5%) at age 4, are 50% recruited at age 6 and are fully recruited at age 8.

2. Atlantic salmon. In April 1970, 5 drift net sets and 2 longline sets were made in the Labrador Sea. Twenty-seven salmon were tagged, 22 from drift nets and 5 from longlines. All 3 returns were from the Canadian mainland.

3. Atlantic mackerel, *Scomber scombrus* L. Mackerel were reported to be abundant in the Strait of Belle Isle during August-September 1970 and were plentiful as far north as Domino and Cape Harrison during late August. This is the second year in succession that mackerel have occurred in relative abundance in southern Labrador coastal waters compared with previous years. During 1969 mackerel were taken at Black Island, Labrador (53°46'N), considerably north of Triangle Harbour, the previously authenticated northern range limit. The occurrence of mackerel at Cape Harrison during August 1970 represents an even farther northward extension of their range.

4, Harp seal. Aerial survey showed about 120,000 harp seals whelping on the Front. Estimates made by aerial photographic survey are usually too low. Comparison of the strength of the one-year-old age-class with the catch of young of the same year-class suggests a production of 180,000 young on the Front in recent years. The analysis is reported in Serial No. 2476, Canada's contribution to the mid-term seal assessment meeting at Charlottenlund, 25 January 1971.

Subarea 3

A. Status of the Fisheries

I. Cod

Canadian landings from Subarea 3 were not available when this report was written and only general accounts of the status of the fisheries can be given from Newfoundland landings only. Total cod landings in Newfoundland were about fifteen percent less than in 1969. This was principally due to a poor inshore cod fishery especially in Labrador and on the northeast coast of Newfoundland.

Cod landings from the inshore fishery at Twillingate (Div. 3K) in the summer of 1970 were substantially lower than in 1969 for the corresponding period, 27 May-10 July. Handline fishing was almost non-existent whereas about 35 part-time fishermen were handlining in 1969. Also, many of the larger boats capable of fishing in water up to 360 m were concentrating on Greenland halibut, American plaice and witch flounder whereas formerly the main fishery was for cod.

In Div. 3L, observations were carried out during the summer periods of maximum fishing intensity at Bonavista and St. John's on the east coast and

Admirals Beach in St. Mary's Bay. Boats which had been engaged in the deep-water fishery with longlines off Bonavista since 1952 have changed to gillnets almost completely this year because of greater success with this gear in catching the variety of species which the processing plants now accept. Cod, American plaice, Greenland halibut and wolffish are being landed, with species other than cod amounting often to 50% of the catch. In the 1950's only cod were landed. The change in fishing and landing practice is a combined result of the decrease in the abundance of large cod and of the processing plants now being able to accept a greater number of species. Landings at Bonavista and St. John's in the peak June-July period were 15-20% lower than in 1969 and continued at a low level throughout the remainder of the year. However, trap landings in Admirals Beach were much higher in June than in 1969.

Rough weather was a severe hindrance in late summer and autumn, reducing the number of fishing days considerably. Squid for bait was again lacking as only very small quantities appeared in the coastal waters.

II. Haddock, *Melanogrammus aeglefinus* L.

Newfoundland haddock landings at about 2,070 tons, and probably mainly from Div. 3Ps, were slightly lower than 1969 landings of 2,435 tons.

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

Newfoundland landings from Subareas 3 and 4, mainly from Div. 4R increased to about 41,600 tons from 31,900 tons in 1969.

IV. American plaice, *Hippoglossoides platessoides* (Fabricius); Witch flounder, *Glyptocephalus cynoglossus* (L.); Yellowtail flounder, *Limanda ferruginea* (Storer); and Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum)

Newfoundland landings of American plaice fell slightly to 63,000 tons from 67,000 tons in 1969. Landings of witch flounder rose to 8,800 tons from 6,100 tons in 1969. Landings of yellowtail flounder increased greatly to 20,000 tons from 6,000 tons in 1969.

Newfoundland landings of Greenland halibut decreased to about 11,200 tons from 11,900 tons in 1969.

V. Herring, *Clupea harengus* L.

Herring landings in Newfoundland, mainly from the inshore area of the western part of Div. 3P, fell slightly to 158,000 tons from 163,000 tons in 1969.

VI. Atlantic salmon

Newfoundland landings of Atlantic salmon from the commercial fishery rose to 1,740 tons from 1,440 tons in 1969.

VII. Capelin, *Mallotus villosus* (Müller)

Capelin landings in Newfoundland almost entirely from the coastal area of Subarea 3 at 3,440 tons were slightly greater than those of 1969, 3,340 tons.

VIII. Short-finned squid, *Illex illecebrosus* LeSueur

Squid were very scarce and only 75 tons were landed.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic Studies. The five standard sections across the continental shelf and Labrador Current were occupied at the usual times in July-August using the Fisheries Protection vessel, *Cape Freels*. The year-round monitoring Station 27 off Cape Spear was occupied monthly or oftener throughout the year. The results of these hydrographic observations are presented in a separate document (Res.Doc. 71/22).

II. Biological Studies

1. Cod. The commercial fishery for cod, both inshore and offshore, was sampled in important Newfoundland fishing ports. Information was gathered on size, age, growth, sexual maturity, spawning, food, location of catch and catch-per-unit-effort.

For the east coast of Newfoundland, including ICNAF Div. 3K and 3L, the bulk of the work for an analysis of the stock by the virtual population method has been completed. Estimates have been made or are being made of numbers of cod of each year-class present in the fishery by each of the inshore gears and for otter trawl. This work will be completed in 1971, and will cover the period 1955-68 in Div. 3L and 1961-68 in Div. 3K.

In the trap fishery in Div. 3L, samples indicate that the 1965 and 1966 year-classes are the heavy contributors. In the gillnet catches, the 1962-64 year-classes contributed most heavily (over 50% of the numbers) at St. John's and Admirals Beach, whereas in Bonavista these year-classes were not as important as the dominant 1960 and 1961 year-classes.

Age determinations have been completed for 7,600 cod from representative samples taken in research vessel cruises in the northern Grand Bank area (ICNAF Div. 3L), 1960-70, covering depths from less than 90 to over 550 m and various seasons of the year. A preliminary analysis shows that most of the cod caught were from 2 to 8 years of age in any one year, with 1- and 16-year-olds being the extremes. Year-class dominance was in evidence but the strongest did not exceed 30% of the total in samples of any year, and strength of an individual year-class was evident in samples for 4 to 5 consecutive years. Relatively strong year-classes in the samples were those of 1955, 1957, 1958, 1959, 1962, 1964, 1966 and 1968.

During an otter-trawl survey of ICNAF Div. 3N in the spring of 1970, catches were composed almost solely of fish of the 1966-68 year-classes. Results indicate that the 1966 and 1968 year-classes were probably fairly good ones but the 1967 year-class seems to have been less abundant. Catches during a fall cruise were generally small and were composed almost solely of 1968 year-class cod.

Although no regular groundfish survey was conducted in Div. 3O during 1970, bottom sets made during squid survey cruises in spring and early summer

failed to produce significant catches of cod of any size.

The very strong 1964 year-class, which contributed to a three-fold increase in landings from Div. 3N and 3O in 1967, seems to have all but disappeared from the fishery. The landings decreased in 1968 from the high 1967 level and in 1969 were only slightly above the 1966 level before the entrance of the 1964 year-class.

Indices of abundance of pre-recruit cod caught during research vessel cruises to St. Pierre Bank in the 1957-70 period were compared with those of new recruits to the Newfoundland commercial otter-trawl fishery in this area. Correlation coefficients of 0.88 indicated that the indices from research surveys could be used to predict relative abundance indices of year-classes entering the commercial otter-trawl fishery.

Analyses of length frequencies by depth zone in connection with this study indicated that young cod of 2-3 years of age (< 37 cm) remained in most years in the 90-180 m depth zone throughout the entire March-June period, although peculiar hydrographic conditions could alter this picture. Older cod, on the other hand, were confined to the 90-180 m depth zone during the winter-early spring period but moved onto the top of the bank in the 0-90 m depth zone during late spring-early summer, and some migrated to the Newfoundland coast in summer.

Relative strengths of year-classes determined from these abundance indices indicated that survival of the 1954-65 year-classes varied only moderately, with the weakest year-classes being only 75% less than the long-term 1954-68 average and the strongest year-classes being about equal to the average. The 1966 and 1968 year-classes appear to be considerably stronger than the average, and the 1967 year-class is slightly below average.

2. Haddock. Although no regular haddock surveys were conducted in the haddock areas of the southern Grand Bank (Div. 3N-O) in 1970, bottom sets made during squid survey cruises in spring and early summer failed to produce significant catches of haddock of any size. Indications are that the adult stock of haddock in this area is at a very low level and only small quantities of commercial-sized haddock can be taken. Catches of pre-recruits in recent years indicate that the most recent year-classes up to 1968 have been poor.

During a cruise to St. Pierre Bank (Div. 3Ps), fish of the 1966 year-class were still important contributors to the catches but catches of pre-recruit fish indicated that the 1969 year-class was probably a fairly good one. However, year-classes 1967 and 1968 seemed to be very poor.

Reports of quantities of haddock were received from several areas of the south and east coasts of Newfoundland, and early in the season contributed significantly to catches by codtrap.

3. Redfish. Echo-sounder surveys accompanied by baited handline fishing in 1969 have confirmed existence of large numbers of pelagic redfish almost continuously distributed from the northern part of the Grand Bank and southern Labrador to Greenland. These redfish (*Sebastes mentella*) were usually at the 140-270 m depth and were found over water from 370 m to over 2700 m. An echo-sounder survey by the *E. E. Prince* in July 1970 from Hamilton Inlet Bank to Flemish Cap showed almost continuous records from the edges of the slopes and

over the intervening oceanic depths similar to those confirmed as redfish on previous cruises by the *A. T. Cameron*. Unfortunately during the *E. E. Prince* cruise attempts at identifying the source of the echoes as redfish were not successful and only on two occasions were fish taken from the depths at which the echo targets were most plentiful. Both of these were, however, *Sebastes mentella*.

4. American plaice and yellowtail flounder. Total mortality rates (Z) and natural mortality (M) were calculated for male and female American plaice from the northeastern and the southeastern Grand Bank. Calculations of total instantaneous mortality rates were made using two-year combinations of commercial catch curves. A comparison for the earliest and latest available data is as follows, with annual mortality rates in parentheses.

Northeast Grand Bank (north of 46°N)

	Males	Females
1955-56	0.35 (30%)	0.19 (17%)
1967-68	0.60 (45%)	0.45 (36%)

Southeast Grand Bank (south of 45°N)

	Males	Females
1957-58	0.36 (30%)	0.21 (19%)
1965-66	0.67 (49%)	0.44 (35%)

Estimates of natural mortality (M) by the Silliman method for the northeast Grand Bank were 0.24 for males and 0.14 for females and for the southeast Grand Bank 0.30 for males and 0.18 for females. The increase in total mortality reflects the increase in the rate of exploitation of this species since the fishery began in the early 1950's. A detailed assessment of this fishery is nearing completion.

A research cruise in June surveyed a series of lines on the southeast, east and northeast slopes of the Grand Bank and also the shallow central areas (Div. 3N and 3L). No large concentrations of juvenile flatfish were located. The best catches of commercial-size plaice were located on the eastern slope near 45°N where 800 kg were caught at 230 m in a 1/2-hour tow. The largest concentrations of yellowtail flounder were located just south of the Virgin Rocks (230-270 kg in 1/2-hour tow). Nearly every shallow water set (< 90 m) on the northern half of the Grand Bank produced at least 70 kg of this species.

A cruise in October to the Grand Bank north of 45°N (mainly Div. 3L) indicated that the yellowtail had migrated from the northern half of the bank since the same stations that produced up to 230 kg in June all yielded less than 45 kg in October. Plaice catches were fiarly similar for both cruises.

5. Greenland halibut. Of the 238 Greenland halibut tagged during October 1969 near the entrance to White Bay, Newfoundland, 5 were recovered during the early spring of 1970 by European trawlers northeast of Funk Island, roughly 145 nautical miles from the tagging site, and 2 were taken by inshore

boats on the eastern side of Notre Dame Bay, 75-85 nautical miles from the tagging locality. The remaining 13 of the recoveries occurred within a 50-mile radius of the tagging site, all by longliners using gillnets. All 5 offshore recoveries occurred during April and May and the inshore recoveries occurred during the July-December period. This suggests a winter migration to the continental slope for spawning.

6. Herring. In the autumn of 1969, studies were initiated to test the hypothesis that herring which over-winter in southwest Newfoundland migrate from the southern Gulf of St. Lawrence. Herring samples taken from seiner catches at Magdalen Islands (Bird Rocks) in early November just prior to the start of the fishery off southwestern Newfoundland were compared with samples taken a few weeks later off southwestern Newfoundland. Statistical analyses of eight biological characteristics (length, age, maturity condition, vertebral numbers, dorsal, pectoral and anal fin ray numbers and nematode incidence) indicate that the herring fished in both areas belong to the same stock complex. The samples from both areas consisted of similar proportions of two spawning stocks - about one-third spring spawners and two-thirds autumn spawners.

The 1969-70 samples for age determination, and those for the earlier seasons, were complicated by the presence of two basic spawning groups with autumn spawners constituting 69% of the seasonally weighted samples. The determination of ages from otoliths for fish with more than 9 growth zones is so unreliable that a 10+ grouping is used for the older fish. More than half of the autumn spawners had 10 or more growth zones and thus belong to year-classes spawned in the late 1950's, whereas fewer than one-third of the spring spawners belong to pre-1960 year-classes.

Preliminary analysis of age determinations for samples taken in the 1965-66 to 1968-69 seasons indicate that the purse-seine fishery since its beginning in 1965 has been based largely on herring of pre-1960 year-classes. During 1954-56 the herring populations in the Gulf of St. Lawrence were severely stricken with a fungus disease (*Ichthyosporidium hoferi*) and it is reported that probably more than 50% of the herring were destroyed. The resulting reduction in predation and competition for food may have been favourable to the production of good year-classes of herring in the late 1950's. Unless recruitment to the currently-exploited stocks soon increases considerably more than is apparent from the present data, the winter herring fishery along southwest Newfoundland must inevitably decline to a lower level than at present.

In an attempt to identify the various herring stocks contributing to the large fall-winter herring fishery in March 1970, 25,000 herring were tagged with internal stainless steel tags on the southwest coast of Newfoundland. Tag recoveries were reported from the meal-line magnets at the Isle aux Morts plant within a week of the commencement of tagging and, up to mid-December 1970, 559 tags were recovered from plants in southern Newfoundland and southern Gulf of St. Lawrence, representing a recovery rate of 2.2%. Seeding experiments at the Isle aux Morts plant indicated a recovery efficiency of 30%. The distribution of tag returns was as follows:

Area of recapture	Dates of recapture 1970	No. tags recovered
Southwest Nfld.	6 March-15 April	391
St. Pauls-Magdalens	16-30 April	51
Bird Rocks	1-15 May	13
Gaspé-Chaleur Bay-Bradelle Bank	26 June-20 October	90
Burgeo Area, Nfld.	3-19 December	4
Doubtful	-	10
		559

The significant feature of this recapture data is that the herring stocks which support the fall-winter fishery on the south coast of Newfoundland represent the over-wintering phase of a stock complex of herring derived from spring and fall spawnings in the southern Gulf of St. Lawrence.

Studies of the incidence and intensity of infestation of herring with larval *Anisakis* continued during 1970. Preliminary analyses of the occurence of larval *Anisakis* in adult herring ($\geq$ 30 cm) indicate that this parasite is valuable as a biological indicator of stock heterogeneity. Incidence of infestation was higher in herring from southwestern and northeastern Nova Scotia (74% and 64%) and the Banquereau-Sable Island area (66%) than in herring from southwestern Newfoundland and the southern Gulf of St. Lawrence (25-29%). *Anisakis* incidence increased northwards along western Newfoundland to 61% in the Strait of Belle Isle. There was a southward decrease in eastern Newfoundland to 8% in spring-spawning herring from Notre Dame Bay and thence an increase to 48% in herring along the eastern Avalon Peninsula. Both the incidence and intensity of infestation increased with fish age (size).

The intensity of infestation in herring from southwestern Newfoundland and the southern Gulf of St. Lawrence (about 0.50 nematodes per fish) is very low in comparison with eastern North Atlantic herring, particularly those from the North Sea. Even the highest intensities in the Canadian area (2.01 to 2.96 nematodes per fish) are comparable to the intensities in herring from Scotland and Ireland, which have been termed low by European investigators.

The remarkable similarity in *Anisakis* incidence in herring from the Magdalen Islands in the autumn and spring, from southwest Newfoundland in winter, and from the Gaspé area in summer supports the view that the fisheries in these areas at different times of the year occur on the same stock complex. Although only a few samples from Nova Scotian areas have been examined, the higher but similar incidence values for southwestern and northeastern Nova Scotia and the Banquereau-Sable Island area suggest a possible inshore-offshore migratory pattern on the Scotian Shelf and that these herring do not intermingle to any great extent with the more northerly Gulf of St. Lawrence-southwest Newfoundland stocks. From nematode abundance it appears that herring along the northwest coast of Newfoundland are also relatively distinct from southern Gulf-southwestern Newfoundland herring.

Studies on herring which over-winter along southwestern Newfoundland have revealed significant meristic differences between spring- and autumn-

spawning herring. Mean numbers of gillrakers and of pectoral, anal and dorsal fin rays are all higher for autumn-spawning than for spring-spawning herring ($P < 0.01$), with gillraker and pectoral fin ray numbers exhibiting the greatest degree of difference between spawning groups. However, there is no significant difference between mean vertebral numbers of spring and autumn spawners of this population.

7. Atlantic mackerel. During 1970, approximately 900 mackerel were collected from Newfoundland coastal areas for studies of length, weight, sex, maturity, age and growth and feeding.

A sample of adult mackerel obtained from Placentia Bay during early July 1970 contained a high proportion of pre-spawning and spawning fish. This is the first documented capture of pre-spawning and spawning mackerel in southern or eastern Newfoundland waters and confirm the occurrence of at least sporadic mackerel spawning in southeastern Newfoundland as suggested by the presence of 0-group mackerel in Conception Bay during November 1968. Juvenile mackerel captured in Conception Bay during November 1968 were much smaller than those reported in late fall in the coastal waters of northeastern United States.

8. Capelin. Certain irregular zones that have been noted in the otolith structure of Newfoundland capelin resemble the descriptions of spawning zones or checks in other species of fish. These irregular zones are characterized by an accentuated translucent (winter) band followed by a narrow opaque (summer) band which in the younger fish is sometimes divided by a check. A comparison of the marginal zone of the otoliths of recovering-spent capelin at the end of their growing period in October and November with the marginal zone of the otoliths of pre-spawning, spawning and recently-spent capelin has demonstrated that these irregular zones represent spawning zones and that the well-defined winter band and narrow summer band are the result of the pronounced inhibition of growth due to spawning. A preliminary study has indicated that a few individuals survive to spawn three times; that on a percentage basis repeat-spawning is more common among females (average 30%) than amongst males (10%) and that on the average, repeat-spawners are smaller than first-time spawners of the same age.

9. Launce, *Ammodytes dubius* Reinhardt and *A. hexapterus* Pallas. Analyses of meristic and morphometric data of launce have revealed that the Grand Bank and St. Pierre Bank specimens are slender with relatively short heads and high meristic counts, whereas those from Trinity Bay and St. Mary's Bay are deep-bodied with relatively longer heads and low meristic counts. Consequently the offshore launce have been provisionally assigned to *Ammodytes dubius* and the inshore specimens to *Ammodytes hexapterus*. Differences in body form and meristics are also evident within these two groups, particularly in meristic characters of the inshore specimens.

10. Atlantic salmon. Additional returns were recorded from the 1969 tagging of 247 salmon out of 270 caught by drift nets of synthetic twine at Port aux Basques. Returns to 31 December 1970 amounted to 42.5% of the fish tagged. A previous experiment in 1937 with similar methods of obtaining the fish for tagging but with hemp instead of synthetic twine in the drift nets and a tag attached to the dorsal instead of immediately in front of the dorsal gave a return of 13.3% of the fish tagged.

Distribution of returns from the 1970 tagging was as follows:

	Returns in 1969	Returns in 1970	Total	%
West Greenland	-	1	1	1
Labrador	-	1	1	1
W and SW Newfoundland	22	3	25	24
Miramichi River & drift nets	34	2	36	34
Chaleur Bay	17	-	17	16
Gaspé & Anticosti	4	-	4	4
Quebec North Shore	15	3	18	17
Nova Scotia	3	-	3	3
Total	95	10	105	100

Twenty-one percent of the returns were from anglers. Fish were rated as fair, good or excellent condition when released, and percentage returns from each group were 26%, 45% and 43% respectively. Of the salmon tagged from monofilament nets, 49.1% were returned; the corresponding return of fish tagged from multifilament nets was 40.6%.

Two qualitative differences in the non-specific serum protein patterns of salmon were employed to differentiate between North American and European salmon.

Of twenty-five salmon in six samples taken by the *A. T. Cameron* in April 1970 just off the continental shelf of northeastern Newfoundland and southern Labrador, 52% were of European and 48% of North American origin. In 1969 for northern Greenland waters 43% were of North American origin. The European content of the Labrador-Newfoundland sample is unexpectedly high.

To find out just how close to shore European salmon might migrate, samples were gathered from Bonavista and St. Anthony, Newfoundland during the early summer. These fish were caught in shallow water just off the shore. Of approximately 150 fish analysed, only one had protein patterns identical to the European control samples. This fish had five river years.

In August salmon sera were collected in Iceland. Thirty-four fish were sampled, 15 of which were from the State Experimental Fish Farm at Kollafjördur, north of Reykjavik; the remainder were from two rivers of Faxa Bay. All fish showed the European type of protein pattern.

11. Pink salmon, *Oncorhynchus gorbuscha* (Walbaum). Field work at North Harbour River associated with the pink salmon transplant was continued in 1970.

The estimated fry run in 1970 was 670,000, from spawning of 1,116 adults in 1969. Estimates of fry survival from the 1969 spawning were obtained from egg samples buried in plastic containers in the gravel of the main river (77%), by enumeration of fry at the mouth of the spawning channel from egg

deposition by 7 females in 1969 (75%), and by a mark and recapture experiment during the fry run in the main river (72%). In each case, the estimate is slightly below that for 1969 (80, 78 and 76%).

To determine the extent of predation on pink salmon fry during their migration to sea, gillnets were fished near the head of tide at various times during the run. Stomachs of 135 brook trout, 28 brown trout and 310 smelt were examined. One smelt contained 2 fry in its stomach while 4 brook trout contained a total of 209 fry.

Returns in 1970 were an estimated 1,490 to the river plus 600 reported from other areas, mainly in the commercial fishery. These were the progeny of the natural spawning of 1,353 adults in 1968 (no eggs planted since 1966). The first recorded return at the fence was on 15 July, and the last on 14 September. The fence was extensively damaged by flood conditions on 8 August and again on 11 August and was inoperative during most of the period between 8 and 14 August. The total count of adults through the fence was 316; the estimated number of 1,490 was calculated on the basis of redd counts after spawning was complete, the ratio between number of redds and number of females counted in 1969, and the sex ratio of the 316 fish actually counted in 1970. With the exception of a few late-running fish, spawning occurred from 8 to 25 September, mainly 15-20 September, and was distributed over the lower 5 1/2 km of North Harbour River and 1 km of a tributary (Cataract Brook). At the beginning of the spawning period, 100 male and 101 female salmon were transported to the spawning channel (most spawning takes place in the main river below the mouth of the channel). Reports from other areas were as follows: 568 fish from the commercial fishery, of which 80% were from St. Mary's and Placentia bays on the Newfoundland south coast (North Harbour River empties into St. Mary's Bay), and the remainder almost entirely from the Newfoundland northeast coast. Twenty-five fish were sighted in other rivers in St. Mary's and Placentia bays, 6 fish angled from scattered Newfoundland areas, and 1 fish taken at a counting fence at Indian River on the northeast coast.

Twelve egg samples were placed in plastic containers in the gravel of the main river. Development was more rapid than in the previous few years (with hatching on 13-19 November, compared with 5-9 December in 1969 and 9-20 December in 1968).

12. Short-finned squid. Previous research has indicated that the populations of squid which are commercially exploited in Newfoundland inshore waters during the summer and fall months migrate from the south and appear on the continental shelf off southern Newfoundland and Nova Scotia in spring, prior to their arrival inshore. Two cruises were conducted in these areas to study the distribution, abundance and biology of the northward migrant squid, with special reference to characterizing populations from size distributions, maturities, parasite burden and polymorphic proteins.

During the first cruise (*R/V A. T. Cameron*), fifty 30-minute otter-trawl sets were run from 22 May to 2 June on 12 lines of stations running from 100 to 370 m. Squid were taken in 11 sets in numbers ranging from 1 to 390. The only squid taken south of Newfoundland were 390 specimens at the mouth of the Haddock Channel; most specimens were taken on the southern part of the Scotian Shelf and were smaller than those on the Newfoundland banks.

During the second cruise (*R/V E. E. Prince*), 56 otter-trawl sets

were run 23 July-4 August in the same areas fished on the previous cruise. Squid were taken in all areas except the southern tip of the Grand Bank. Most catches ranged from 1 to 50 specimens with larger catches being taken in the Haddock Channel (350 and 204 specimens) and the southwestern part of the Sable Island Bank (146 and 207 specimens). Squid were generally smaller on the Scotian Shelf but maturities were further advanced in the larger males.

B. Subareas 4 and 5

by F. D. McCracken

Canadian researches in Subareas 4 and 5 on oceanography and fish stocks were carried out by the Fisheries Research Board from the following establishments: the St. Andrews Biological Station, the Marine Ecology Laboratory (Dartmouth), the St. John's Biological Station, and the Arctic Biological Station (Ste. Anne de Bellevue). The Bedford Institute of Oceanography of the Department of Energy, Mines and Resources also contributed to these research efforts.

Reports on studies by many scientists whose names appear in the list of Canadian scientists engaged in work concerned with ICNAF problems were used in preparing this report. Raw data for preliminary summaries of 1970 landings were obtained from the Canadian Department of Fisheries and Forestry.

Subarea 4

A. Status of the Fisheries

I. Groundfish General

A strike by fish handlers at various Canadian mainland ports in March and April and a strike by fishermen at three ports in eastern Nova Scotia from May to December markedly affected Canadian mainland groundfish landings. We estimate that the former strike reduced landings by about 12,000 metric tons and the latter by 20,000 metric tons. Total reduction is about 12% of total Canadian mainland landings. Pro-rated over actual landings for 1970, the species breakdown for "lost" landings is approximately (in metric tons):

Cod	-	12,800
Haddock	-	2,900
Redfish	-	7,800
Flatfish	-	5,000
Others	-	3,500

II. Cod

Mainland landings declined by 4% from 1969 but made up about 40% of total weight of groundfish landed. Cod landings from Div. 4R-S-T and 4Vn continued their trend upward from 1967. Cod landings from Div. 4Vs, 4W and 4X decreased by 23% from 1969 and 44% from 1968 levels. This decrease is partially attributed to strikes and closure of an area in Div. 4X in March and April. In addition, larger units of our mobile fleet are spending less time in these areas due to poor availability of haddock and possibly cod.

III. Haddock

Haddock landings, declining since 1967, dropped sharply by 40% from the 1969 level and were only half that of 1968. Slight gains were registered from Div. 4R-S-T and 4Vn. However, these are not really significant since haddock landings from all these areas account for less than 4% of the total. Div. 4W and 4X show large declines of about 43% in each. Some of this decline resulted from diversion of effort from haddock to other species, mainly cod, flounder, and redfish in Div. 4V and 4T, and some resulted from the strikes.

IV. Flatfish

Total landings of flatfish (plaice, witch, yellowtail, winter flounder) were about 8% below those of 1969. This decline seems definately a result of the strike at ports in eastern Nova Scotia. At these ports in 1969 flatfish comprised over a third of their landings and contributed about 25% of the total mainland flatfish landings.

Generally, increases were registered in Div. 4R-S-T, 4Vn, and 4X, while the remainder of the area showed decreases.

Atlantic halibut landings were down by 23% from 1969, but this may reflect a reduction in effort rather than a change in abundance.

V. Redfish

The rising trend in landings begun in 1963 has continued, and the increase of 4% would have been much higher except for the strikes. Landings from Div. 4R-S-T were down slightly, but landings from 4Vs, 4W and 4X increased. This suggests that, due to poor availability of haddock in the latter Division, some trawlers fished deep water for redfish more often than in previous years.

VI. Pollock

Pollock landings were down by 20% from 1969. Since most of these are caught in Div. 4X and 4W, the decline may result from decrease in effort in these areas.

VII. Other groundfish

Other groundfish include hake, cusk, wolffish, unspecified or mixed groundfish. Together, they comprise about 5% of the total landings. Hake and cusk are important to several localized inshore fisheries, the former in Div. 4T and the latter in Div. 4X. Landings of these two species showed increases in 1970.

VIII. Sea scallop, *Placopecten magellanicus* Gmelin

Total landings remained around the 1969 level at 14,200 metric tons whole weight (1,702,00 kg meats). A decline in landings to 3,860 metric tons in Div. 4X was offset by an increase in landings from Div. 4T to 9,400 metric tons. A new event was the landing of some Iceland scallops (*Chlamys islandicus*) from Div. 4T, 4V, and 4W. Since most scallops are shucked at sea, it will be difficult to distinguish landings of this species from those of *Placopecten*.

IX. Herring

Landings in Subarea 4 (excluding Div. 4R) amounted to 317,000 metric tons, about the same quantity as landed in 1969. Landings increased from 143,000 to 169,000 tons in Div. 4T, and from 6,000 to 17,000 tons in Div. 4W. These increases were offset by smaller landings in Div. 4X: 132,000 tons in 1970 compared with 170,000 tons in 1969 (and 280,000 tons in 1968). The increases and decreases can be related in part to changes in fishing effort although in Div. 4X it is evident that abundance has declined. Landings from all regions are expected to be lower in 1971.

X. Swordfish

Canadian swordfish catches which are all landed in Subarea 4 amounted to nearly 5,000 tons in 1970, an increase of about 700 tons over 1969. The catch by Subarea was (approximately): Subarea 3, 1,900 tons; Subarea 4, 1,200 tons; Subarea 5, 1,300 tons; Subarea 6, 600 tons. Fishing records indicate that both availability and effort were somewhat greater in the eastern part of the range (Subareas 3 and 4) in 1970. Mean size of swordfish landed continued to decline, but this chiefly reflects the large numbers of small (< 20 kg) swordfish taken in Subareas 5 and 6. Because of high levels of mercury in swordfish flesh, there is unlikely to be a fishery in 1971.

XI. Mackerel

Landings in Subarea 4 (excluding Div. 4R) were nearly 15,000 metric tons, an increase of 2,000 tons (15%) over 1969. Landings from Div. 4W and 4X were about 10% less than in 1969, but this decrease was more than offset by increases in the southern Gulf of St. Lawrence and its approaches (Div. 4T and 4V). Evidence from all Subarea 4 regions indicates a substantial increase in the abundance of mackerel in the northern part of its range.

XII. Tuna

Total Canadian landings of tuna in 1970 amounted to slightly more than 3,900 metric tons, about 40% of which (1,560 tons) came from a reactivated fishery for small bluefin and skipjack off the coast of New Jersey (Subarea 6). Incidental landings of bluefin, bigeye, yellowfin, and albacore from swordfish vessels were approximately 300 tons. The remainder (2,100 tons) was a mixture of yellowfin and skipjack from the eastern Pacific and the Gulf of Guinea. Except for the virtual certainty that incidental landings by swordfish fishermen will disappear in 1971, no reliable forecasts for the tuna fishery can be made.

XIII. Sharks

Landings of several species amounted to 7.6 metric tons, about the same as in 1969.

XIV. Atlantic Salmon

Total catch, commercial and angling, for Subarea 4 (exclusive of Div. 4R) declined to 575 tons from 670 in 1969 and 804 in 1968. Commercial catch in Div. 4S-T-V-W decreased by 10% from 1969 but rose in Div. 4X by 20% (catch 44 tons). The angling catch (79 tons) was about half that in 1969. Grilse

again comprised 60% by numbers of angled fish.

XV. Harp and hood seals

The fishery started on 20 March. The Canadian (also the entire) catch in the Gulf of St. Lawrence (Div. 4R-S-T) was 45,000 whitecoats and ragged jackets, and 11,000 beaters or 56,000 young seals in all. In addition, less than 1,000 older harp seals were taken. Hood seals are protected in the Gulf of St. Lawrence.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic studies. A numberical study of the M_2 tide and tidal streams in the Gulf of St. Lawrence (Div. 4R-S-T) was completed. Circulation pattern there, deduced from salinity and temperature observations, were also correlated with the pressure systems in and around the Gulf area. The detailed observations in the Gaspé-Bradelle Bank (Div. 4T) area reported previously were analysed, and the drogue movements agreed with the geostrophic calculations, although no gyres were observed. The observations program in that area was repeated in November 1970 for a tighter network of stations and with a computer on board so that preliminary analysis could be done in ship time. The observations were partly repeated after 2 weeks, and the oceanographic conditions were completely changed, pointing to the danger of combining observations so far apart in time. Current observations during that period are being analysed.

A study of the response of the Scotian Shelf water to hurricane "Gladys" was done, taking into consideration the partition of energy among different scales of motion and the apparent concentration of energy near the Shelf edge. A general study of the response of the Shelf to meteorological conditions is continuing.

Studies of different inlets around Nova Scotia (Div. 4V and W) continued, including Chedabucto Bay, Canso Strait, Petpeswick Inlet, Halifax Harbour, Bedford Basin, and St. Margaret's Bay.

2. Plankton studies. A four-year study of the relative abundance and seasonal distribution of herring larvae in the Bay of Fundy (Div. 4X) and Gulf of Maine (Subarea 5) was completed in 1970. The program consisted of four seasonal cruises each year, extending over a 1,200-mile cruise track, with plankton hauls, temperature and salinity observations, releases of drift bottles and seabed drifters at about 90 locations for each cruise.

Preliminary analyses suggest that, although there were differences between years, especially in total numbers of larvae caught, the general pattern was similar each year. Herring larvae were abundant in autumn, considerably less in winter and spring, and virtually absent in summer. Distribution of newly hatched larvae indicated two important spawning areas: the northern edge of Georges Bank (Div. 5Z), and the southwest coast of Nova Scotia (Div. 4X). For both areas the significant spawning is in autumn. These autumn-hatched larvae grow slowly, reaching a length of 30-45 mm by spring.

The main features of surface circulation in the region are variations in the southwest drift along the coast of Maine and in exchange of surface

waters between the Bay of Fundy and the Gulf of Maine. Both are associated with the northerly drift along the west coast of Nova Scotia and with formation and disappearance of the Gulf of Maine eddy.

Surface circulation undoubtedly influences distribution of herring larvae and it appears that larvae from southwest Nova Scotia spawnings are held within the Bay of Fundy and its approaches. There were no recoveries of drift bottles released in the southern part of the study area and hence nothing can be said about the effect of surface circulation on the eventual fate of larvae produced on Georges Bank.

In 1970, analyses of a herring larval survey were completed for the Scotian Shelf (Div. 4V-W). Field studies of recruitment of cod and other species in Div. 4T by menas of egg and larval surveys continued but at a reduced level.

3. Other environmental studies. A program of environmental survey and monitoring was begun for the Gulf of St. Lawrence (Div. 4R and T) by a special cruise to assess pollution levels by sampling the water column, biological organisms and sediments through the Gulf, Estuary, and River.

Charts of sea surface temperature, layer depth, and selected bathythermograms for Subareas 3, 4, 5, and 6 were prepared and broadcast daily by the Maritime Command Weather Office of the Canada Forces.

II. Biological Studies

1. Groundfish general. Research-vessel survey methods were reexamined and revised during 1970 and a new stratified random method developed for groundfish populations extending from Div. 4X to Div. 4T. Annual quantitative groundfish otter-trawl surveys were extended to encompass the entire Bay of Fundy (Div. 4X), the Scotian Shelf (Div. 4V-W-X), and the southern Gulf of St. Lawrence (Div. 4T). These surveys were coordinated with comparable surveys by the USA and USSR, forming part of a survey program extending from Cape Hatteras (Subarea 6) to Banquereau (Div. 4V).

2. Cod. Continuing population studies in Div. 4T showed 4- and 5-year-old fish predominating in landings. Numbers of prerecruit cod and other commercial species in the autumn trawl survey (Div. 4T) indicated adequate recruitment to the 1971 fishery.

Analysis of the Div. 4X cod fishery indicated that the rapid increase in landings in the 1960's resulted mainly from development of an offshore, predominantly Canadian, otter-trawl fishery on Browns and LaHave Banks. Abundance (by weight) of the exploited stock declined 30% between 1965 and 1969. The level of fishing mortality from 1965 to 1969 ($F = 0.70$) was considerably above that giving maximum sustainable yield-per-recruit.

3. Haddock. Assessment of the eastern Scotian Shelf (Div. 4V-W) haddock stock indicated that the traditional, mainly Canadian, fishery on adults has been exploiting this population close to its maximum yield-per-recruit under present mesh regulations. Impoverishment of the 1961-64 year-classes by the greatly increased fishery in 1965-66, combined with recruitment of several naturally poor year-classes, resulted in the present low adult stock abundance.

The average abundance in 4V-W of 1954-59 year-classes at ages 1-3, from research-vessel surveys, is significantly correlated to their abundance estimated from Canadian commercial fishery statistics at age 4. From tentative predictions of year-class strengths, and assuming that fishing mortality remains at about F = 0.50, the total population available to the fishery will decline further from 25 million fish in 1969 to 20 million in 1972 and yield from 9,000 to 12,000 tons. Prerecruit surveys in 1970 gave no indications of improved recruitment prior to 1974.

Most recent studies of the Div. 4X haddock fishery indicate that the ICNAF annual quota of 18,000 tons annually for 1970-72 is much too high to prevent serious stock decline. Recruitment to this fishery has been poor since 1963, and prerecruit surveys in 1970 gave no indication of significant improvement.

Studies of spawning period and fecundity of haddock showed that peak spawning in Div. 4X-W stocks occurred about the last week in April in 1970.

4. Silver hake. Studies of gill parasites in this species were concluded and are being reported; there was no evidence that the parasites were useful as biological indicators.

5. Northern sand launce. Meristic and morphometric studies of launce continued in an effort to characterize populations and relate characteristics to environment. Experimental fishing indicated that catches may vary with tidal flow, probably as a result of the behaviour of the fish in relation to tidal currents.

6. Food resource and digestion rates. Studies on seasonal changes in gross energy content of major natural fish foods have been virtually completed. While many species showed no regular seasonal fluctuation in calorific value, some crustaceans changed seasonally by as much as 48% of their annual minimum value. The euphausiid, *Meganyctiphanes norvegica*, showed significant annual differences in energy content as well as regular seasonal change.

For young cod acclimated at 5, 10, and 15°C and fed 0.4 g (dry weight) of euphausiid and shrimp, the time taken to empty their stomachs was: for euphausiids 29, 15, and 13 hours; for shrimp 58, 25, and 20 hours.

7. Herring. Studies of herring stocks show that the 1968 "sardine" year-class on the New Brunswick side of Div. 4X was apparently poor and that of 1969 seems poor also. Stocks in the Nova Scotia region of Div. 4X are being maintained by the 1966 year-class. In the Gulf of St. Lawrence (Div. 4T) the exploited herring stock was made up of a high proportion of older fish. The scarcity of younger recruits indicates that a period of lower catches will likely follow.

In Div. 4T, 56,000 herring were marked with internal metal tags, from commercial traps at the Magdalen Islands and from purse seines off Gaspé. Recaptures in 1970 numbered 497. Seeding experiments with tags introduced directly into the fish plants gave average recovery rates of 28%. Thus, the 497 recaptures are probably less than half the number actually taken.

The pattern of tag recaptures shows a migration of herring into and

out of the Gulf of St. Lawrence. The returns suggest that, whatever the spawning type, the herring at times occur together in the same general area and the same populations of fish contribute to three major fisheries: off the Magdalens and off Gaspé in Div. 4T, and off Newfoundland in Subarea 3.

Meristic analysis of Bay of Fundy herring (Div. 4X), especially the "sardine" component, suggests that the New Brunswick and Nova Scotia stocks might be distinct. The conclusion that Nova Scotia (Div. 4X) herring and those of Georges Bank (Div. 5Z) are discrete is reinforced by these results.

8. Swordfish. Preliminary tagging results suggest that swordfish may return to the same area of the continental shelf each year and tend to remain there all summer. The results also show a tenfold increase in the return rate of harpoon-tagged, free-swimming fish compared to that of fish released from longlines.

9. Tuna. Size data for bluefin tuna show that the 1969 year-class was strong in the New Jersey Subarea 6 fishery during August, with the 1967 year-class dominating September landings. The 1966 year-class apparently did not contribute to the fishery, although some older fish were caught.

Large bluefin have been increasingly abundant in the more northern parts of their range, including Div. 4T. This may be associated with warmer than average surface water (0.5-1.5°C above the mean), particularly during the summer warming period. Such early warming may be important in determining the distribution of bluefin forage species, and hence the subsequent occurence of this predator species.

Continuation of a sonic tagging program in cooperation with the Woods Hole Oceanographic Institution resulted in temperature-telemetering sonic transmitters being attached to 8 large bluefin. Seven of these fish were followed for up to 56 hours and 130 miles, all but one leaving St. Margaret's Bay, N. S., where they were tagged. Data demonstrating regulation of body temperature by these fish were obatined.

10. Atlantic salmon. About 137,000 hatchery reared and 37,000 wild smolts were tagged and liberated in stock evaluation and utilization studies. Over 3,000 adult salmon and grilse were tagged and liberated in fishery areas or as they entered and ascended rivers.

Drift-net tagging of Atlantic salmon was carried out in the Miramichi drift-net fishing area (Div. 4T) in June and July; 384 fish were caught and 304 of these tagged. Returns of tagged grilse (20.9%) were lower than returns of tagged larger fish (47.3%). Slightly higher returns were obatined from salmon tagged after capture in monofilament, as opposed to multifilament, nets.

Tag returns for wild Miramichi smolts tagged from 1964 through 1968 show: 52% as grilse in Canada (15% to commercial fisheries, 19% to angling, 18% escapement), 10% from Greenland, 38% as large salmon in Canada (33% to commercial fisheries, 3% to angling, 2% escapement).

Returns as large salmon only (1965-68 liberations) show: 24% off Greenland area, 9% in Newfoundland, 52% in Miramichi area commercial fisheries, 4% in other mainland fisheries, 7% by inland angling.

Returns as grilse from a group of wild smolts given a subacute dosage of DDT were only half as great as from a group given similar handling but without DDT.

Recruitment in mainland rivers to the 1970 underyearling class was low in most sample areas. This reflects decreased numbers of adults, especially 2-sea-year and older females. Available data indicate still lower adult runs in 1970.

Pollution in rearing areas from forest operations and mines was associated with lowered production of young. Industrial pollution from pulp mills and wood-treatment plants was accompanied by slower upstream passage of ascending salmon, as shown by tracking individual fish, and by simultaneous water quality studies.

Using biochemical techniques, genetic polymorphism was shown to exist for blood transferrins of Atlantic salmon. Different gene pools appear to be characteristic of different areas, large river systems, and possibly even parts of some river systems.

Returns from five lots of hatchery reared smolts of selected 2-sea-year parents included 63% as 2-sea-year fish and 37% as 1-sea-year fish. Returns from four lots of hatchery reared smolts from 1-sea-year parents gave 61% as 1-sea-year and 39% as 2-sea-year fish.

11. Harp seals. Aerial survey showed about 65,000 harp seals whelping in the Gulf. Estimates made by aerial photographic survey are usually too low. Capture-recapture tagging corrected for distribution of tagging and sealing suggested about 80,000 young seals born in the Gulf in 1970. Comparison of the strength of the 1-year-old age-class with the catch of young of the same year-class suggests a total production of 265,000 young for the whole population and 180,000 young for the Front in recent years, leaving 85,000 for production in the Gulf. The analysis is reported in Serial No. 2476, Canada's contribution to the mid-term seal assessment meeting at Charlottenlund, 25 January 1971.

Orientation of young seals was studied in the Gulf by experimental release and short-term tracking of 25 1-month-old animals in various parts of the Gulf in April 1970. The animals consistently moved into the wind, showed no clear pattern of activity under windless conditions, and moved towards an icefield at 20 m distance only. Although wind patterns in April 1970 would have allowed the animals to migrate correctly by moving into the wind, the same is not true for other years. Two distant tag recoveries from the released experimental animals, up to 1 year of age, showed that their subsequent migratory behaviour was normal.

III. Gear and Selectivity Studies

Continued development and trials of acoustic echo-counting equipment have been carried on. This has proved to be successful for demersal surveys, and studies are in progress to determine usefulness in guiding commercial operations.

The acquisition of quantative data on the behaviour of commercial types of groundfish otter trawl and the development of verified engineering principles for the rational design of new trawls remain the current aim of fishing gear engineering research. A procedure, based on recognized engineering principles,

was developed for extending the information available from data already obtained. Experimental information, after primary reduction, provides simultaneous quantitative data on: wing spread, headline height, hydrodynamic (stagnation) pressure in the mouth of the trawl, four bridle tensions at the wing tips, warp tensions, and warp angles at the towing block, vessel speed through the water, towing velocity over the sea floor, ocean currents, and structural details of each trawl.

The above engineering procedure will also provide from these experimental data: detailed shape of the headline and footrope involving estimated load distributions, resolution of each of the four wing-bridle tensions into three force components (drag, transverse, and vertical), detailed shape of the wing bridles and ground warps, three components of ground-warp tension at the doors, detailed shape of the towing warps, three components of towing-warp tension at the doors, door spread, transverse or spreading force produced by the doors, and the vertical force exerted by the doors on the sea floor. These synoptic statements of simultaneous data taken for fifteen different trawl constructions at speeds ranging from 2.5-5 knots should provide enough factual information to check most hypotheses concerning the distribution of stresses in and the shape of the "working gear" of otter trawls.

Subarea 5

A. Status of the Fisheries

I. Cod

Canadian mainland landings of cod, at an estimated 2,500 tons, declined by 57% from 1969.

II. Haddock

Landings of haddock for the area were down by 53% from 1969. Over 19,000 metric tons of haddock were landed by mainland Canada from this area in 1966. In 1970, the landings were estimated at 1,900 tons.

III. Sea scallop

Landings from Div. 5Z continued to decline and the 33,400 tons whole weight (4,024,000 kg meats) landed were 8% lower than for 1969. The decline resulted despite addition of four vessels to the Canadian offshore fleet. A small recruitment to the fishery, within a limited area on the Northern Edge of Georges Bank, was fished intensively. The remaining effort was distributed over the rest of the Northern Edge, and in deeper water off the Northeast Peak. A survey at three principal Canadian ports in May-August 1970 showed a significant difference between ports in meat size landed. Analysis of log records suggested that this reflected an underlying difference in area fished by boats from these ports. Vessels from two of the ports concentrated on the area of recent recruits and landed meat sizes were around 101 and 95 meats/kg. Boats from the third port (landings averaging 57 meats/kg) fished pockets of larger scallops to the exclusion of the area of recent recruits.

IV. Herring

The Canadian fishery continued at a relatively low level at about 3,800

tons. Most of the catch was made in the southern part of Div. 5Y.

V. Swordfish

Landings for the whole ICNAF area are included in the section on Subarea 4. However, catches in Subareas 5 and 6 were approximately 1,900 tons, about 38% of the total.

B. Special Research Studies

I. Biological Studies

1. Scallop. A research cruise to the Northern Edge of Georges Bank (Div. 5Z) in June used a modified scallop drag with attached underwater camera to estimate a standing stock of approximately 1.4 million kg of scallop meats within the 80 square nautical mile (274 km^2) area of the recruitment concentration. Population densities within the area averaged more than $1/m^2$ and were considerably higher than those observed elsewhere.

Experiments on size selection for scallops were carried out within the area of high density small scallops.

2. Herring. A successful international project to survey Georges Bank (Div. 5Z) spawning beds by submersible, involving the USA, Canada, and the USSR, was carried out in late September and early October. The Canadian contribution was the use of the 8-ton submersible *Pisces* which traversed herring egg beds, resulting in the collection of valuable information on the physical structure of the beds, their faunal characteristics, and on the herring populations using them.

II. Danish Research Report, 1970

by Erik Smidt

Subarea 1

A. Status of the Fisheries

The nominal catches taken by Denmark (Greenland) in 1970 are given in the following table:

Table 1. Greenlanders' nominal catches, 1970 (provisional figures).

Species	Nominal catch (tons)	Increase or Decrease from 1969 (%)
Cod	20,174+)	-15
Redfish	154	+12
Wolffish	2,700	-20
Greenland halibut	1,325	-14
Halibut	4	+33
Atlantic salmon	1,267++)	-10
Capelin	3,124	+1,688
Lumpsucker roe (not converted to round fresh fish)	417	+63
Arctic char	120	-38
Industrial fish	278	+24
Deep sea prawn	8,429	+27
Total	37,992	+11

+) Excl. 926 tons landed by small Faroese boats in Faeringehavn (Div. 1D).

++) Excl. Danish drifters (app. 335 tons).

I. Cod

1. The fisheries. The downward trend of recent years has continued in 1970 with a decrease of 15% from 1969. Considering that in 1970 about 21% of the catch was landed by the Greenland trawlers, which is a little more than twice the 1969 landings, the Greenland inshore fishery from small vessels has probably decreased about 20% from 1969.

The decrease of the Greenland inshore fishery was mainly due to the failing pound-net fishery, which began about one month later (in June) than in 1969. The ice conditions and the cold surface water are regarded as the main causes for the decrease.

2. Forecast for 1971-72. It is expected that the cod fishery in 1971-72

will be based mostly on the 1965 and 1966 year-classes. Presumably the 1966 year-class will be dominant in the northern catches (Div. 1B-C) while there may be a more equal representation of these two year-classes in the southern catches (Div. 1D-F), where the 1963 year-class is also expected to be of some importance. However, as the 1963 year-class originates mainly from the East Greenland - Iceland spawning area, a considerable spawning migration to that area may be expected. Most likely the recent years' decline in the Greenland coastal fishery will continue, while the new Greenland trawlers (4 vessels in 1971) will raise the landings from offshore fishing.

II. Atlantic salmon

The total catch in 1970 was of the same order as in 1969 (about 2,150 tons, of which the Greenland-Danish-Faroese catch amounted to about 1,600 tons). There was an especially good inshore fishery in Div. 1E-F contrary to 1969 when Polar ice ("storis") impeded the fishery. The drift-net fishery also had good catches in the southern part of Div. 1E in September. In the previous year almost all drift-net caught salmon were fished in Div. 1A, 1B, and 1C. Also in 1970 a considerable number of Greenland vessels took part in the offshore fishery.

III. Other fish

Fisheries for wolffish, Greenland halibut and Arctic char decreased. There was a considerable increase in the lumpsucker fishery for caviar production, and the fishery for capelin increased immensely. A small increase is noted for the redfish fishery.

IV. Deep sea prawn

There was a considerable increase in the prawn fishery in continuation of the previous years' growth in that fishery. The offshore fishery has now become of some importance, five vessels having taken part in that fishery in 1970.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. (See F. Hermann, "Hydrographic conditions off West Greenland during 1970.", ICNAF *Redbook* 1971, Part III)

II. Biological Studies

1. Cod

a) Eggs and larvae. Hauls with 2 m stramin net were taken at the standard hydrographic sections in Davis Strait in May-June. Oblique hauls were taken from approximately 50 m to surface (wire length 225-0 m). Eggs taken in May-July are shown in Fig. 1. The greatest quantities were taken in May over the western slopes of the banks off Godthåb and Frederikshåb, but the numbers were considerably smaller than in 1969.

Cod larvae taken in the same months are shown in Fig. 2. Numbers per half-hour were even smaller than in 1969 when the larvae also were scarce.

Thus the amount of larvae as well as the hydrographic conditions indicate a very poor West Greenland 1970 year-class.

b) Occurrence of pre-recruit cod (age-groups I, II and III). These age-groups were generally very poorly represented in 1970. In commercial pound-net landings (Fig. 3) age-group III was represented in Div. 1B in smaller quantities than in 1969. In Div. 1F no pre-recruits were observed in landings from pound-nets, whereas small cod, mainly the II-group, were represented in beach-seine catches. In an offshore research catch (Div. 1D, depth 300 m) by small meshed otter-trawl (36 mm), age-groups II and III amounted to 11 and 10% respectively, while age-group IV amounted to 62% and older age-groups to 17%.

c) Age and size distribution of cod in landings. Fig. 3 shows age and size distribution in cod from offshore landings from otter-trawl and inshore landings using various gears. All samples are from commercial landings except sample No. 10 which is from a research vessel.

In 1969 the 1966 year-class was regarded as relatively good in the pre-recruit stage. In 1970 it occurred in the landings for the first time, expecially in landings from gears, in which smaller fish are captured. In pound-net landings from Div. 1B (sample No. 7) it amounted to 41% by numbers, while it was scarce in landings from the same gear in Div. 1F (sample No. 8). Further, the 1966 year-class was dominant in inshore landings in Div. 1C (sample No. 13, gear not known) and in the above mentioned offshore research trawl catch (Div. 1D). By the end of 1970, the 1966 year-class reached a size which allowed it to be represented in the offshore trawl catches (sample No. 4, Div. 1D). To judge from its occurrence the 1966 year-class is of West Greenland origin.

In addition to the 1966 year-class, the most important year-classes were 1963, 1964, and 1965. They dominated the trawl landings from Div. 1C - 1D (samples Nos. 1 - 4), while the 1963 year-class only was dominant in trawl landings from Div. 1E (samples Nos. 5 - 6). Also in the inshore landings in Div. 1F (samples Nos. 8, 10, 14) the 1963 year-class was absolutely dominant. The occurrence of the 1963 year-class strongly suggests its East Greenland origin, while the 1965 year-class is regarded as West Greenlandic to judge from its occurrence.

The previous rich 1960 and 1961 year-classes have decreased very much, but they were still dominant in some inshore catches in Div. 1B (sample No. 11, long-line, and No. 12, gear not known, but likely also long-line).

d) Tagging experiments. A total number of 1,642 cod was tagged, of which 796 were small cod (less than 50 cm total length) caught in inshore waters in Div. 1D (pound-net) and in Div. 1F (beach-seine). Details are given in the following table:

Div.	Inshore small cod	Inshore big cod	Offshore big cod
1C	0	11	0
1D	567	0	54
1E	0	105	0
1F	229	676	0
Total	796	792	54

2. Atlantic salmon

As in previous years, collaboration with scientists from Denmark, UK and Canada was carried out. From 29 March to 1 April 1971, the ICES/ICNAF Joint Working Party on North Atlantic Salmon met in Pitlochry. The resulting report includes the 1970 data. Therefore only a brief summary is given here.

Major effort was concentrated on tagging salmon. In the Kapisigdlit River (Godthåb Fjord, Div. 1D) 155 parr were tagged; in the coastal area 67 gill-net captured salmon were tagged; and 21 long-line captured were tagged in the offshore area. Further effort was concentrated on sampling for age and size distribution and for blood and tissue. Much material was collected also from the commercial catches.

3. Other fish

American plaice was sampled from trawl catches, as this species is now regarded as a possible resource for the industry. In Godthåb Fjord (Div. 1D), 639 Greenland halibut were tagged. In the same area, and in Julianehåb district (Div. 1F) herring samples were collected and a total of 305 specimens tagged.

4. Deep sea prawns

Continuous research catches were taken on offshore grounds in Div. 1B and 1D, and new offshore fishing experiments were made in Div. 1E.

5. Seals

Jaws and sexual organs were collected from hooded seals in southwest Greenland (Div. 1F) and in East Greenland (Angmagssalik district) for age and maturity determination. In northwest Greenland (Div. 1A) about 100 harp seal jaws were collected in different settlements, and about 50 jaws of ringed seal were collected in Angmagssalik district.

C. Practical Fishing Experiments

As in previous years the Royal Greenland Trade Department (KGH) has conducted practical fishing experiments in Greenland waters. The most important were some comparative experiments with different types of prawn-trawls in Disko Bay (Div. 1A) in order to find the most effective gear. A Norwegian trawl and a Danish North Sea trawl were compared with the traditional Greenland trawl. Results favoured the Norwegian trawl and several Greenland fishermen

are now using this gear.

Off Sukkertoppen (Div. 1C) experimental fishing for American plaice was started for a production of frozen fillets.

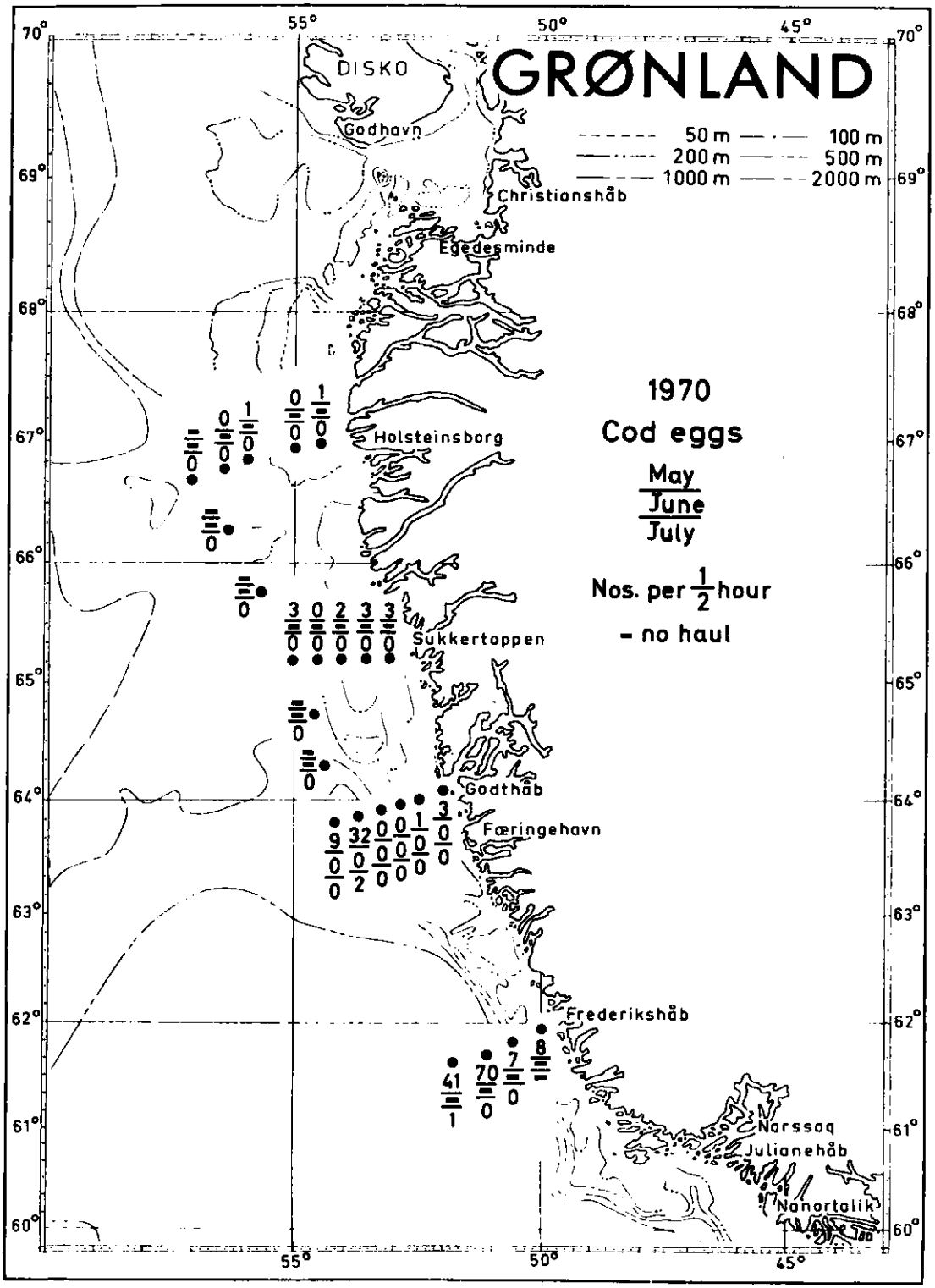


Fig. 1. Cod eggs (number per 1/2 hour) taken by 2 m stramin net in the upper water layers (maximum depth about 50 m).

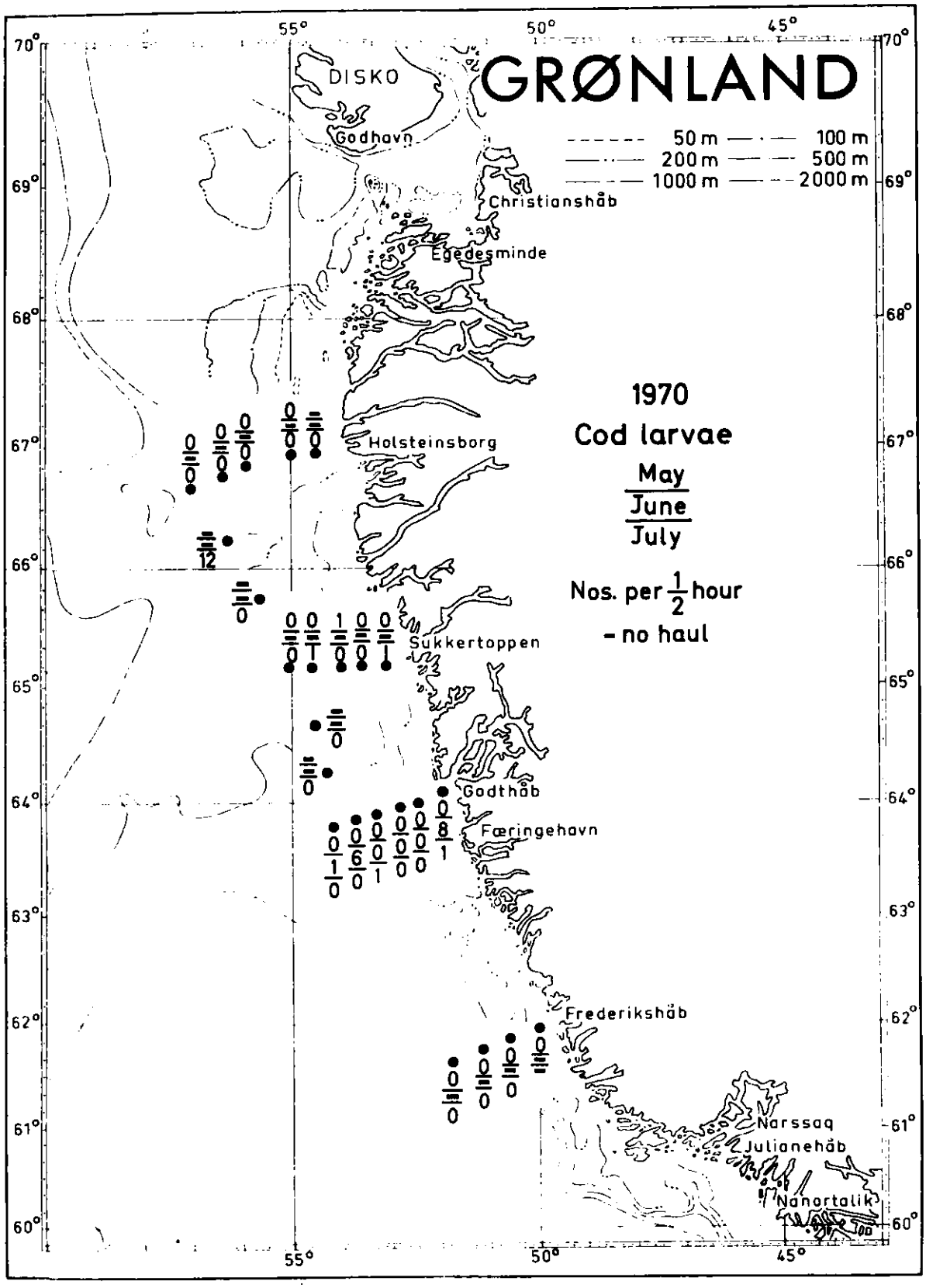


Fig. 2. Cod larvae (number per 1/2 hour) taken by 2 m stramin net in the upper water layers (maximum depth about 50 m).

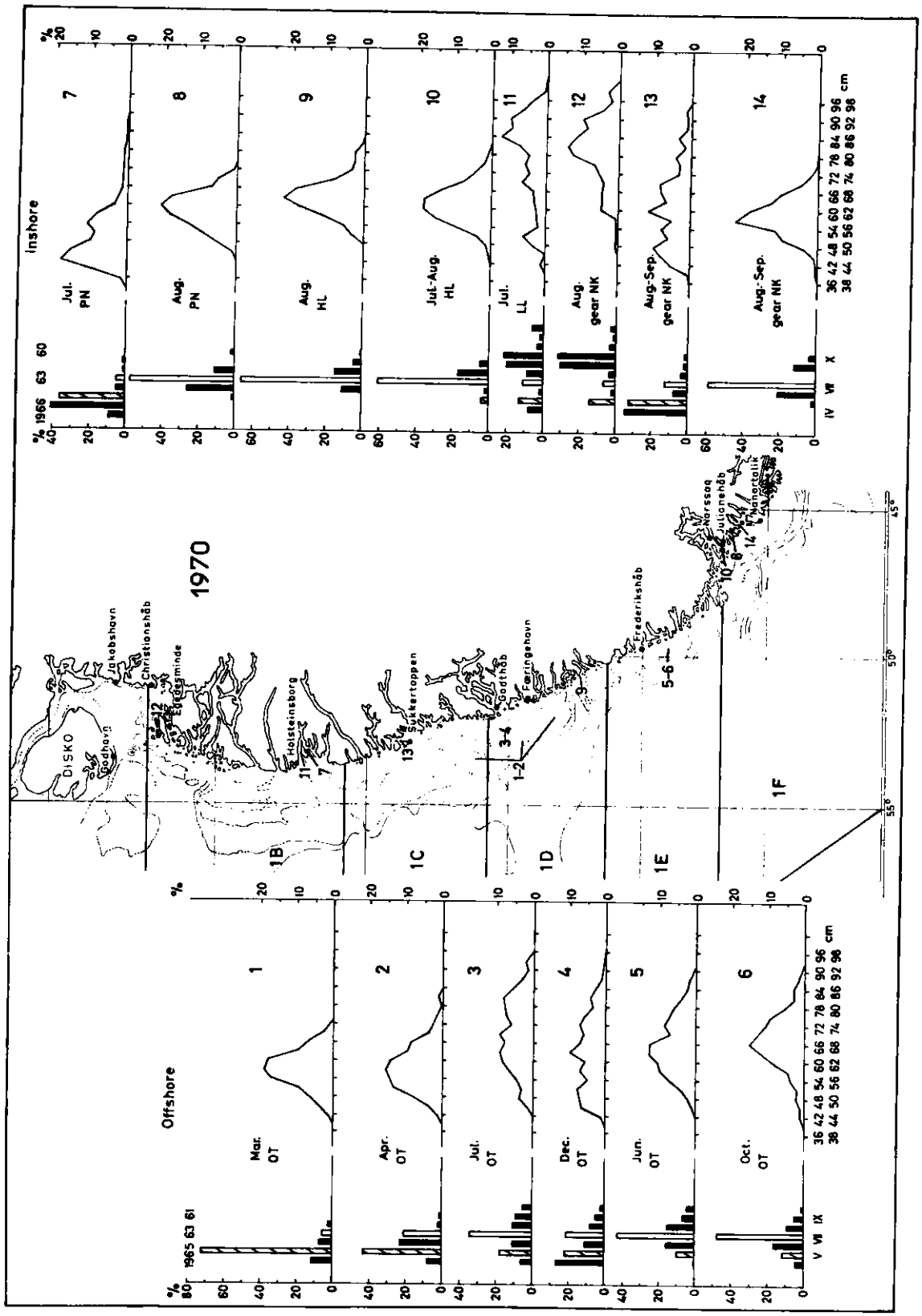


Fig. 3. Age and length compositions of cod sampled from commercial landings (one research catch sample No. 10). To the left offshore samples (Nos. 1-6) and to the right inshore samples (Nos. 7-14). The locations at which samples were taken are shown on the map. OT = otter-trawl, PN = pound-net, HL = hand-line (snelle), LL = long-line, NK = gear not known.

III. French Research Report, 1970

A. Subarea 1

by Ch. Allain

Research Studies

The oceanographic vessel *Thalassa* based at L'Institut des Pêches Maritimes worked in Subarea 1, between Frederikshaab and 72°30'N lat during the period 6 July to 20 August (Fig. 1, 2 and 3).

I. Environmental Conditions

1. Ice situation. Ice covered all the southwestern banks and work could only be attempted commencing at Frederikshaab Bank, on the edge of the slope. In the northern part, from the sill of Davis Strait to the centre of Baffin Bay, the ice pack occupied all the eastern section up to meridian 60°00'W.

2. Hydrographic observations (Fig. 1, 2, 3, and 4). Because of this situation, observations were made under poor conditions at the limit of Frederikshaab, Dana and Fiskenaes Banks. The eight sections on the latitudes of Godthaab, Sukkertoppen, Holsteinborg, Egedesminde, south and central Disko, from the 72nd parallel and through the deep of Disko were occupied without any major difficulty.

A total of 541 temperature, salinity and dissolved oxygen observations were made from 51 standard stations, to a depth of 1,500 m. These observations were complemented by 75 bathythermograms which were effected mainly after each trawl, and by a continuous recording of surface temperature and salinity.

The surface temperature remained very low up to Dana Bank where a minimum of 0.4°C was observed, and a maximum temperature of 4.2°C was found south of Disko Bank. In the north centre of and on the sill of Davis Strait, the temperature remained lower than 0°C, to the west of the meridian 57°, due to the influence of the northern ice.

The minimum temperature of Arctic water reached 0.9°C at about 30-40 m in the south, +0.15°C to +0.6°C at about 100 m from Fyllas Bank to the outside north of Hellefiske Bank, -0.98°C to -1.7°C at about 50-80 m between Disko and the 72nd parallel.

The underlying, intermediate Atlantic water, enclosed by isotherms of 4°, and by 3 and 2° in Baffin Bay, was separated from the Arctic water by a rather distinct gradient situated between 120-200 m and 240-370 m. The higher isotherm of 4° was found at about 300-400 m on the Davis Strait banks. The maximum temperature of 5.04° was reached on slope of Sukkertoppen at about 450 m.

North of the sill, the deepest observation of 1050 m gave a temperature of 0.26° at that depth.

The conditions are different in the deeps depending on whether the barriers which closes them off partially at the entrance are found at tne level of the cold layer or at the warm layer in open sea. Thus the temperature of 1.40° is observed at 440 m in the Holsteinborg deep, while at the same level,

at sea, it is 4°. On the other hand, the deep which extends along the Disko Bank is washed with water of a temperature higher than 4° and a salinity of 34.70°/$_{oo}$.

The bottom temperatures are given in Fig. 1, 2 and 3. As the banks are found at different depths, the conditions change appreciably from one section to another. On Fyllas Bank, we observe 2.15°; on the top of Lille Hellefiske, 1.6° and on Store Hellefiske, 2.15° to 3.5°. At about 80-160 m one enters the Arctic layer where temperatures are barely above 0°. The gradients of the contact zones between the different masses are more or less restricted according to the inclination of the slope.

The regularity of the Danish observations on 4 sections of West Greenland allows one to make a comparison with preceding years. At the 500-m station, on the western edges of Fyllas Bank and with regard to data averages up to 1968, the anomalies are negative up to 300 m, but a little lower than in 1968: from 0 to 50 m = -1.08°; from 50 to 100 m = -1.17°; from 100 to 200 m = -1.44°; from 200 to 300 m = -0.71°; on the other hand, from 300 to 400 m = +0.04°; from 400 to 500 m = +0.17°.

Furthermore, the surface temperature is generally lower than in 1968, but the Arctic layer is a little less thick. The Atlantic layer from Irminger seems more important, with values appreciably higher.

II. Observations on Fishing

During this survey, 96 trawl hauls were made, on top of the banks as well as on the slope. The Lofoten trawl, modified on the lower wings, and the semi-pelagic trawl 35/42 were used, the first in the southern section and the second in the northern section, according to the difficulties encountered in this section.

Eighty-nine trawl hauls were chosen for scientific study. These were grouped by geographic section and by stage. For data purposes, the duration (often shortened) was brought to one hour of fishing.

The main commercial species are represented by cod (*Gadus morhua*), redfish (*Sebastes marinus marinus* and *Sebastes marinus mentella*), American plaice (*Hippoglossoides platessoides*), wolffish (*Anarhichas lupus*, *A. minor*, *Lycichthys denticulatus*), and the Greenland halibut (*Reinhardtius hippoglossoides*). We can also add to this list the pink shrimp (*Pandalus borealis*) sometimes taken in large enough quantity.

1. Yields. The yield per hour calculated by stage for these different species appears in Fig. 5, 6, 7 and 8 for cod, redfish, American plaice and Greenland halibut.

The largest quantities of cod were taken south of the Godthaab latitude (ICNAF Div. 1D), at depths of 50-150 m and 150-300 m. with yields of 544 and 1,063 kg/hr. It will be noted that a one-hour trawl haul made southwest of Dana Bank, between 170 and 230 m, yielded 4,300 kg cod.

The best redfish catches were made north of Godthaab, and particularly in the Disko section where the hourly yield surpassed 1,300 kg, between 350 and 400 m. Nevertheless, on "Banana" Bank, at a depth of 380 to 420 m, a haul of

76 min produced approximately 1,700 kg of beautiful fish.

North and south of Godthaab, the American plaice was taken in small quantities in all surveyed stages, at a depth of 0 to 550 m, but still yielding 208 kg/hr on Fyllas Bank at a depth of 140 to 170 m.

The wolffish and Greenland halibut are represented among all other species taken. Wolffish were mainly taken on Dana, Fiskenaes and Fyllas Banks at a depth of 50 to 400 m with hourly yields reaching 219 kg/hr; the Greenland halibut was encountered more particularly beyond 400 m on the edges of "Banana" Bank and in the deeps of Sukkertoppen and Holsteinborg.

2. Observations on stocks and biology of main species.

Cod (Fig. 9). Since 1967, fishermen of all nationalities exploiting the West Greenland fishing grounds found that their annual cod tonnage decreased year after year.

If one refers to the works of Hensen, Rasmussen and Templeman, one realizes that, in addition to the local populations of the fjords, there exist two cod stocks west of Greenland, one being southern which would extend from Cape Farewell to Frederikshaab, and the other northern, from Frederikshaab to north of Disko. Tags indicated that individuals of the first stock would sometimes migrate to the spawning grounds of Iceland; whereas, the second stock would be relatively stable. There would not be any exchange between these two populations which would reproduce from March to May-June and more particularly in April; the spawning would be carried out particularly south of 65°N and at a depth of more than 200 m. The rate of production of the southern stock would be less than that of the northern stock.

The ice situation prevented us from studying the first stock and our study was thus limited to the northern population. This study was concentrated on the banks south of Godthaab where the hourly yields of certain trawl hauls were satisfactory: 4,280 kg, 1,156 kg, 1,190 kg and 4,960 kg on Dana Bank; 1,155 kg and 938 kg on Fiskenaes Bank. In the majority of cases, the size varies from 40 to 90 cm, with means predominating at 61, 64 and 79 cm. From the previous results of foreign vessels, these dimensions would correspond by analogy to age groups V and VIII, *i.e.* year-classes 1965 and 1962. On Fiskenaes Bank, at a depth of 150-380 m, one also observes a relatively important proportion of individuals measuring 43 to 46 cm and being probably three-year-olds (year-class 1967).

In these sections the presence of sand launce was detected. These were in their period of reproduction and were the essential nutrition for cod.

North of Godthaab, the hourly yields were very small at all levels; the best yield provided 67 kg/hr at a depth of 150-200 m. Beyond latitude 69°13'N (off Disko) and up to 72°30', the limit of our survey, no cod were taken.

The size of fish varies from 22 to 97 cm in both Div. 1B and 1C. However, the presence of little individuals (19 to 34 cm), not more than two years old, was noted; there were less at a depth of 150-280 m, and were more numerous at a depth of more than 280 m.

In all sections studied, reproduction had ceased, but it was noticed that in July reproduction had ceased only recently for some fish.

Three cod larvae only were identified in the numerous plankton samplings made during the survey, which only confirms the low rate of reproduction for cod shown for some years. Therefore, recruitment will apparently not improve in the coming years.

Redfish (Fig. 10). The two types, *Sebastes marinus marinus* and *S. marinus mentella* were encountered predominantly in the form '*marinus*' south of Godthaab and '*mentella*' to the north.

In the southern part, low yields reach a maximum of 120 kg/hr between 350 and 400 m, but it must be emphasized that we did not trawl above this last level. The size of fish is interesting, however, since it varies from 20 to 55 cm, with means of 27-28, 30, 36, 42 and 46 cm. In Div. 1D one establishes that the form '*marinus*' is found uniformly spread from 150 m, while the form '*mentella*' is observed beyond 280 m.

North of Godthaab, the yields are clearly above the previous ones mentioned and reach 1,340 kg/hr between 350 and 400 m, but in most cases the '*mentella*' type fish is not commercial size (averages of 11-16 cm). Nevertheless, west of "Banana" Bank, we observed an average of 40 cm during a 76-min haul which produced 1,664 kg.

It will be noted that in this northern section, the type '*mentella*' was always caught at depths beyond 280 m, while the type '*marinus*' only appeared at depths of 150-280 m in Div. 1C where the size of fish was mainly between 16 and 34 cm.

As far as reproduction is concerned, this had already ceased.

American plaice (Fig. 11). As previously mentioned, the American plaice (*Hippoglossoides platessoides*) does not give an interesting yield on the western border of Greenland. The yield is 50 kg/hr at the top and south of Godthaab (Div. 1D and 1C) and decreases progressively towards the north, becoming nil in Div. 1A, north of 68°30'.

This fish is encountered at all levels, but it is noted that the best catches are made on Fyllas Bank between 140 and 170 m (208 kg/hr) and in the Holsteinborg deep between 270 and 320 m (210 kg/hr). South of Godthaab, the size is between 12 and 45 cm, giving three means: 15-16 cm for the young individuals, 25-26 cm for males and part of the females, 37-38 cm for females only. The most frequent size is found between 20 and 30 cm. The largest individuals (21 to 41 cm) of commercial size are mostly encountered at depths beyond 280 m.

North of Godthaab, in Div. 1C, averages are 26-27 cm for males and a part of the females and 33-36 cm for females only. The young individuals (mean 8 cm) do not appear until further north, Div. 1B; in this section other means are 18-19 cm (male and female), 26 cm (male), 36-37 cm (female). The most frequent size, 20 to 45 cm, is observed in depths of 100 to 150 m.

In most cases the American plaice were spawning or had just spawned, which leads one to believe that, having been given the period of time from the

beginning to the end of observations (starting in July for the south, starting in August for the north), reproduction is carried out progressively from the south to the north.

Greenland halibut (*Reinhardtius hippoglossoides*). This fish is encountered in all sections surveyed. Its yield increases with latitude since one passes from 15 kg/hr in Div. 1D to 26 kg/hr in Div. 1C, 35 kg/hr in Div. 1B and finally 75 kg/hr in Div. 1A.

South of Godthaab, the best catches were made between 250 and 350 m, with an average yield of 47 kg/hr and a maximum yield of 71 kg/hr in the deeps of Godthaab.

North of Godthaab, the small catches at the depth of 150-200 m increase regularly with depth, reaching 350 kg/hr at about 850-900 m. This yield increase on the slope of Baffin Sea is inversely proportional to the number of individuals caught, due to the fact that their size increases with depth and their number decreases from the edge of the shelf to the greater depths surveyed.

In fact, in Div. 1A, the size is distributed from 8 to 56 cm between 350 and 450 m with means of 10 cm, 18-20 cm and 26-32 cm. Between 550 and 600 m for the same demonstration, a mean of 39 to 41 cm is added to the first three. At about 800-900 m the fish measure from 25 to 70 cm with a single mean of 41-47 cm. It will be noted that in the Holsteinborg deep the distribution is made between 11 and 48 cm with means of 14-15 cm, 24-28 cm and 36-41 cm.

Wolffish. These are present in all stages south of Godthaab; the best catches were made on Fiskenaes Bank. The size of *Anarhichas lupus* mostly varies from 46-47 cm to 68-69 cm with a mean of 60-61 cm.

Shrimp. The pink shrimp (*Pandalus borealis*) was sometimes taken in great quantity along the whole edge of Greenland. It will be noted that shrimp was especially abundant in the deeps, where the bottom is muddy. The highest yield was obtained in the deeps of Godthaab, Sukkertoppen with 55 kg/hr, and in the Holsteinborg deep with 60 kg/hr. However, the *Thalassa* was not equipped for this kind of fishing and it is known that the Danish trawlers take more than 100 kg/hr.

It will be noted that the shrimp was also present, but in lesser quantity, on the exterior slope of the banks, at a depth of more than 280 m.

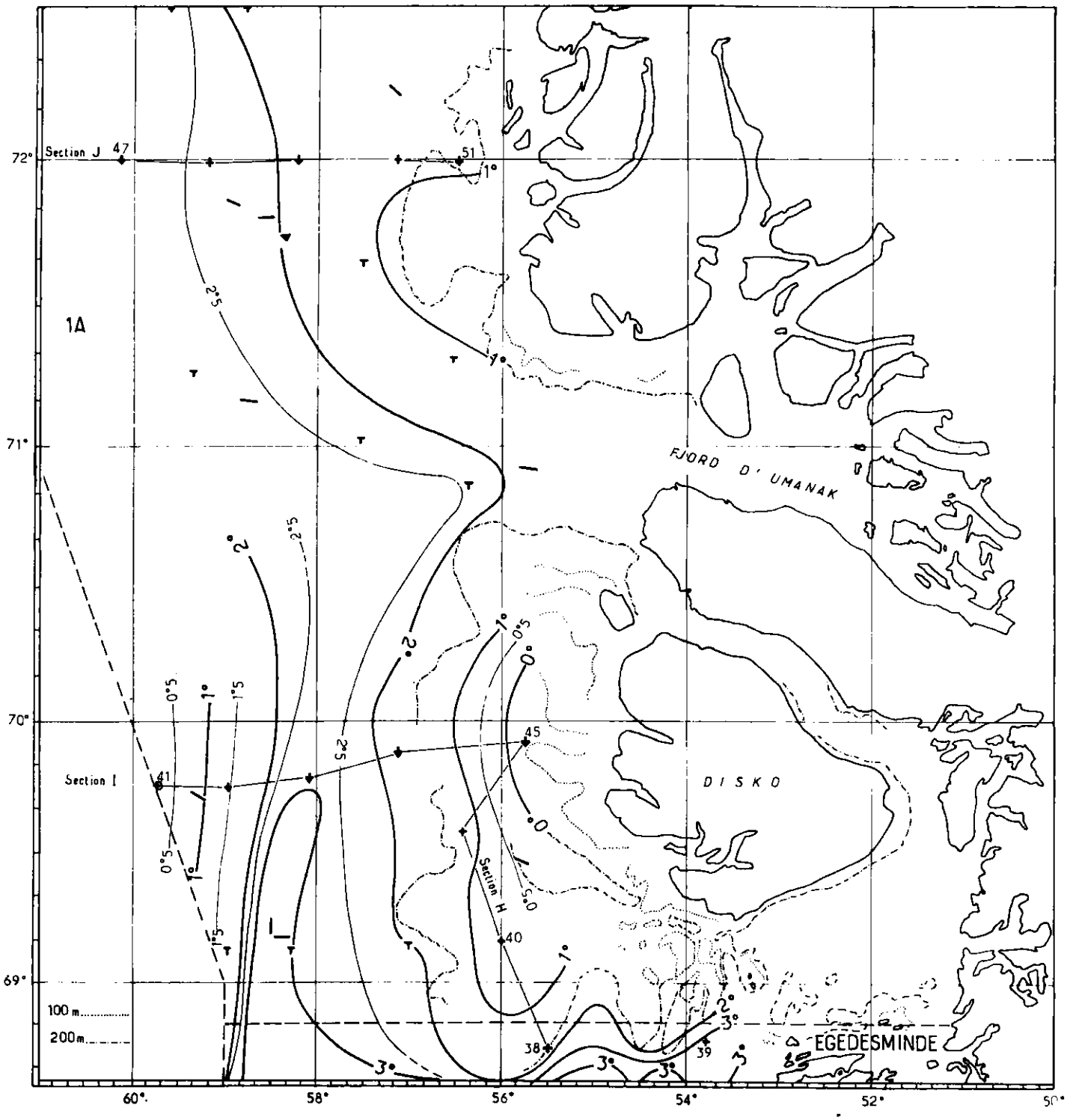


Fig. 1. Plots of trawl hauls and various stations, showing isotherm profiles near bottom between latitude 72°30' and Egedesminde. (See Fig. 2 for legend.)

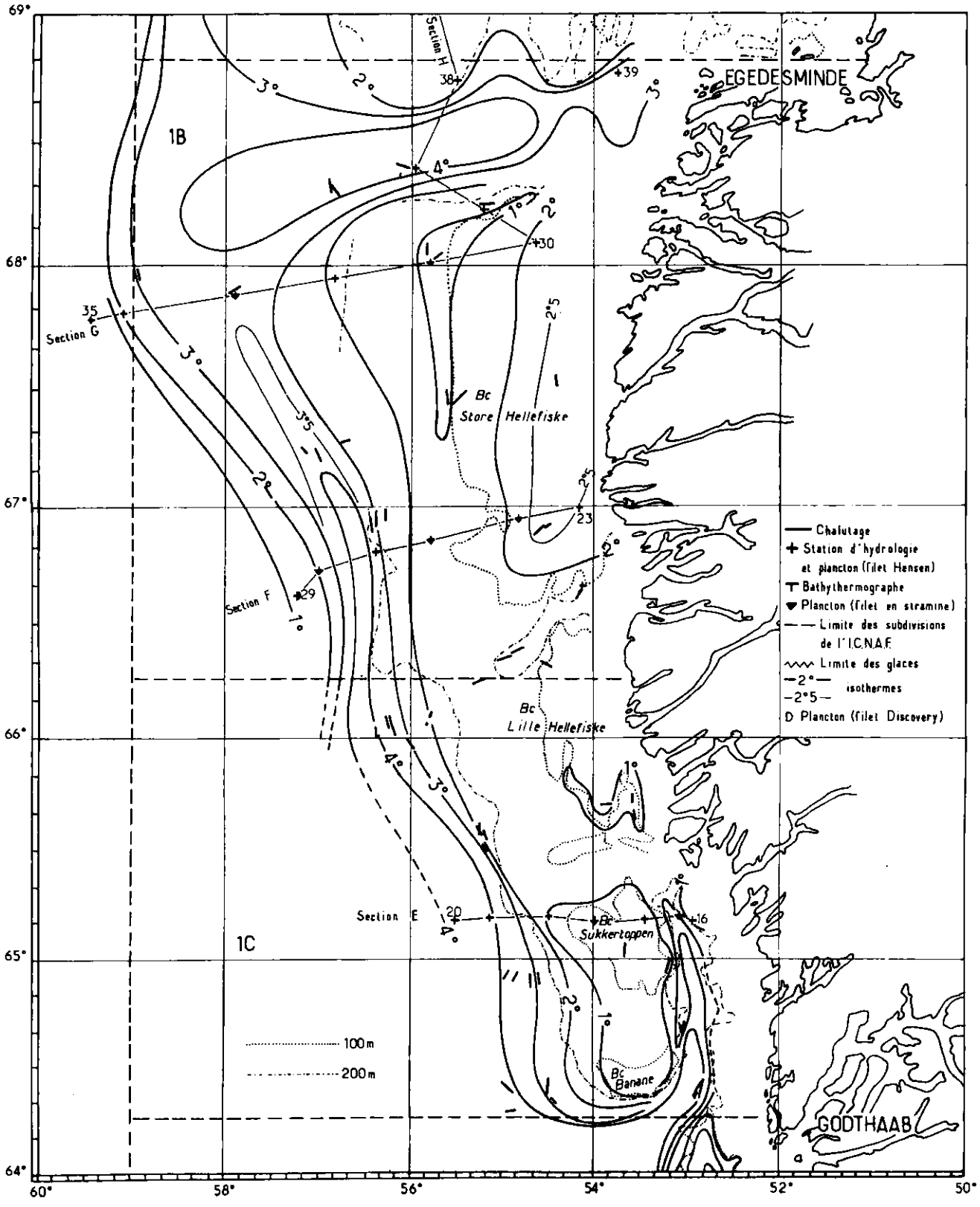


Fig. 2. Plots of trawl hauls and various stations, showing isotherm profiles near bottom between Egedesminde and Godthaab.

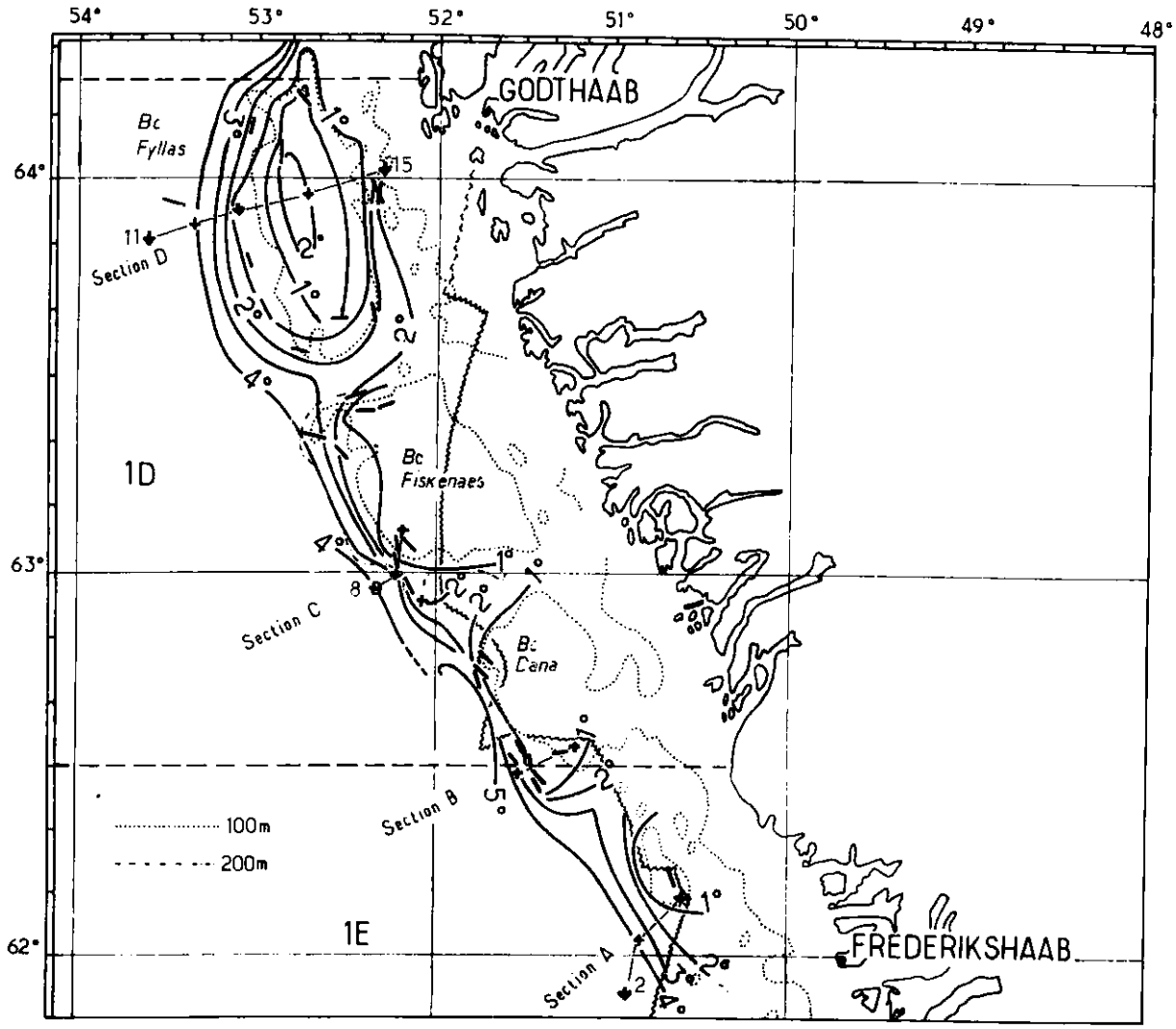


Fig. 3. Plots of trawl hauls and various stations, showing isotherm profiles near bottom between Godthaab and Frederikshaab. (See Fig. 2 for legend)

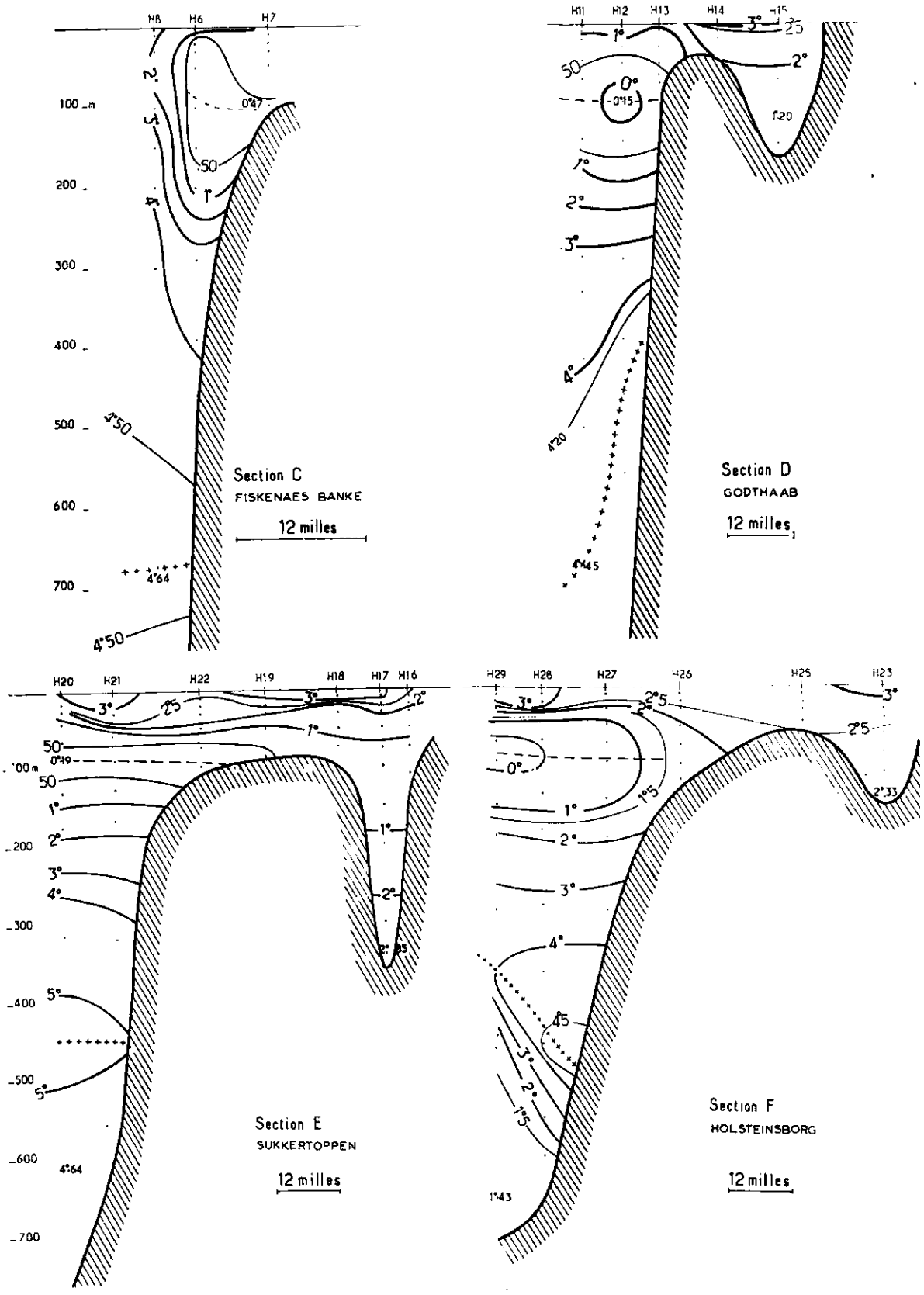


Fig. 4. Vertical temperature distribution: Fiskenaes Bank, Godthaab, Sukkertoppen and Holsteinsborg.

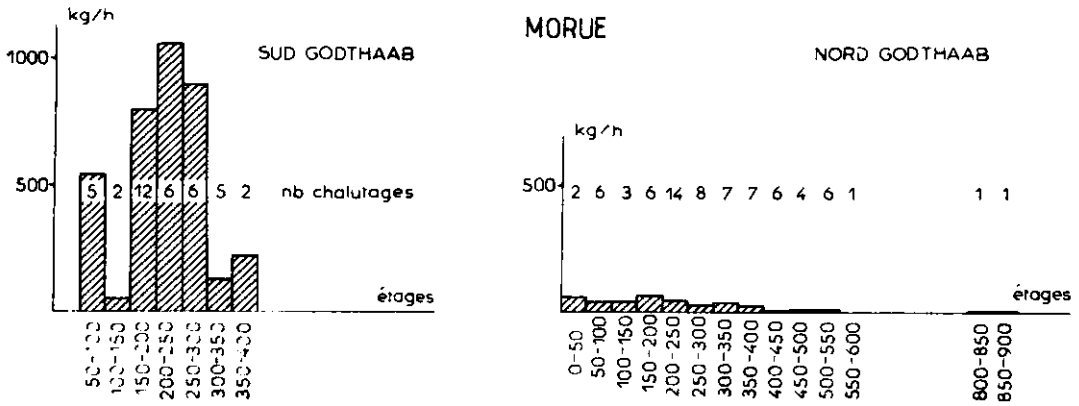


Fig. 5. Cod: Average yield at 50-m intervals, south and north of Godthaab, with number of trawl hauls.

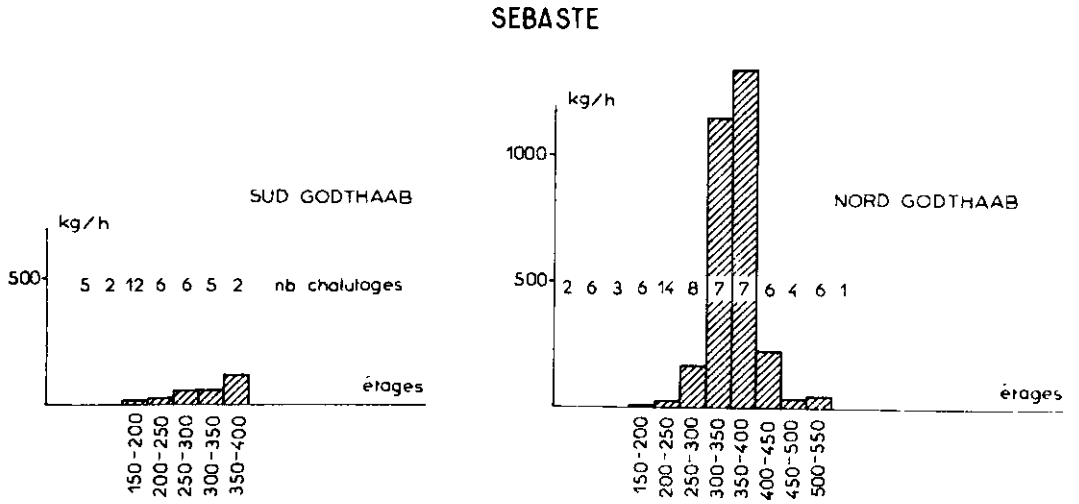


Fig. 6. Redfish: Average yield at 50-m intervals, south and north of Godthaab, with number of trawl hauls.

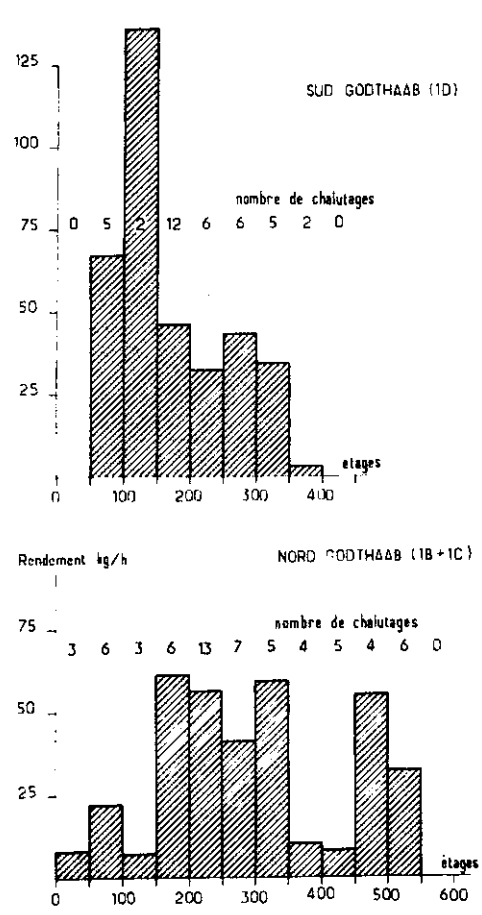


Fig. 7. American plaice: Yield according to depth, south and north of Godthaab.

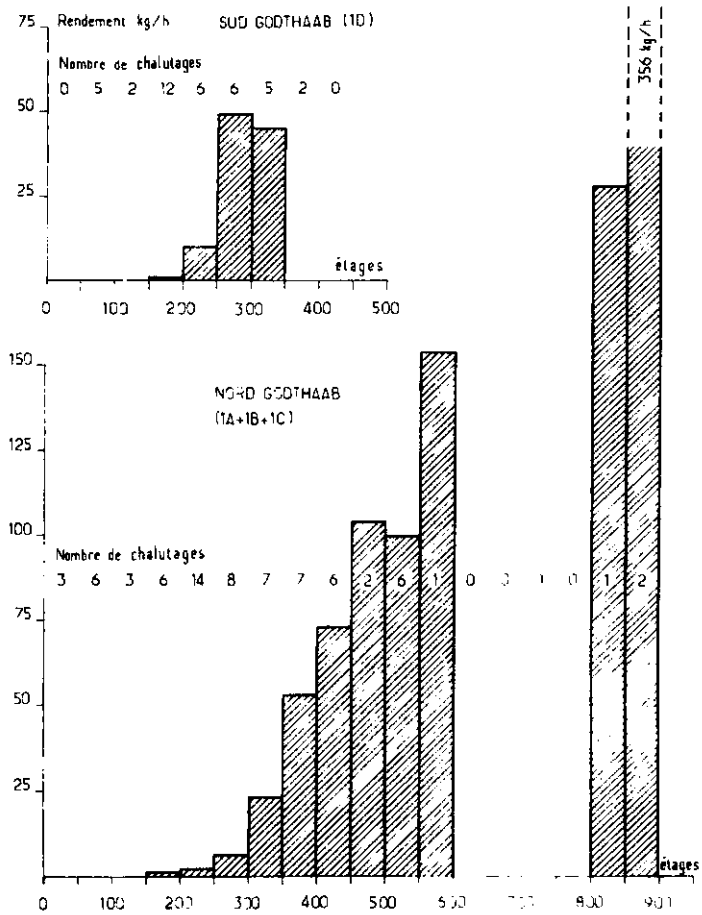


Fig. 8. Greenland halibut: Yield according to depth, south and north of Godthaab.

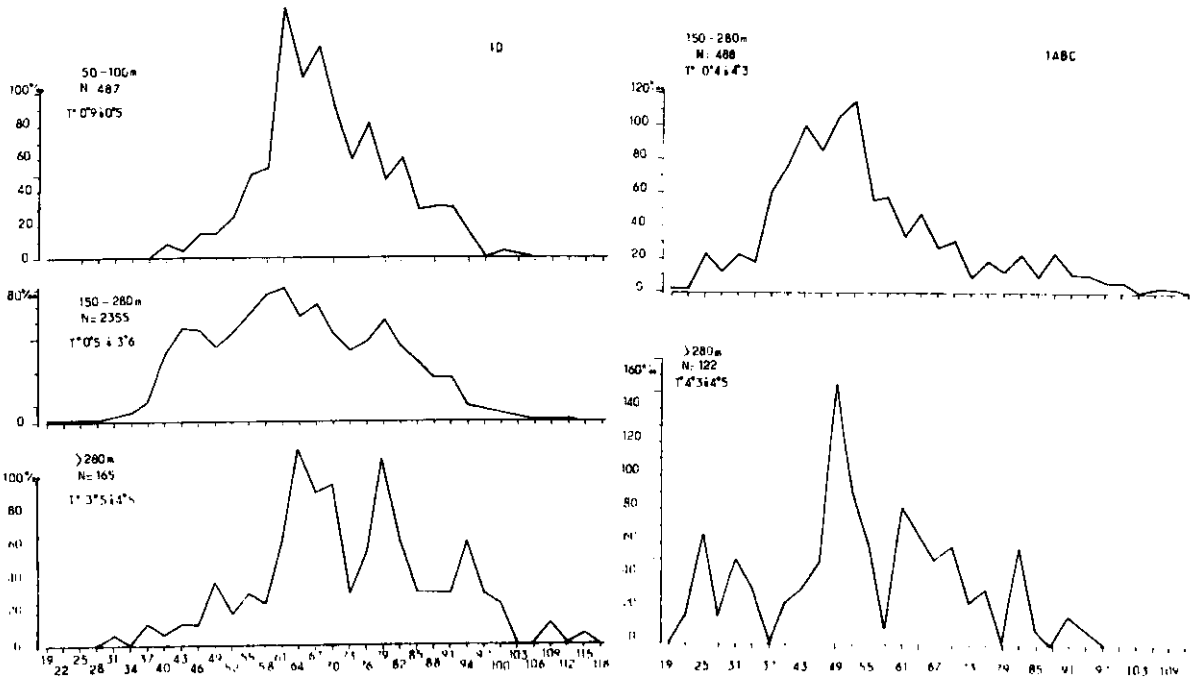


Fig. 9. Cod: Length frequency in ICNAF Div. 1D (south of Godthaab) and Div. 1A, 1B, and 1C (north of Godthaab) for each stage considered.

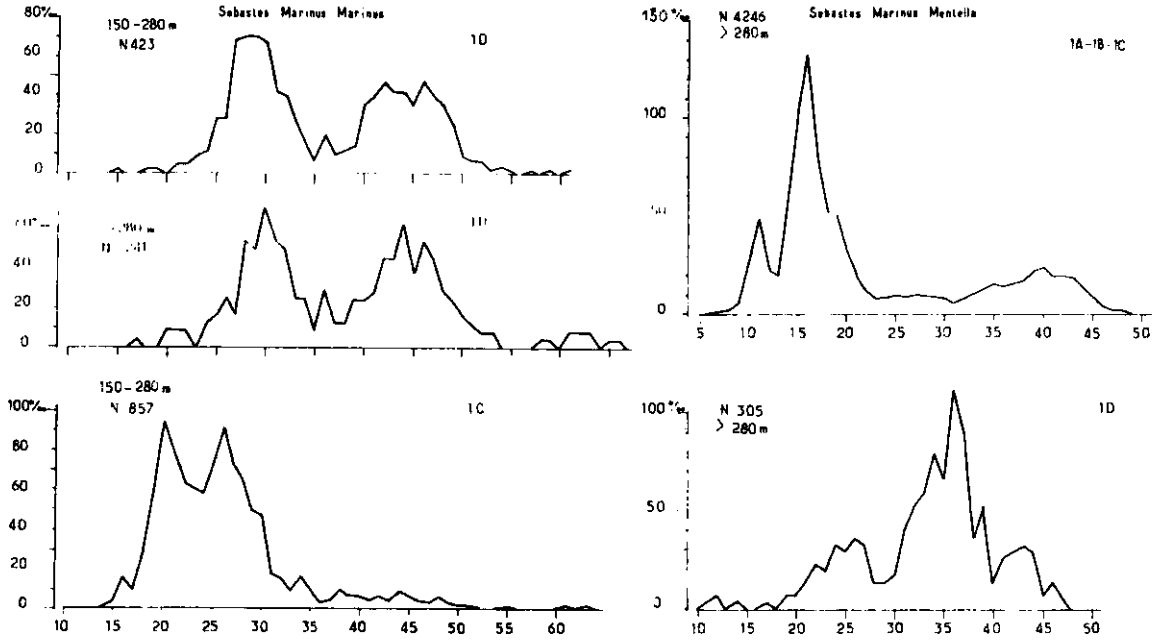


Fig. 10. Redfish (*Sebastes marinus marinus* and *Sebastes marinus mentella*): Length frequency by section and stage considered.

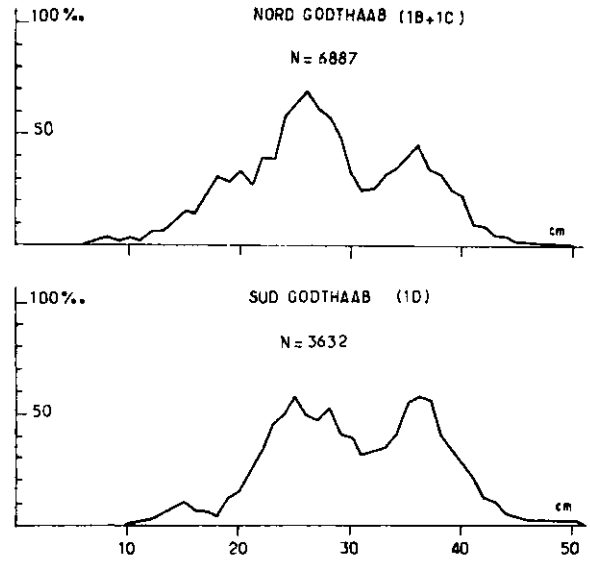


Fig. 11. American plaice: Length frequency, north and south of Godthaab.

B. Subareas 3 and 4

by Jean Morice

In 1970, a total of 6,784 various fish were landed in the Convention Area by trawlers of the Territory of St. Pierre and Miquelon.

Subarea 3

A. Status of the Fisheries

As indicated in Table 1 most of the St. Pierre cod catches were made in Div. 3Ps, on St. Pierre and Burgeo Banks, places which are visited all year round. Traditional fishing using motor dories and hand lines is strictly limited to the coastal waters and shallow waters located near the processing centers; the fishing grounds are all included in 3Ps. The dories go to sea from May to November, the best catches are from June to September.

Div. 3L has an abundance of American plaice and is fished very little for cod.

Haddock is taken almost exclusively on the edges of St. Pierre Bank, in Div. 3Ps, from January to May, the most fruitful period being March-April.

Most of the American plaice landed at St. Pierre come from the "platiers" in Div. 3Ps; St. Pierre Bank is exploited practically all year round.

Redfish is taken on the slope of St. Pierre and Burgeo Banks, all year round, but, in 1970, yields were better in July-September and October-November.

Traditional fishing of the Territory in Div. 3Ps. This is relatively important, particularly where cod is concerned, as it yielded 1,306 tons against only 872 tons landed by trawlers (see Table 2).

Subarea 4

A. Status of the Fisheries

Table 1 shows that trawlers take cod in Div. 4R; March was the most important month for St. Pierre vessels in 1970 when large standard trawlers and metropolitan stern-trawlers worked for several months.

It must be noted that the production of the St. Pierre trawlers is essentially directed by the American market which it supplies and not by the actual possibilities of the fishery. The sale of frozen products, obtained after processing at St. Pierre, is subject to severe control conditions. Thus, the tracking down of parasite nematodes is such that it prohibits exploitation of cod in most banks of Div. 4T and 4S.

B. Special Research Studies

In April-May 1970, observations were made on board *R/V Thalassa* in ICNAF Subareas 3 and 4.

I. Environmental Studies

The area of study was limited to the west, from Cabot Strait to Banquereau, and to the east, from Burin Peninsula to south of St. Pierre Bank, that is, ICNAF Div. 3Pn, 3Ps, 4Vn and 4Vs.

On the one hand, 28 hydrographic stations distributed in five sections (two of these sections, the transverse of Cabot Strait and that which joins Cape Breton to the south of Banquereau, are recommended by ICNAF) were occupied, using Nansen reversing bottles to study temperature and salinity. Data collected thusly will be presented to ICNAF in a more important report. On the other hand, 105 temperature measurements were made by bathythermograph at the start of each trawl haul. The surface and bottom temperatures observed were regrouped for a total of 133 stations (Fig. 13 and 14).

A vertical plankton haul was made with a Hensen net, between 100 m and surface, at each of the above-mentioned stations. The results obtained, regarding volume of plankton collected, will be presented to ICNAF in the aforementioned report on environment.

II. Observations on the Fishery

Fishing was carried out with the Lofoten trawl described in ICNAF *Redbook* 1968. Part II, p. 35, and with the shrimp trawl (headline 33.30 m, rubber footrope 39.50 m, mounted on 37.50 m; wings, back and belly: 60-mm mesh; codend: 40-mm mesh).

Unfortunately, plotting of trawl stations was not done according to the stratified method recommended by ICNAF in 1970. The principle is recalled here only to keep in mind that from 1971 the above-mentioned technique will definately be used by CRIP, St. Pierre.

Sampling was based on half-hour trawl hauls. The plotting chart was based on the Canadian chart No. 4490. The axis of the Laurentian Channel was fixed arbitrarily by joining point 47°50'N lat-60°00'W long, to point 43°30'N lat-55°00'W long, an axis which separates ICNAF Subareas 3 and 4.

The 10 divisions studied were distributed normally at this axis, for all 30 miles and extended to a distance of 60 miles, or according to section interest.

A certain number of hauls were distributed in each area thus defined, which allowed the study of the bottom of the Laurentian Channel, the approaches to the shelf, the shelf itself, the edges, and finally the "platier". Fig. 12 shows the plotting and hydrographic radius and trawl haul stations with an overlay of bathythermograph and plankton.

Commercial species taken were cod (*Gadus m. morhua*), red hake (*Urophycis chuss*), haddock (*Melanogrammus aeglefinus*), redfish (*Sebastes m. mentella*), American plaice (*Hippoglossoides pl. platessoides*), herring (*Clupea h. harengus*) ...*etc.* and *Pandalus borealis*.

We shall see, specie by specie, the first knowledge which we can derive from collected data.

Cod (*Gadus m. morhua*)

A total of 8,613 measurements were recorded and 1,549 otoliths read. The most interesting catches concern the following areas (see Table 3):

a) Gulf of St. Lawrence: Div. 4T (2 stations), 4R (1 station).
b) Nova Scotia banks: Div. 4Vn (2 stations).
c) St. Pierre Bank: Div. 3Ps (2 stations).

1. Gulf of St. Lawrence, Div. 4T, Cape St. Lawrence: one station only was valid, commercial-wise, with a yield of 6.8 tons for one hour of fishing. Thirty-six percent of the fish were of inferior length at 40 cm (ages 2, 3 and 4 years) - see Fig. 15: cod length frequency and age composition.

2. Nova Scotia banks near Cape Breton Island: Div. 4Vn: the two stations producing hourly yields of 4.46 and 1.52 tons and very few fish less than 40 cm in length (6.1 and 2.3%) were the only commercial ones. Fig. 16: cod length frequency and age composition.

3. St. Pierre Bank: very small cod with a mean of 19 cm were caught on the western edge of St. Pierre Bank. Ninety to 98.5 percent of the catches were less than 40 cm in length.

Red hake (*Urophycis chuss*)

During these same surveys, yields obtained for *Urophycis chuss* were not very important. During April and May (Fig. 17), eight stations only yielded more than 100 kg/hr fishing. Div. 4Vn was relatively more productive since five trawl hauls allowed a catch of 114, 253, 532, 1,018 and 1,136 kg/hr. The other hauls made in Div. 3Pn and 3Ps yielded in the first case 150 kg/hr, in the second case 127 and 202 kg/hr. The depth varied from 180 to 450 m during these different trawl hauls.

The length of individuals varied from 15 to 91 cm and the length frequency curve allowed the distinction of three means: 42-43 cm, 56-57 cm and 64-65 cm.

In December the catches reached a maximum of 78 kg/hr on the south and west coasts of Newfoundland while the length of the fish was between 21 and 88 cm with two main means at 36-37 cm and 54-55 cm (Fig. 18). During this survey, depth was about 240 m.

Haddock (*Melanogrammus aeglefinus*)

During the *R/V Thalassa* survey along Laurentian Channel and the bordering banks, in April and May, and the *R/V Cryos* survey in December on the south and west coasts of Newfoundland, haddock catches were very small. In the spring, at six stations only, yields surpassed 100 kg/hr of trawl haul and the most important catches produced 320 to 454 kg/hr. In one case, these catches are of interest to Div. 4R (187 kg.hr) and in other cases, of interest to Burgeo and St. Pierre Banks, Div. 3Ps; all catches were made on the edges at depths varying from 140 to 195 m. For all other trawl hauls, yields were nil or very small: 2 to 86 kg/hr of fishing.

Length of individuals varies from 14 to 85 cm and the representative curve allows the distinction of three means: 20-21 cm, 30-31 cm, and 44-45 cm (Fig. 19).

In December, no catch of commercial interest was made in south and west Newfoundland: Div. 3Ps and 4R.

Redfish (*Sebastes m. mentella*)

In April and May 1970, 64 trawl hauls yielded redfish. The best catches were made in Div. 4Vn and particularly in Scatari and Saint Ann areas, at depths varying from 175 to 350 m. Yields, in this area, often surpass one ton per hour and even reach six tons per hour for one station. Among the 64 hauls mentioned above, 33 show yields between 0.6 and 6 tons per hour.

A total of 19,791 individuals were measured: distributed as follows: 9.801 in Div. 3Ps, 6,095 in Div. 4Vn and 3,895 in Div. 3Pn. These measurements allow tracing of population curves in Fig. 20, 21 and 22.

The extreme lengths are from 6 to 55 cm. If one analyzes the curves by division, one realises that in Div. 3Ps two very distinct means appear, one at 16 cm and the other at 33 cm, and that the individuals between 6 and 28 cm represent 85.7% of the population, whereas, in Div. 3Pn the same individuals represent only a little more than half the population, *i.e.*, 56%. Two means appear, one at 15 cm and the other at 33 cm.

A great difference exists between these two divisions and Div. 4Vn where one mean only appears at 32 cm and where practically the whole population is found between 28 and 43 cm (88%).

In addition to these measurements, several biological operations were carried out: otolith readings, sex and weight by length. These various data are exploited and presented to ICNAF in a more detailed report submitted to the 21st meeting of ICNAF.

American plaice (*Hippoglossoides pl. platessoides*)

During the April-May 1970 survey, American plaice catches were essentially made in Div. 3Ps and 4Vn.

In Div. 3Ps, the best yields were obtained north of St. Pierre Bank (230 kg/hr at a depth of about 60 m). However, the smaller yield of other hauls can be explained by the fact that they were mainly carried out on the west edges of this bank in the search for other species. For this division, the measurements made on a sample of 624 individuals show that the length is distributed around a main mean of 19-20 cm, when secondary means of 44-46 cm and 53-54 cm appear.

In Div. 4Vn, the best yields were obtained off Cape Smoky (an average of 530 kg for depths from 130 to 340 m), then on the edges of Mimia Bank (250 kg at depths of 90 m), and on Aspy Bank (210 kg at depths of 100 m). For this division, measurements made on a sampling of 3,812 individuals indicate that the American plaice is larger in this area since the mean length distribution is found at 27-30 cm.

Grey sole (*Glyptocephalus cynoglossus*)

The April-May 1970 survey shows some indications of grey sole catches in ICNAF Div. 4Vn and 3Pn.

In Div. 4Vn, the best catches were made off Cape Smoky (450 kg/hr at depths of 340 to 380 m), off St. Paul Island (400 kg/hr at depths of 480 m) and off Sydney (125 kg/hr at depths between 300 and 340 m).

In Div. 3Pn, the best yields were obtained in May 1970 13 miles south of Couteau Head 230 kg/hr at depths of 250 m. During an *R/V Cryos* survey in December 1970, trawl hauls made at the same position only yielded 70 kg/hr. During this survey, the *R/V Cryos* worked in Div. 3Pn and 3Ps. The best yields were obtained for Div. 3Ps in Burgeo deep at depths of 230 m: 270 kg/hr. Measurements made on a sampling of 1,604 grey sole in this trench show a length distribution from 20 to 60 cm with two means: one at 26 cm and the other at 39 cm.

Herring (*Clupea harengus*)

During the *R/V Thalassa* survey, in spring 1970, the interesting catches (made with the Lofoten trawl) were recorded.

1. Inside the Gulf of St. Lawrence, between Madeleine and Cape Breton Islands, and for one trip only, 17 April.

   - yield obtained for one half-hour of fishing was 348 kg;
   - length varied from 24 to 35 cm (mean length 29 cm);
   - stage V of sexual maturity represented 72% of population.

2. Nova Scotia banks and Saint Ann Bank, 7 to 18 May.

   - small yield of 63 kg for one half-hour of fishing;
   - length varied from 28 to 41 cm (mean length 35-36 cm).

Observations were repeated in the fall by *R/V Cryos*. In November, ahead of Cape Smoky, lengths varied from 27 to 40 cm (mean length 36 cm). In December, near Ramea Islands and on the northern edges of Burgeo, it was noted that lengths varied from 32 to 39 cm (mean lengths 35-36 cm). Finally, small herring (lengths of 11 to 14 cm), with a mean of 12 cm, were observed during two months (October and November) within radius of Miquelon (see Fig. 23).

Shrimp (*Pandalus borealis*)

Research carried out since 1966 in an effort to track down shrimp grounds in the open sea were undertaken in 1970 during the spring survey of *R/V Thalassa*.

Shrimp of the *Pandalus borealis* species are found on the bottom and edges of the Laurentian Channel where they are dispersed; on the other hand, they are concentrated in the deeps here and there.

In December the *R/V Cryos* made a short cruise to test a shrimp trawl of the "balloon" type. Hauls were made in the Burgeo deeps and south coast of Newfoundland on the one hand, and on the other hand in the "Esquimau" Channel and west coast of Newfoundland. At this time of the year, average yields vary with hour of fishing, being very small at dawn and at sunset.

The Burgeo deep produces a smaller average yield per hour of fishing, 44 kg/hr, than the "Esquimau" Channel, 81 kg/hr, but the shrimp collected are greater in size. Males are an average length of 22.5 mm Lc and females are

26 mm Lc in Burgeo Trench, against 21 mm and 24.5 mm in the "Esquimau" Channel.

The trawl used had a 60-mm mesh (stretch mesh) in the wings, belly and back, and 40-mm mesh at the neck and codend.

The percentage of fish of commercial size taken varies according to the hauls, between 10% and 50%. The two species particularly concerned are the redfish (*Sebastes sp.*) and the grey sole (*Glytocephalus cynoglossus*). For example, in a redfish catch of 1,460 kg, fish of commercial size represented only 216 kg.

Benthos

The benthos collected were studied along with the fish stock. A community of *Yoldia thraciaeformis*, Lamellibranch molluscs associated with Pennatules, appeared in the Laurentian Channel. This community is established on a compact black mud bottom. As an associated specie, one must also note the presence of *Pasiphaea tarda* which yields up to 5 kg per hour of haul.

Table 1. Saint Pierre and Miquelon. 1970 Yields - Industrial and traditional fishing - nominal fishing expressed in tons.

Subarea	Div.	Cod	Haddock	American plaice	Redfish	Pollock	Witch	Halibut	Wolf-fishes	Skates	Yellowtail flounder	Angler	Unidentified
3	3Ps	1,970	1,158	397	1,072	1	111	23	11	229	214	19	120
	3L	68	-	389	7	-	2	-	26	111	16	-	43
	3Pn	1	-	1	153	-	2	-	-	2	-	-	-
	3O	3	1	-	-	-	1	-	-	1	1	-	-
Total Subarea 3		2,042	1,159	787	1,232	1	116	23	37	343	231	19	163
4	4Vn	6	1	11	51	-	6	-	-	10	6	-	1
	4Vs	10	15	8	80	-	8	1	-	6	-	-	3
	4S	-	-	-	86	-	-	-	-	-	-	-	1
	4R	120	6	6	178	-	1	-	1	-	-	-	9
Total Subarea 4		136	22	25	395	-	15	1	1	16	6	-	14
Total ICNAF Area		2,178	1,181	812	1,627	1	131	24	38	359	237	19	177

Table 2. Traditional fishing at St. Pierre and Miquelon (in metric tons).

Month	Cod	American plaice	Ray	Total
May	89	-	0.060	89.060
June	405	1	0.120	406.120
July	327	5	0.360	332.360
August	223	1	0.110	224.110
September	166	1	0.250	167.250
October	83	-	0.100	83.100
November	14	-	-	14.000
Total	1,307	8	1.000	1,316.000

Table 3. Cod - hourly yield and age at mean length by station.

ICNAF Divisions	Station	Yield/hour (in tons)	Mean length (cm)	Age at mean length (in years)
Gulf of St. Lawrence				
Cape St. Laurente 4T (91-182m)	1 (St 35)	0.197	22	2
Cape St. Laurente 4T (91-182m)	1 (St 38)	6.812	34 and 49	4 and 6
Cape Anguille 4R (91-182m)	1 (St 61)	2.358	37	5
Nova Scotia Banks				
Cape Egmont 4Vn (91-182m)	1 (St 67)	4.466	46	6
St. Ann Bank 4Vn (91-182m)	1 (St 155)	1.527	52	6
St. Pierre Bank				
3Ps (91-182m)	1 (St 164)	0.480	19 and 34	2 and 4
(91-182m)	1 (St 168)	0.235	19	2

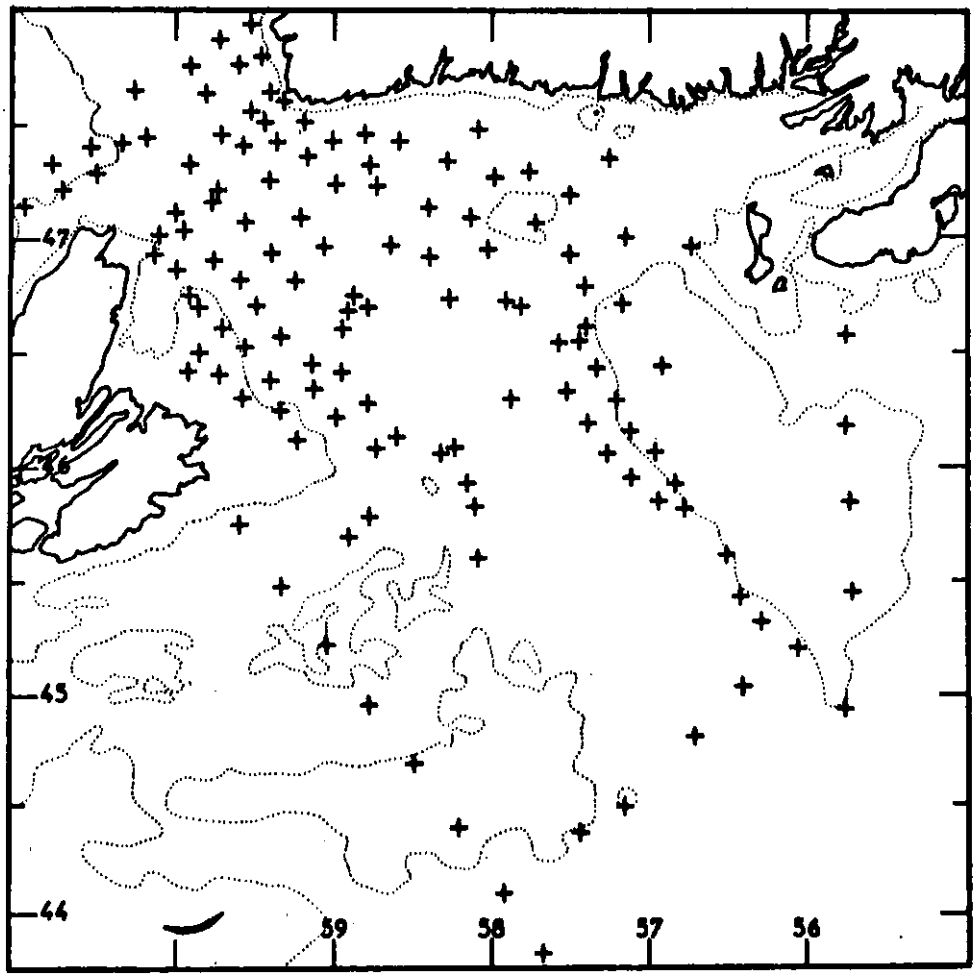


Fig. 12. April-May 1970 - *Thalassa* survey in Northwest Atlantic. Plotting chart of hydrographic stations (bottles and bathythermographs).

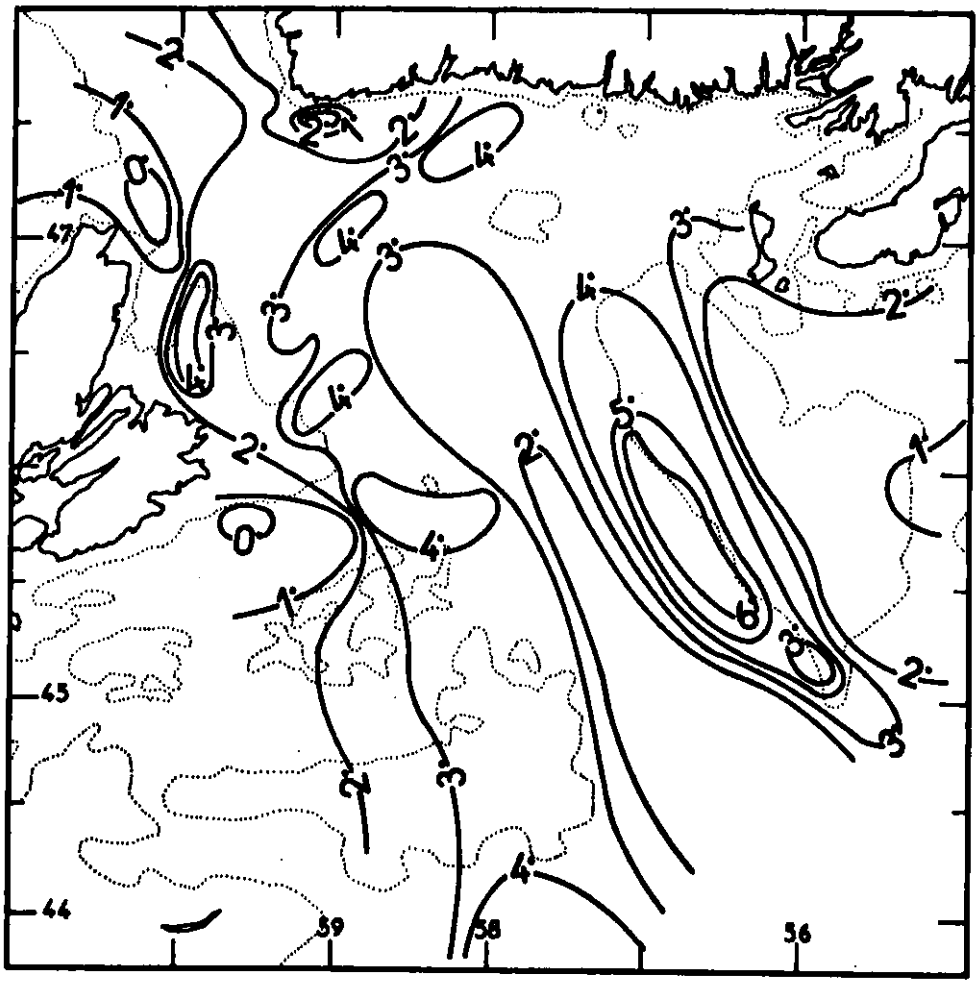


Fig. 13. April–May 1970 - *Thalassa* survey in Northwest Atlantic. Distribution of surface temperature.

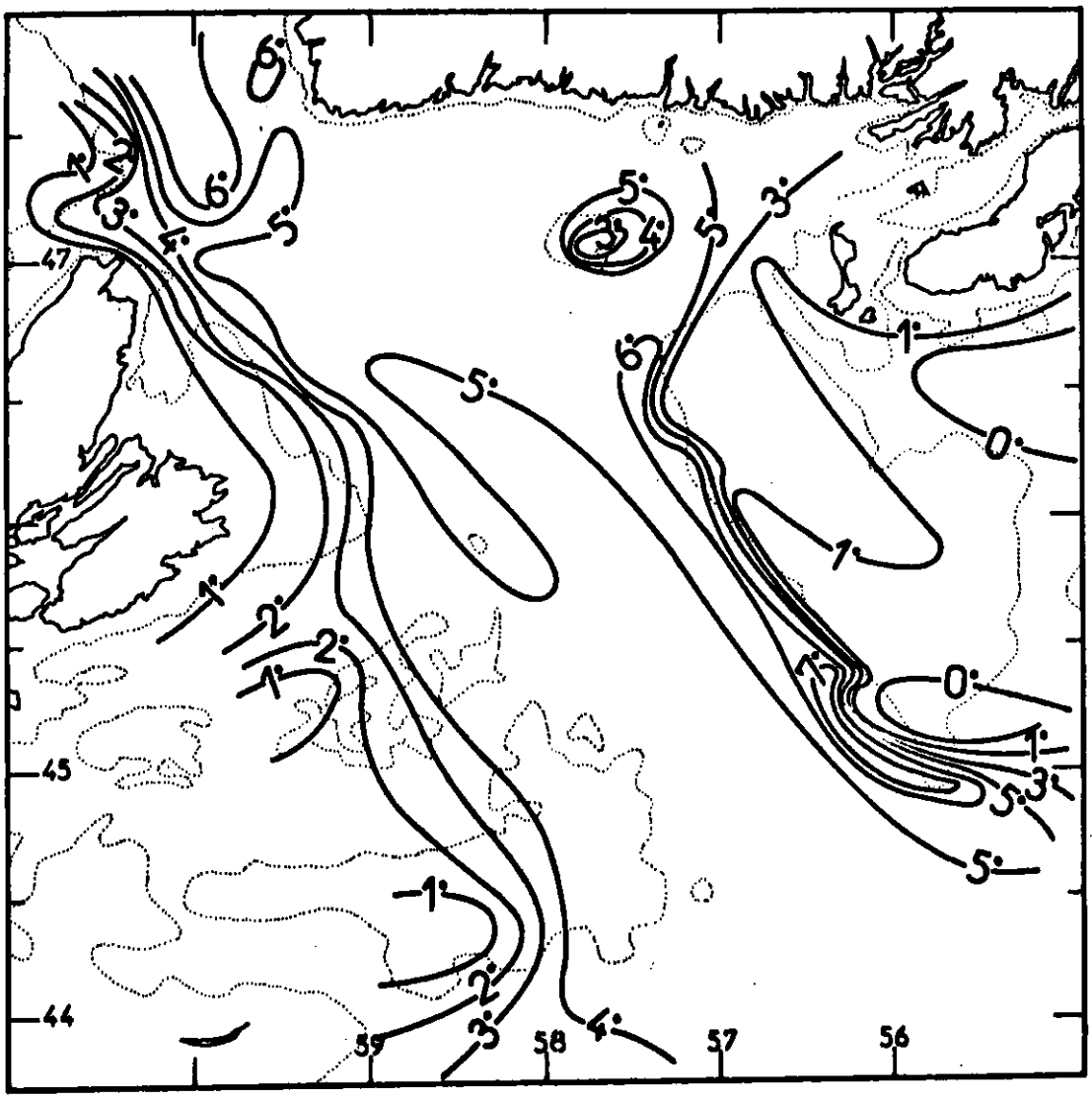


Fig. 14. April-May 1970 - *Thalassa* survey in Northwest Atlantic. Distribution of bottom temperature.

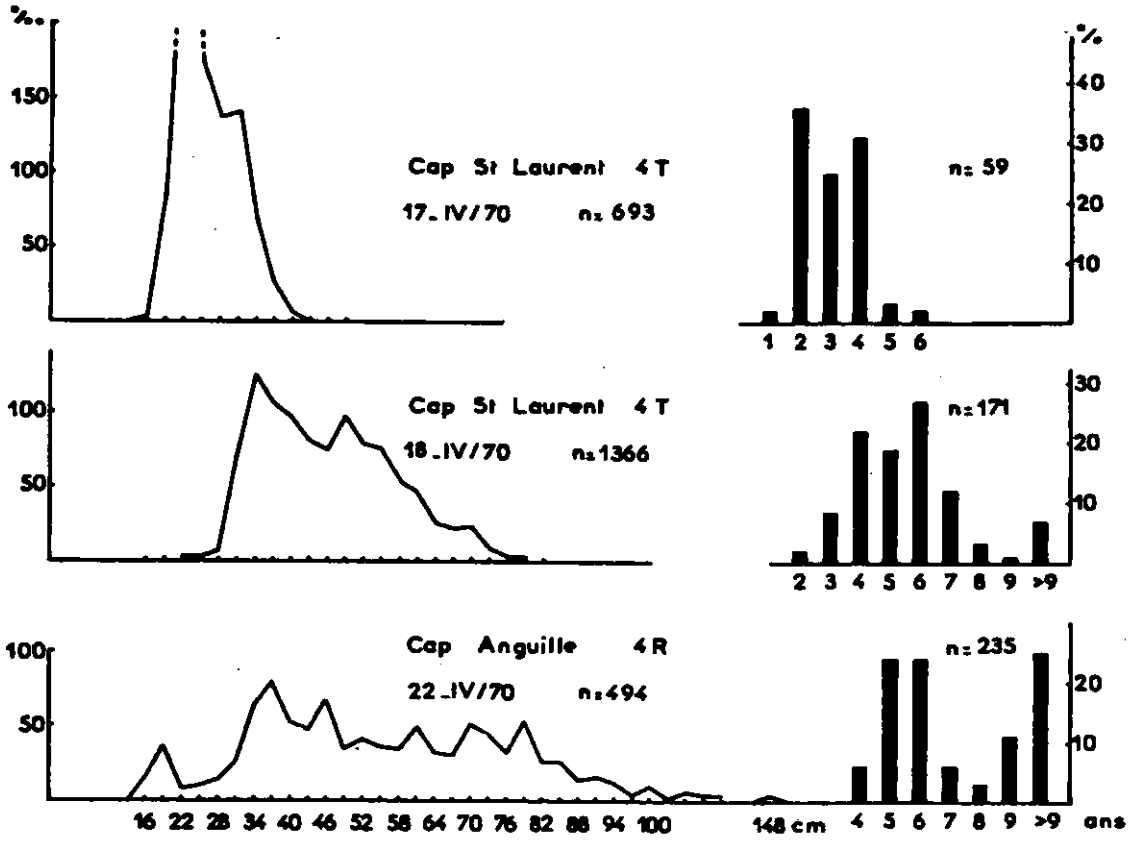


Fig. 15. Cod - length frequency and age composition.

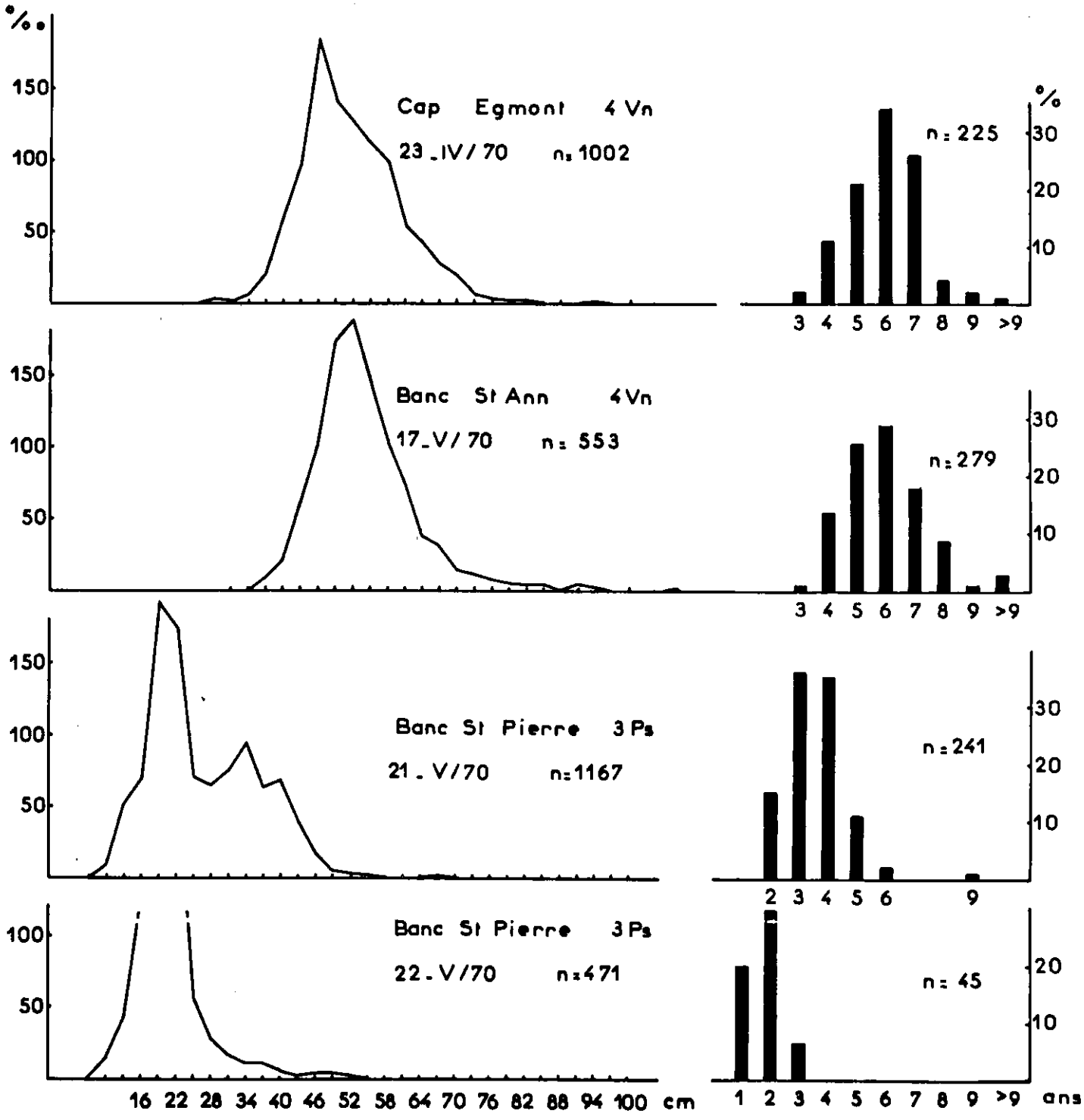


Fig. 16. Cod - length frequency and age composition.

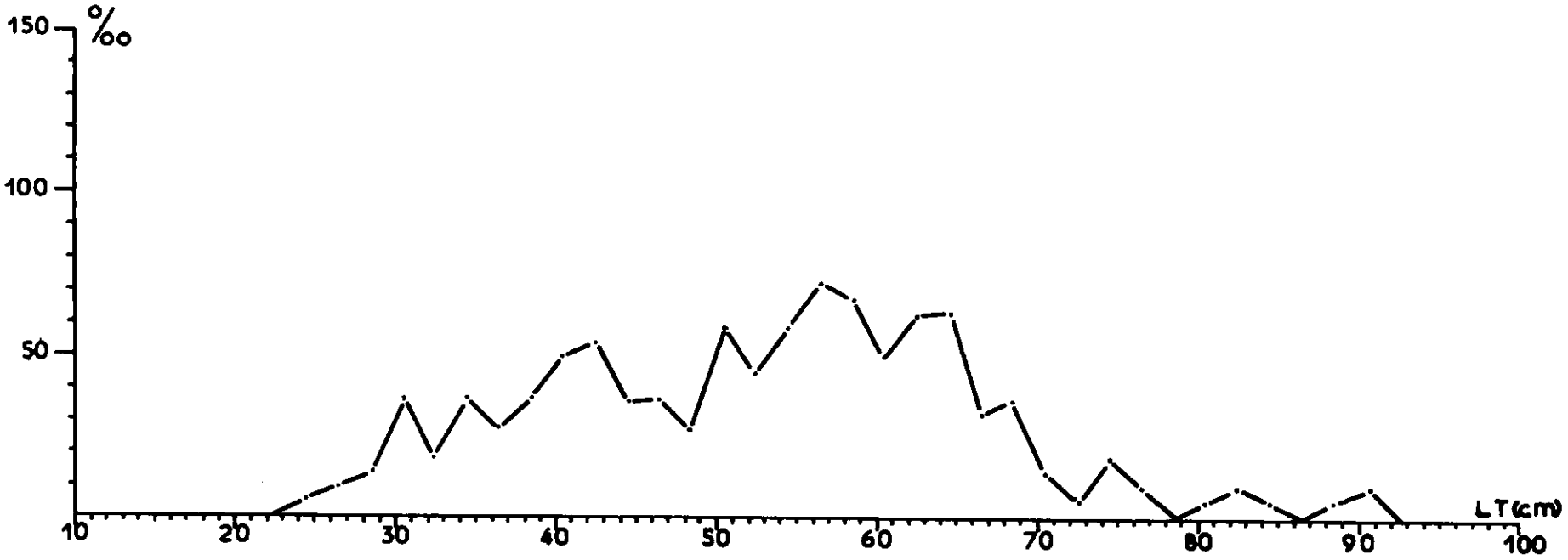


Fig. 17. *Urophycis* - (April-May - Length frequency per thousand.

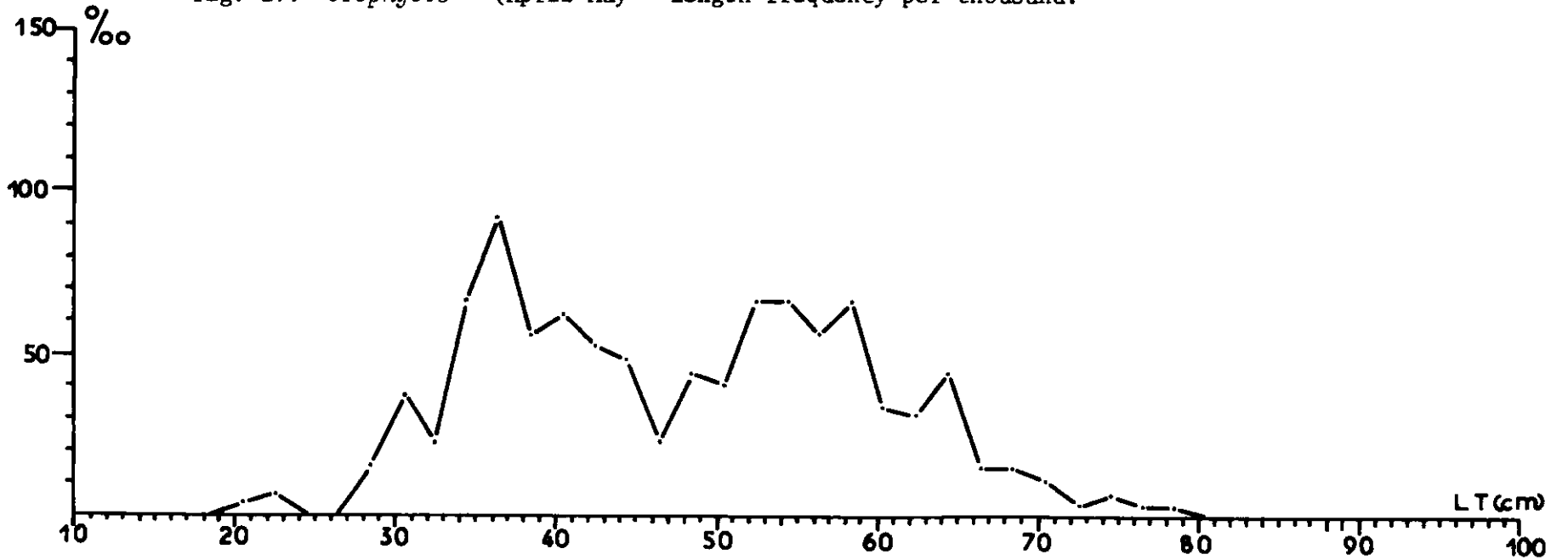


Fig. 18. *Urophycis* - (South Newfoundland - December 1970) - Length frequency per thousand.

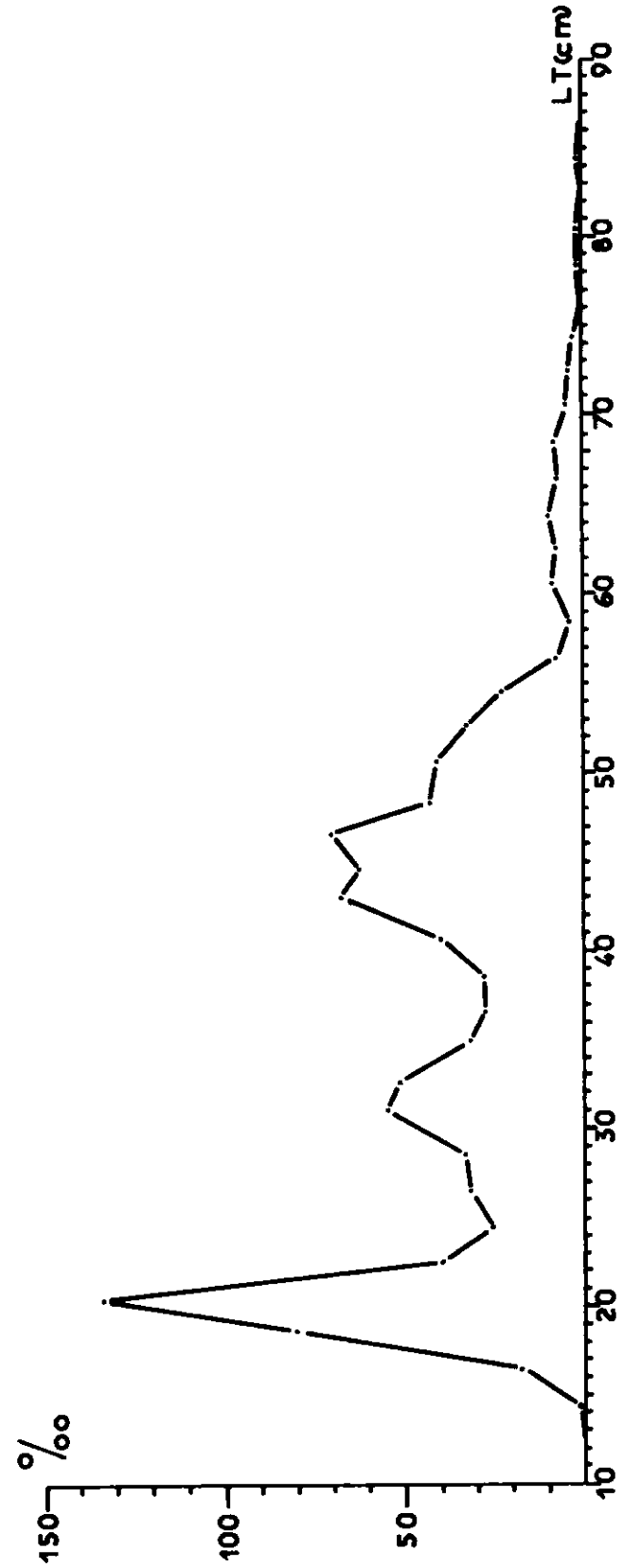


Fig. 19. Haddock - Length frequency per thousand.

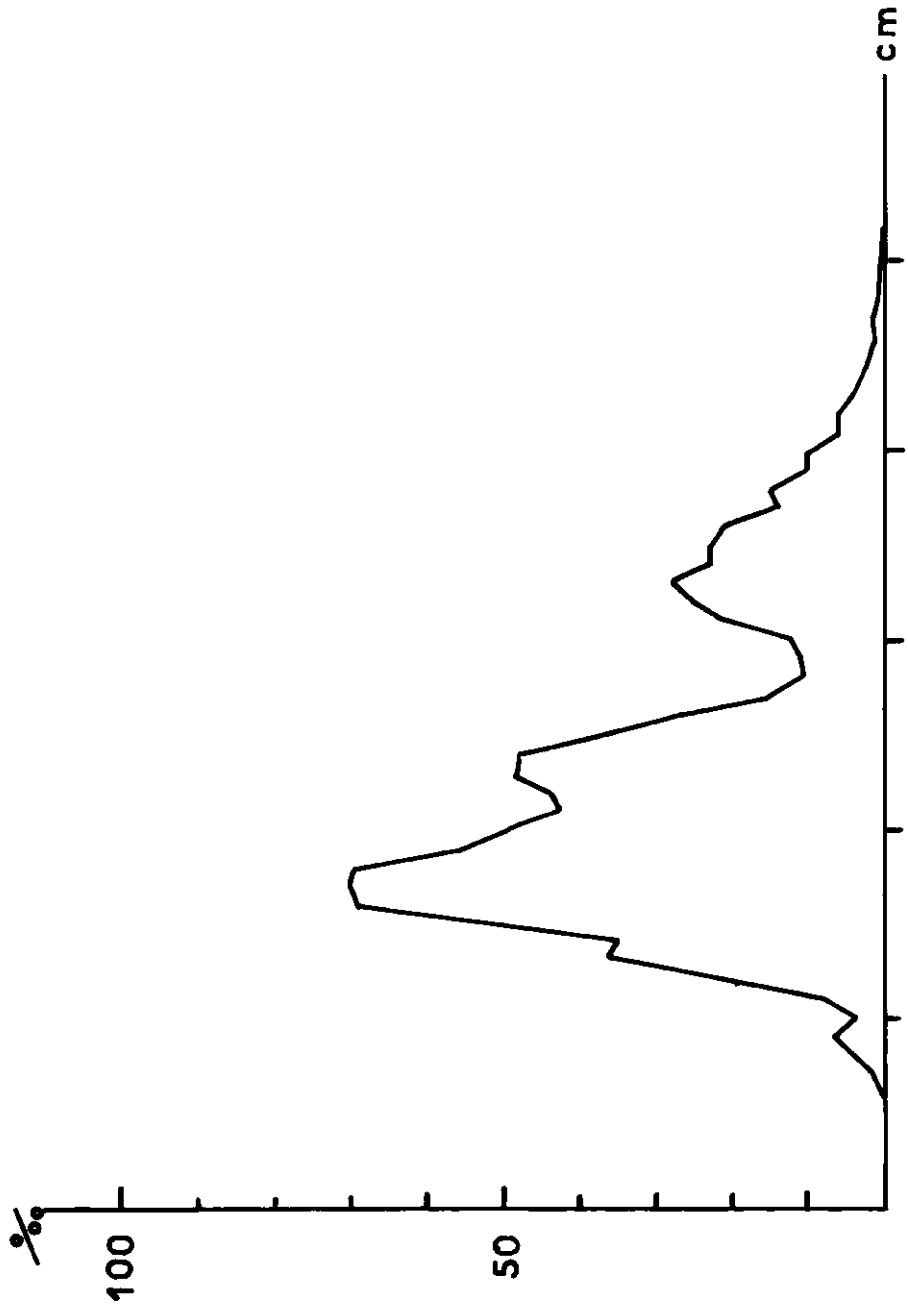


Fig. 20. Redfish - Length frequency per thousand in Div. 3Ps.

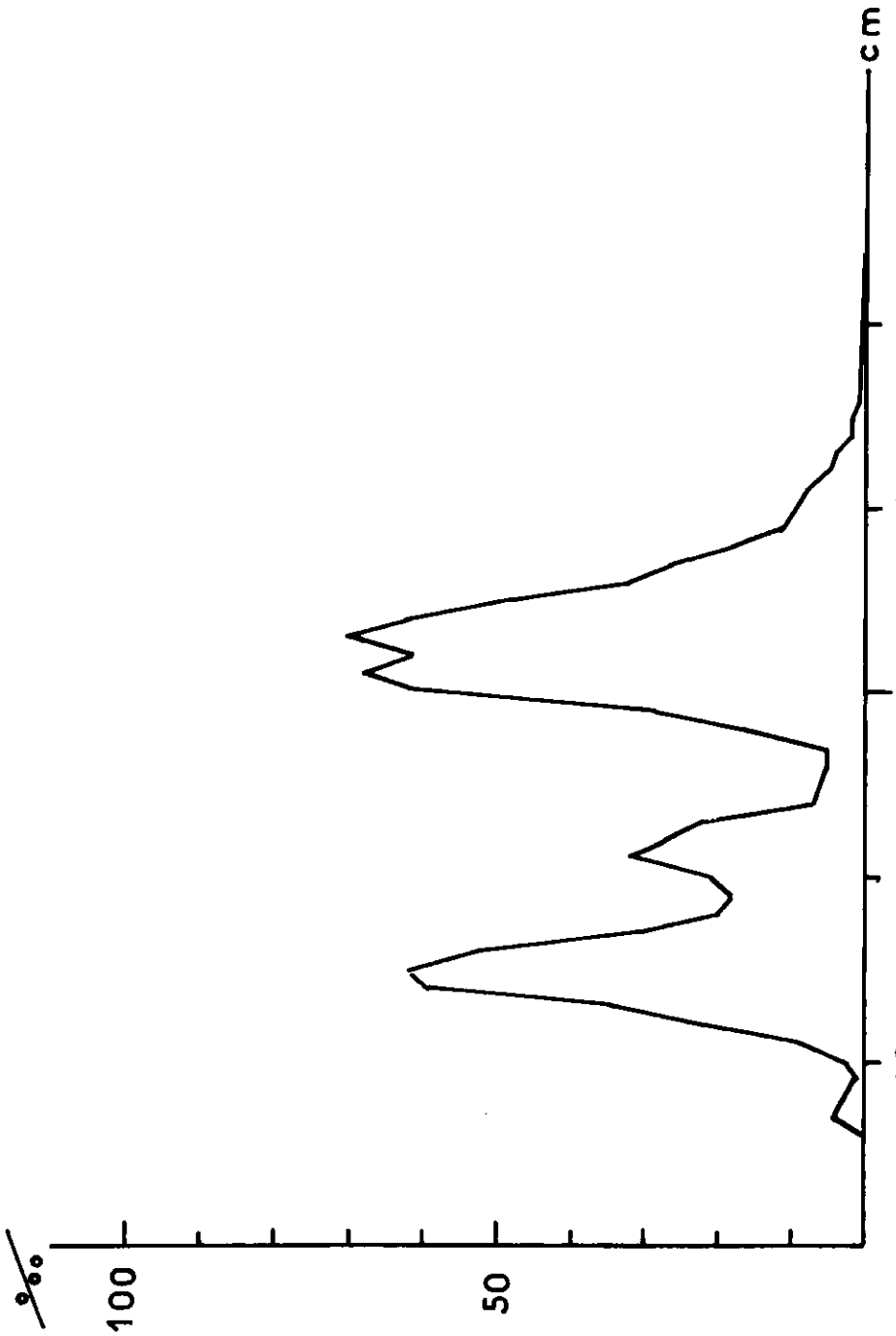


Fig. 21. Redfish - Length frequency per thousand in Div. 3Pn.

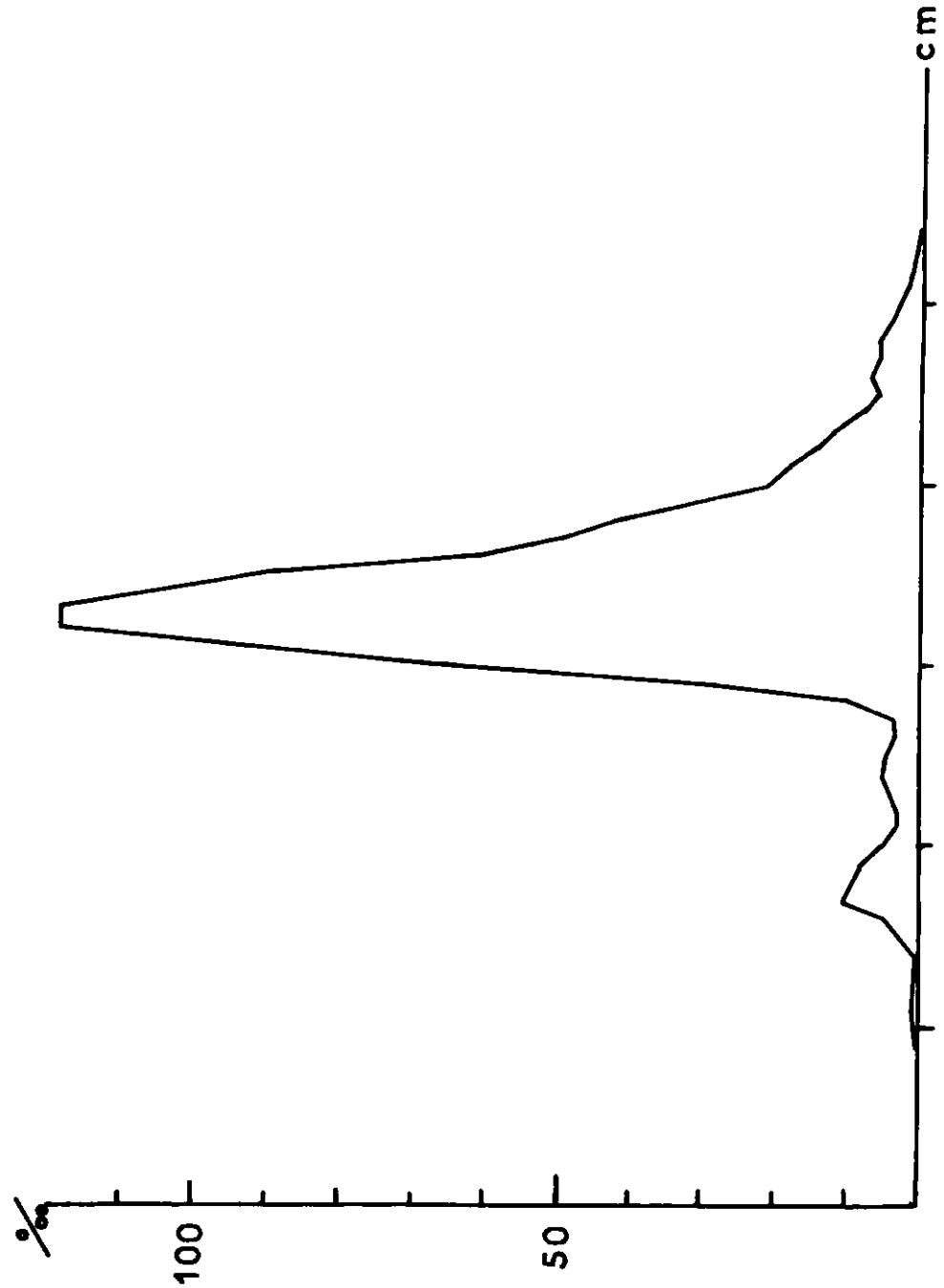


Fig. 22. Redfish - Length frequency per thousand in Div. 4Vn.

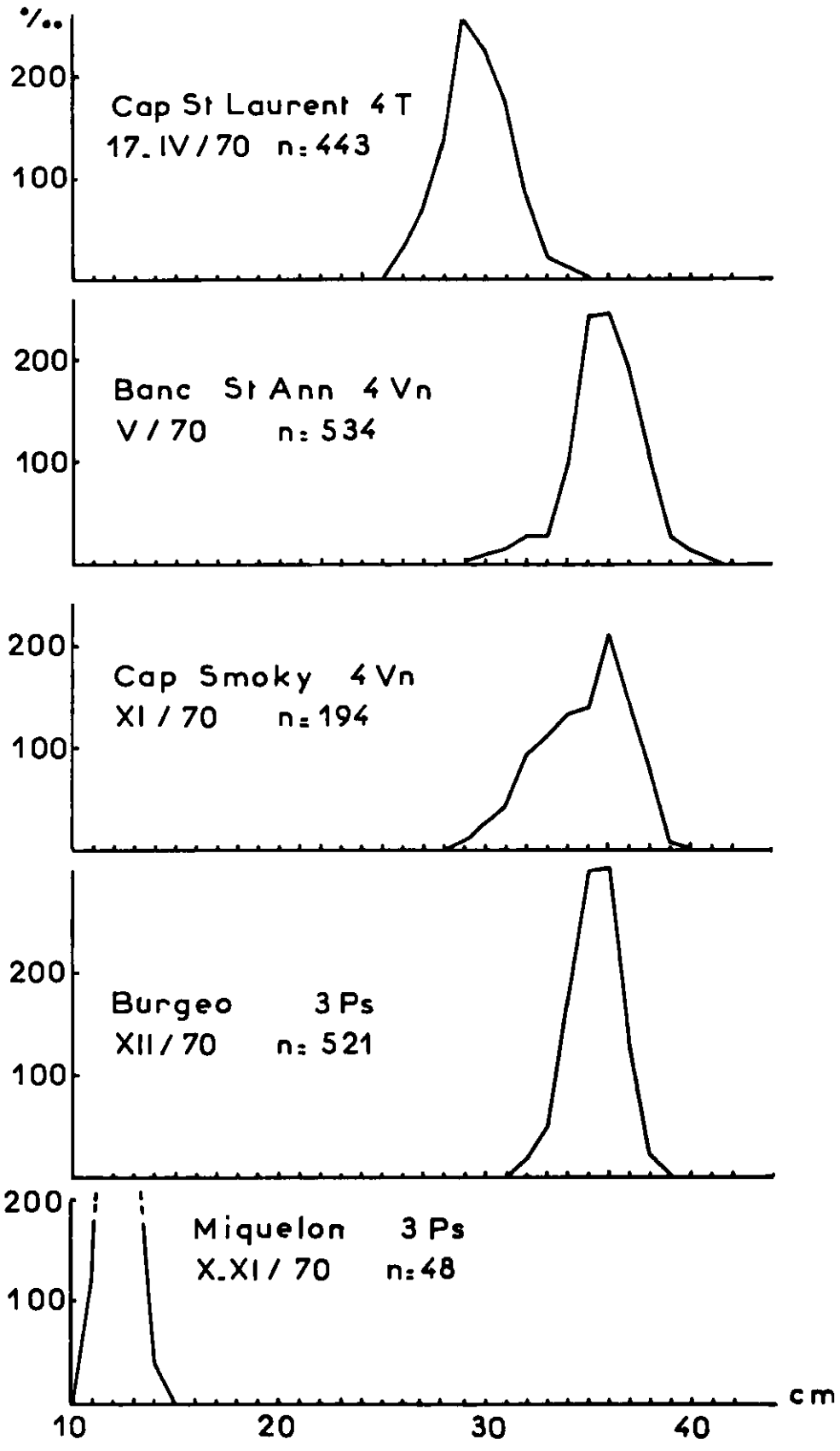


Fig. 23. Herring length frequency.

IV. German (FRG) Research Report, 1970

A. Subarea 1 and East Greenland

by A. Meyer and W. Lenz

A. Status of the Fisheries

Table 1 gives the nominal catch off West and East Greenland taken by the fleet of the Federal Republic of Germany from 1962 to 1970. The total catch off Greenland varied considerably during these years. The drastic decrease in the last two years from a maximum of 251,000 tons in 1963 to 75,000 tons in 1970 was due mainly to less fishing activity off West Greenland.

I. Subarea 1 (West Greenland)

The fishing activity of German trawlers (mostly factory ships and some trawlers for salting and fresh fish) off West Greenland in 1970 decreased by a further 47%. The catch dropped by 41% from 75,000 tons in 1969 to 44,000 tons in 1970, which makes up only 22% of the maximum output in 1963.

There are several reasons for this considerable decrease in fishing activity of the German fleet in Subarea 1:

1) Low stock size of West Greenlandic cod and therefore low fishery output except during the spring when the spawning shoals are concentrated.

2) Very reduced stock of redfish, which only now can be fished to some extent in the southern part of Div. 1E and in 1F. In 1970 redfish catch was only 7.8% of that of 1962.

3) Again - now for the 3rd year - hampering of the fishery by ice during the first half of the year not only in Div. 1F (which is normal) but also in Div. 1E and 1D, which until 1968 were ice-free all year. In 1970, however, the ice situation was not as severe as in 1969 which was the severest ice-year since the start of the West Greenlandic fishery for cod in 1925.

4) Very profitable fishery off Labrador from January to the end of March when ice stopped the fishery in Subarea 2.

5) Early start of the more profitable herring season in Subarea 5.

Thus in 1970 the real West Greenland season was reduced to 3 months only (April - June). On 14 July the last factory ships left Subarea 1. The daily catch in July had become unprofitable. In December the first factory trawlers returned to West Greenland. However, the daily catch was only poor to medium and not nearly comparable to the catch rate in the first half of the sixties at this time of the year.

Since 1953 German trawlers have also been salting cod off West Greenland for export purposes. The catches of these salters in 1970 were so small that there will probably be no repitition of this special production.

II. East Greenland

During the first half of the year, the fishery is often hampered by ice, but can be very profitable when northern or eastern winds press the southward drifting ice-belt against the shore and enable fishing on the very rough banks. More and more factory trawlers are now working off East Greenland, especially during the spawning season for cod (March, April) or when ice hampers the fishery on the western side of Greenland. On the other hand, the activity of the German fresh-fish trawlers is being reduced more and more due to the market situation and the continuous reduction in the number of fresh fish trawlers. In 1970 the total catch off East Greenland decreased by 23% to 31,000 tons. The average daily catch of cod increased by 42% and was the highest since the beginning of the fishery in 1955 in this region. However, the daily catch of redfish decreased further and was the lowest since 1955. For the first time nearly as much cod as redfish was caught, while during the preceding years redfish was always the main species caught.

III. Forecast for 1971

1. Subarea 1

The output of the German factory trawlers in 1971 will depend, as in preceding years, on the possibilities for catching cod off Labrador and in other areas, such as Iceland and the Norwegian Coast, where saithe is now also frozen in increasing quantities. Due to the fact that cod catches off Labrador in 1971 for the first time were smaller than in preceding years and the ice forced the fleet to leave Labrador by 15 March 1971, fishing activity in Subarea 1 in the first 3 months of 1971 was 56% higher than in 1970. During the second half of March part of the fleet because of ice and better catches moved to East Greenland. During the first 3 months the daily catch was 30% higher than in 1970. Also the ice situation, although not normal, seems to be better than in preceding years. Thus it can be expected that fishing effort and total catch in 1971 in Subarea 1 will again increase especially when ice conditions allow a repetition of the very profitable pelagic fishery on post-spawners in May and June in Div. 1E. Even if the 1971 catch exceeds the low landings of the last two years, the total catch certainly will be smaller than during the period 1962-1968. As in preceding years, the German fishery will probably end in July again with the onset of the slack period.

2. East Greenland

There is reason to expect that, off East Greenland in 1971, catches of cod will exceed those of redfish for the first time. This will be due to the increased activity of the factory trawlers and the rather good state of the spawning stock of cod off East Greenland (the 1961, 1962 and especially 1963 year-classes). It must be expected, however, that a substantial part of the spawning stock will emigrate to the Icelandic spawning grounds.

B. Special Research Studies

I. Environmental Studies

1. Hydrography (by W. Lenz)

The cruise track of the German *R/V Walther Herwig* from 8-28 March

1970 (Fig. 1) shows the area where hydrographic investigations were made. In addition to the serial and BT, XBT stations, the fronts of drift and pack ice in March 1969 and 1970 are shown. While the extent of ice was quite similar in both springs off the eastern and southern coast of Greenland an ice barrier was found off the western coast to Fiskenaes Bank in March 1970 which limited our work to the area of Fyllas and Banana Banks.

The year 1969 has been an extremely cold year in Greenland waters, but our measurements in March show that 1970 will be even colder. Compared to March 1969 the situation at Fyllas Bank (Fig. 2) was as follows:

Water in the upper 50 m was warmer in March 1970 than in the previous year by a few tenths of a degree, but from the 50 m to 500 m it was colder with a maximum of almost 2 degrees at 150 m (see *Redbook* 1970, Part II, p. 50-51). Corresponding to the usual T/S relationship in West Greenland waters, the salinity distribution showed a similar difference to March 1969, the 34‰ isohaline lay 150 m deeper at 250 m.

However, further north at the west side of Little Halibut Bank, the water was warmer again, 0° at 90 m and 1° at 150 m; the result of progressive mixing of the cold and warm components of the West Greenland Current.

The core of the warm Irminger component of this current was found at the same depth (ca.500 m) with the same values in temperature and salinity (5.1°; 34.97°/$_{oo}$) as in March 1969.

With a new design of instrument (developed by Dr H. Schulz, Institute for Seafisheries, Hamburg) to measure continuously the vertical temperature structure down to 1,000 m a forward step was taken in understanding more about the hydrography in the fishing areas off the coast of Greenland. Fig. 3 shows the temperature distribution within 3 hours in the trough between Fyllas and Fiskenaes Bank. There was an almost horizontal stratification of the isotherms.

But just north of Fyllas Bank, the situation was quite different. At two stations, only 3 mm apart (Fig. 4) the temperature was similar only in the upper 50 m. On bottom at the shallower station the temperature just exceeded 0° while it reached 2° at the same depth at the deeper station. There was no opportunity to investigate whether this phenomenon was stationary in time.

Off East Greenland, the *R/V Walther Herwig* could always reach the outer fishing grounds. Bottom temperatures were between 3.5° and 5.0° at the end of March 1970. They were generally cooler from north to south, since the core of the Irminger component of the East Greenland Current was moving deeper on at Moestring Ground (Fig. 5) and at Walloe Bank (Fig. 6). The maximum values of temperature and salinity in this core (5.1°, 4.9°; 34.99°/$_{oo}$, 34.97°/$_{oo}$) were slightly lower than in March 1969.

At the south-western tongue of Anton Dohrn Bank the vertical temperature distribution was the same as in March 1969 (only 3 days earlier in the year). From the surface to about 200 m the temperature was slightly above 6° and on the slope of the Bank, below 4°. Salinity was unexpectedly 1/10°/$_{oo}$ higher.

II. Biological Studies

The trend of increasing fishing activity in the two southern Div. 1E and 1F (with the greatest output in 1E) which started in 1968, increased considerably. In 1970, 77% of the total catch in Subarea 1 was caught in its southern part (1967: 27%, 1968: 42%, 1969: 50%) in spite of the fishery on the southern grounds being more hampered by ice than in Div. 1D and 1C (Fig. 1). This shows clearly, as mentioned in last year's report (*Redbook* 1970, Part II, p. 46), that the cod fishery in Subarea 1 for several years has depended mainly on the East Greenlandic year-classes and that the stock of West Greenlandic cod is in a rather poor state.

In 1970, 24,307 length measurements and 6,664 age determinations were made. They showed that, in the northern Div. 1C and 1D (Banana, Fyllas, and Fiskenaes Bank), the 1965 year-class was dominating. This seems for the time being the only year-class of West Greenlandic origin, which could have some commercial importance, especially when concentrating for spawning in the coming years. This year-class made up 36-73% of the catches by the *R/V Walther Herwig* in March and had an average length of 56.4 cm. Ten percent of these 5-year-old cod had already reached maturity. The 1966 year-class was the second strongest (24%) in Div. 1C and 1D. Catches with an average of 13 baskets per hour, however, were rather small. Also, the catches of a factory trawler on Fyllas Bank at the end of June were dominated by the 1965 year-class (37%). However, the catches were not encouraging. The 1965 year-class does not seem to be very promising.

In Div. 1E and 1F, the catches by factory ships in February and June and by a fresh-fish trawler in January were mainly composed of the 1961, 1962 and 1963 year-classes which are mainly of East Greenlandic origin. These 3 year-classes accounted for 80% of the total catch. The 1963 year-class (average length 66.6 cm) is at present the most important one (44%) followed by the 1962 (20%) and 1961 (16%) year-classes. Most of these cod were mature and on their way to the spawning grounds off East Greenland (January-February) or post-spawners coming back (June). Almost no cod of the 1965 year-class were found in these catches. Specimens of this year-class were absent from the catches of some trawlers fresh fishing occasionally west of Cape Farewell from August to November. This confirms that the year-class is a real West Greenlandic one. In the autumn catches in Div. 1F, the 1963 year-class dominated (50%) followed by the 1964 (28%), 1962 (14%), and 1961 (8%) year-classes.

Off East Greenland during the first 4 months of 1970, when on spawning migration (January, February) or spawning (March, April), the rich 1961 year-class was again of greatest commercial importance as in preceding years. During this time (the main German fishing season off East Greenland) the 9-year-old cod dominated (42%) (average length 81.1 cm). The other two good year-classes, 1962 and 1963, each contributed 25%. Their average length was 74.1 and 77.3 cm respectively. Thus these 3 important year-classes constituted 92% of the total catch.

Maturity studies of catches made by the *R/V Walther Herwig* and *R/V Anton Dohrn* in March and April showed that on the southern banks of East Greenland (Walloe and Discord Bank, and Moesting Ground) the 7-, 8-, and 9-year-old cod were 49, 61 and 77% mature respectively. However, on the northern banks (Heimland Ridge and Dohrn Bank) 88, 92 and 93% were mature. Probably a substantial part of these mature cod will have emigrated to Iceland and strengthened the Icelandic spawning stock.

In the catches after the spawning season from May to October the 1963 year-class was dominating (43%) followed by the 1962 year-class (20%) and the 1961 year-class (15%). The average length of these year-classes was 70.0, 72.4 and 77.8 cm respectively.

Table 1. Subarea 1 and East Greenland. German nominal catches in tons (industrial fish included), 1962 - 1970

	Year	Days fishing	Cod	Catch per fish.day	% industrial	Redfish	Catch per fish.day	% industrial	Total	Catch per fish.day	% industrial
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
	1967	6,305	137,773	21.9	9.1	13,600	2.2	3.0	155,606	24.7	9.4
	1968	5,819	132,498	22.8	5.3	11,858	2.0	1.8	146,432	25.2	5.3
	1969	3,234	67,431	20.9	4.0	6,964	2.2	5.2	75,293	23.3	4.3
	1970	1,722	38,551	22.4	4.0	4,501	2.6	9.1	44,283	25.7	5.9
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
	1967	2,157	13,025	6.0	0.1	22,879	10.6	4.7	37,803	17.5	4.4
	1968	1,361	9,825	7.2	0.2	15,432	11.3	2.0	26,417	19.4	2.0
	1969	2,164	14,292	6.6	0.9	24,587	11.4	4.6	40,505	18.7	4.2
	1970	1,532	14,388	9.4	0.9	15.672	10.2	4.5	31,104	20.3	3.3
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
	1967	8,462	150,798	17.8	8.4	36,479	4.3	4.1	193,409	22.9	8.4
	1968	7,180	142,323	19.8	4.9	27,290	3.8	1.9	172,849	24.1	4.8
	1969	5,398	81,723	15.1	3.5	31,551	5.8	4.8	115,798	21.5	4.3
	1970	3,254	52,939	16.3	3.2	20,173	6.2	5.5	75,387	23.2	4.9

Table 2. Discarded fish in Subarea 1 in tons, 1970

	Cod	Redfish	Species unknown	Total
1C	5	-	4	9
1D	3	-	2	5
1E	10	-	8	18
1F	12	-	12	24
Total	30	-	26	56

Table 3. Average gross registered tonnage of German trawlers fishing in Subarea 1, 1962-1970

1962	832 G.R.T.	(589 - 1561)
1963	864 G.R.T.	(566 - 1561)
1964	890 G.R.T.	(648 - 1561)
1965	1015 G.R.T.	(651 - 2557)
1966	1094 G.R.T.	(537 - 2557)
1967	1095 G.R.T.	(632 - 2557)
1968	1163 G.R.T.	(640 - 2557)
1969	1319 G.R.T.	(651 - 2684)
1970	1320 G.R.T.	(645 - 2684)

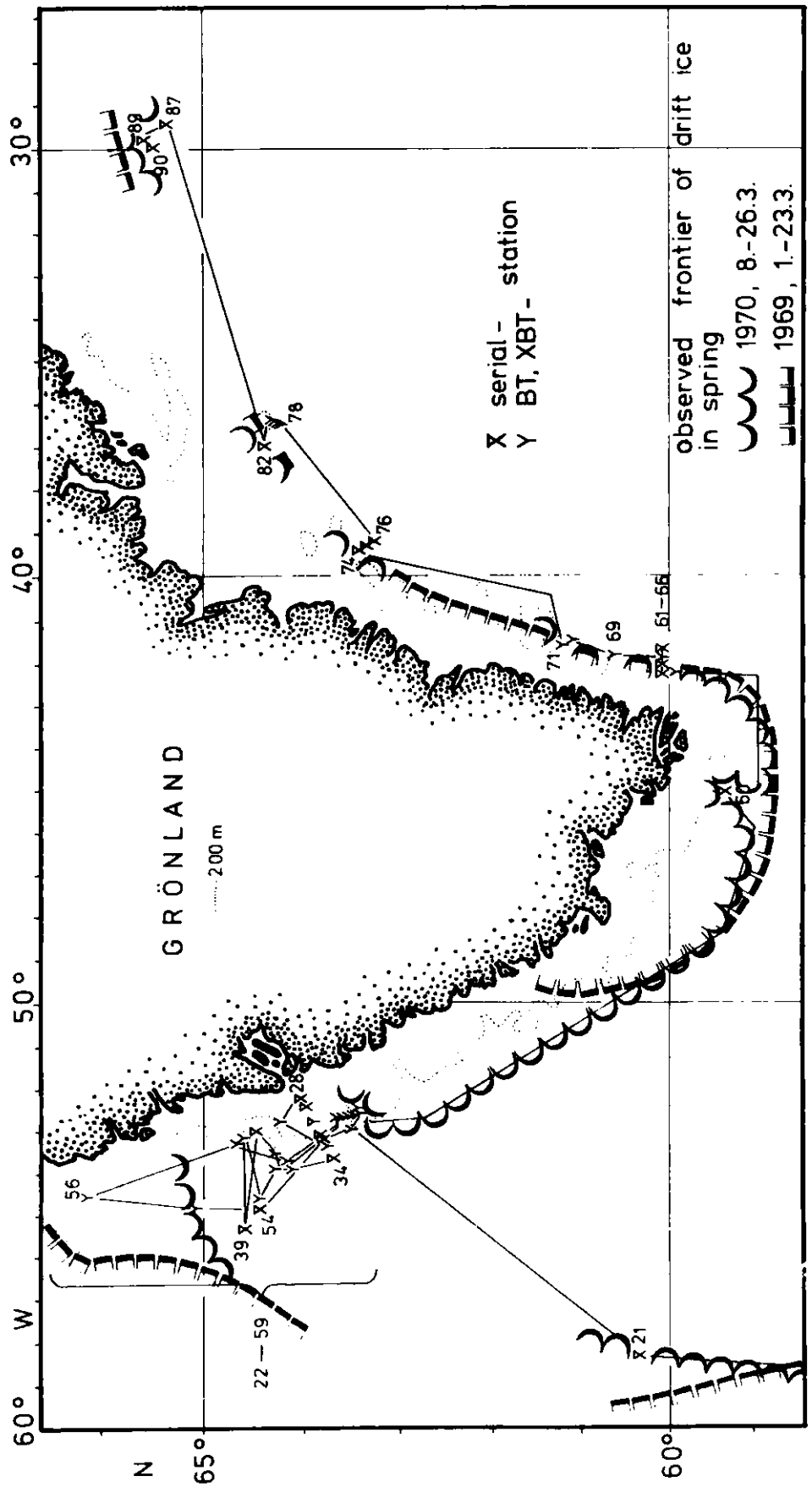
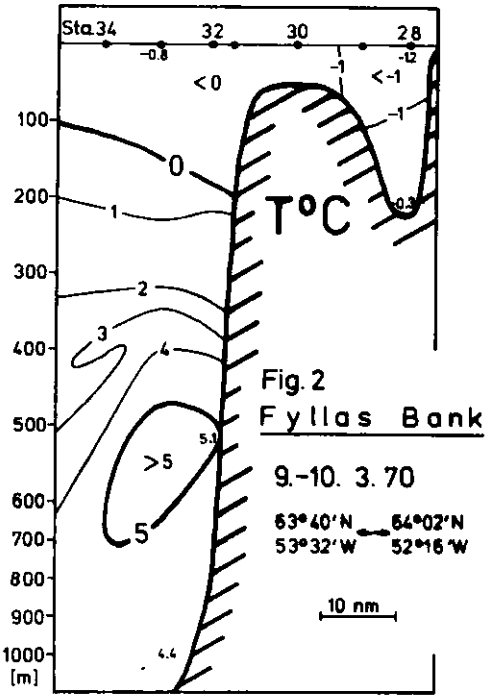
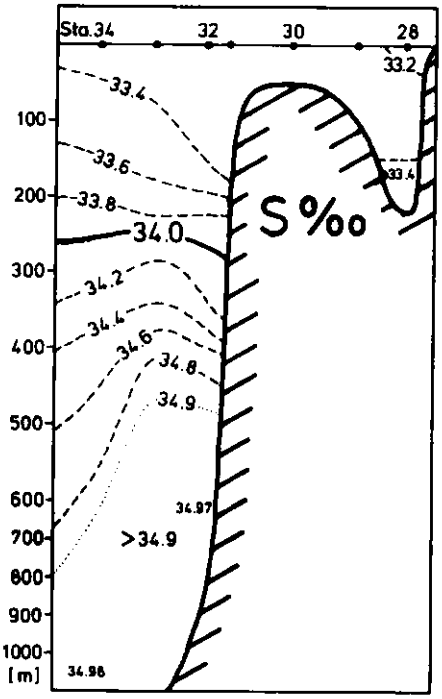
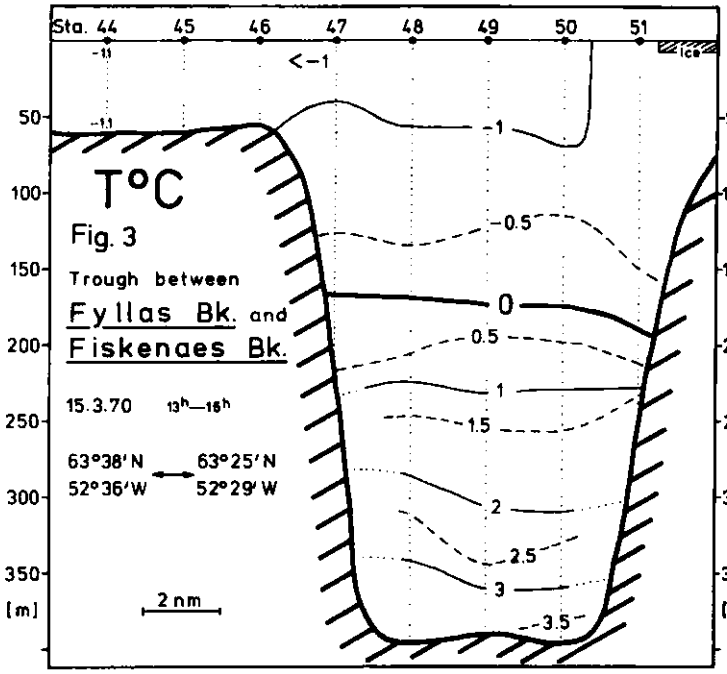
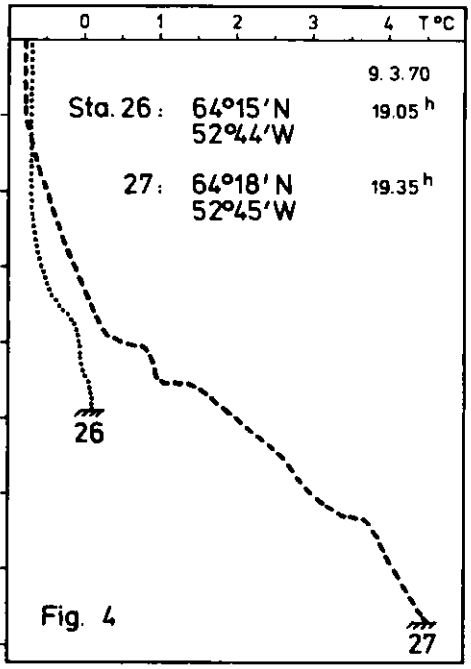

GRÖNLAND
200 m
X serial- station
Y BT, XBT- station
observed frontier of drift ice in spring
1970, 8.-26.3.
1969, 1.-23.3.
61-66
22 — 59
60°
50°
40°
30°
W
N
65°
60°

Fig. 1


Sta.34 32 30 28
T°C
Fig. 2
Fyllas Bank
9.-10. 3. 70
63°40'N ⟷ 64°02'N
53°32'W ⟷ 52°16'W
10 nm
[m]


Sta.34 32 30 28
S‰
>34.9
[m]


Sta. 44 45 46 47 48 49 50 51
T°C
Fig. 3
Trough between
Fyllas Bk. and
Fiskenaes Bk.
15.3.70 13h—16h
63°38'N ⟷ 63°25'N
52°36'W ⟷ 52°29'W
2 nm
[m]


0 1 2 3 4 T°C
9. 3. 70
Sta. 26: 64°15'N 52°44'W 19.05h
27: 64°18'N 52°45'W 19.35h
26
27
Fig. 4

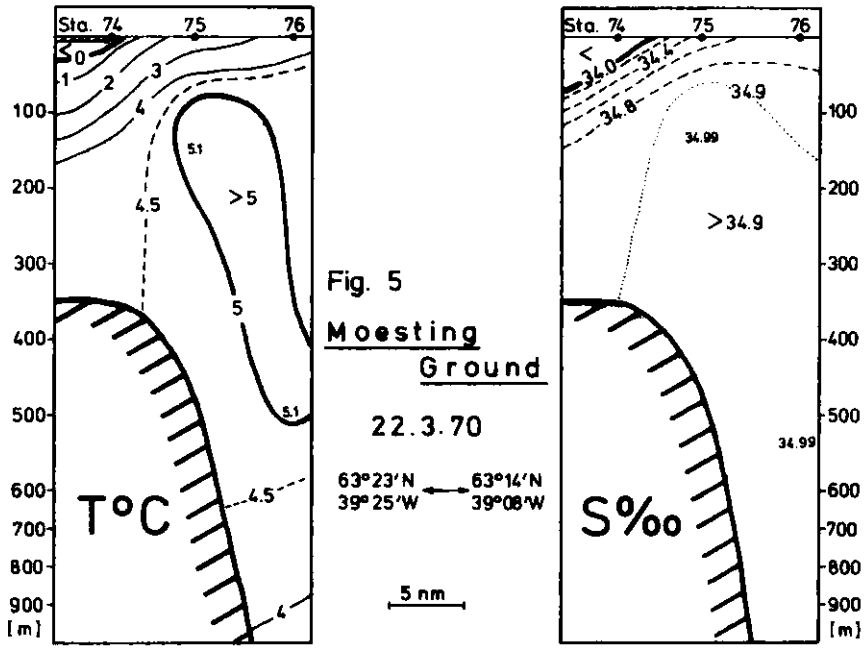


Fig. 5

Moesting Ground

22.3.70

63°23'N ⟷ 63°14'N
39°25'W 39°08'W

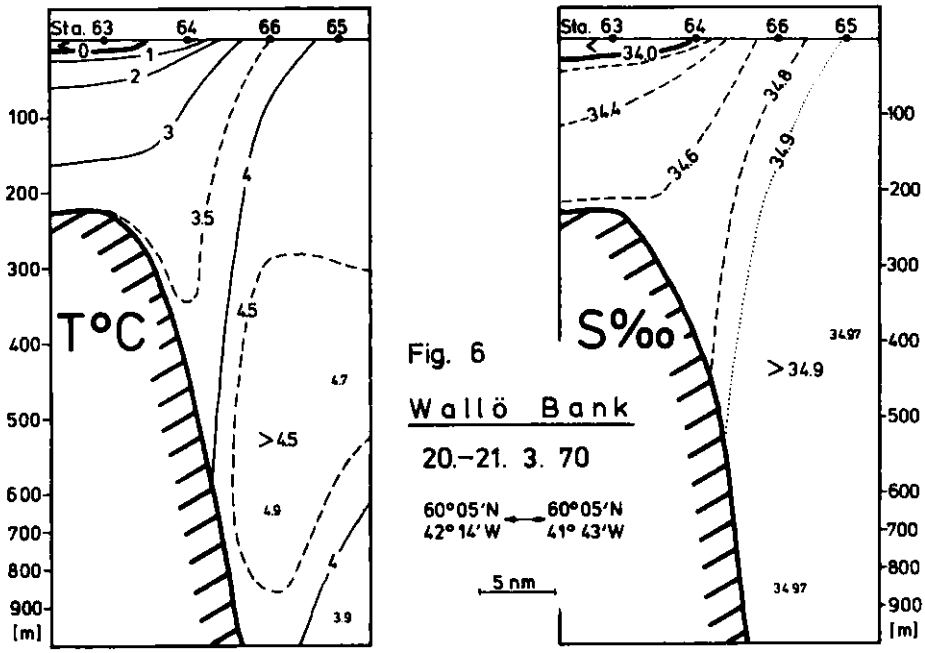


Fig. 6

Wallö Bank

20.–21. 3. 70

60°05'N ⟷ 60°05'N
42°14'W 41°43'W

B. Subareas 2 - 5 (excluding herring)

by J. Messtorff and W. Lenz

Subarea 2

A. Status of the Fisheries

The total catch taken by trawlers of the Federal Republic of Germany off Labrador decreased sharply by 23,400 tons (32%) in 1970 from the record catch of 1969 and fell even below that of 1968. For comparison, the nominal catches of the last six years are given in Table 4.

As in the preceding two years, 97% of the total catch consisted of cod. The sharp decline of the Subarea 2 catch of cod was mainly due to a considerable reduction of fishing effort (days fished) by about 25% from 1969. But this reduction was almost completely compensated by a corresponding shift of effort to the most northern part of Div. 3K from March to May just adjacent to the main fishing area of the German fleet in the southern part of Div. 2J. As there was practically no separation of fishing operations in both Divisions obviously the same cod population (Labrador stock) was exploited. Moreover no additional fishing activity took place in Subarea 3 Divisions farther south. Therefore the combined nominal catches of Subarea 2 + 3 are given at the bottom of Table 4. Off central Labrador (Div. 2H) some fishing activity was recorded only in February but none off North Labrador (Div. 2G). But even the combined cod catches show a remarkable decline of 13,500 tons (19%) from 1969, although the total effort was almost the same.

The following reasons may have been responsible for the less efficiency of the fishery:

1) More severe ice conditions than in 1969. The drift ice covering the Labrador shelf in spring 1970 extended still farther east than in 1969 and even beyond the continental slope off south Labrador (Fig. 7). Trawlers were frequently forced to operate under very difficult conditions within limited and often rapidly changing areas of more or less open water inside the ice frontier.

2) Hydrographic observations indicated that, on the other hand, the area of optimum bottom temperatures was less restricted in 1970 so that cod may not have formed quite as dense concentrations as in 1969.

3) Reduced abundance of the adult stock exposed to fishery.

Fishing activity was recorded from January to June. However, 89% of the total catch was taken during the main season from February to April with a peak of 45% in March.

Although there was no special redfish fishery the relatively small by-catch of this species increased slightly in Subarea 2 since 1968 probably due to the restriction of fishing operations to the slope of the shelf on account of the extreme hydrographic as well as ice conditions. The redfish catch, however, remained unimportant with only 1% of the total catch in Subarea 2 and 5% in Subarea 3 (Div. 3K).

Forecast for 1971

After preliminary estimates of cod catches taken by trawlers of the Federal Republic of Germany off Labrador in January and for the most part in February 1971 may have exceeded those of the same months in 1970 by approximately 40%, but in spite of that the catch-per-unit effort has probably decreased. By about the middle of March, however, ice as well as presumably unprofitable catches forced the fleet to leave Labrador and fishing has not been taken up again since. The German fishery off Labrador is therefore not expected to yield much more than 30,000 tons in 1971.

B. Special Research Studies

I. Environmental Studies (by W. Lenz)

Hydrographic observations were carried out by *R/V Walther Herwig* in Subarea 2 in February/March 1970 mainly in the southern part of Div. 2J where the fishing fleets were concentrated. Although the operations were rather restricted by severe ice conditions one hydrographic section (Fig. 8) could be obtained even among the drift ice up to some 80 miles inside the ice frontier. The temperature distribution underneath the ice showed a rather horizontal stratification with a cold upper layer extending beyond the slope of the banks and reaching down to over 100 m at the innermost station. In the whole area of observations bottom temperatures were above 3° C between 280 and 350 m and even above 4° C in deeper water at the slope. Compared to the hydrographic situation observed at the same time of the year in 1969 a considerably wider area was covered by warmer bottom water. Because of the drift ice only few salinity values could be determined, but those indicate that also the salinities in the West Greenland component of the Labrador Current were slightly higher than in the year before.

II. Biological Studies

R/V Walther Herwig worked off Labrador in February/March 1970 but sampling for length and age distribution of cod was restricted on account of ice to the area of the commercial fishery in the most southern part of Div. 2J. After preliminary results the mean lengths of cod in research and commercial catches varied between 51 and 56 cm and did not differ significantly from last year's estimates. But the predominant length-groups (40 - 60 cm) as well as age-groups (year-classes 1962 - 1965) were more evenly distributed in 1970.

In order to test a new egg-counting device developed by Dr Schulz of the Institute for Seafisheries at Hamburg, a sample of ovaries of Labrador cod (pre-spawners) was collected in March 1970. Although the material was rather limited the results of the successful test countings seemed good enough to give at least some rough estimates of the egg production of Labrador cod. The actual egg numbers from cod of 50 to 72 cm varied between 0.13 and 1.8 million. The mean values were 0.8 million eggs at 61.2 cm total length of fish. A comparison with egg numbers of East Greenland cod obtained by the same method showed that, in relation to length of fish, they fitted in roughly the same exponential curve. But whether this relationship is in fact specific for all Atlantic cod and independant of different stocks can only be derived from more comprehensive material. The slow growth rate of Labrador cod, however, results in a much smaller size at first maturity and hence in a considerably lower egg production to start with than in fast growing cod populations.

Subarea 3

A. Status of the Fisheries

The nominal catch taken by trawlers of the Federal Republic of Germany is given in Table 4. As the fishing activity was restricted to the most northern part of Div. 3K and was connected with the fishing operations in Div. 2J more detailed information is given in Section A for Subarea 2.

B. Special Research Studies

Samples for length and age distribution of cod were taken by *R/V Walther Herwig* in February/March 1970. The average length of 42.3 cm for cod was considerably lower off south Labrador at the same time and the same depth zone (300 - 400 m). The predominance of younger cod formed a pronounced peak at 37.5 cm in the length distribution. In the research vessel catch, 69% of cod were smaller than 45 cm.

Subarea 4

A. Status of the Fisheries

Except for herring, there was no commercial fishery.

B. Special Research Studies

During April extensive selectivity experiments with polyamide bottom trawl codends were carried out by *R/V Walther Herwig* in Div. 4Vn. The assumption that the elongation of the netting yarn is one of the most important factors by which the selectivity might be influenced, could not be substantiated. The results of the experiments are given in ICNAF *Redbook* 1971, Part III (H. Bohl: Selection of cod by polyamide trawl codends in ICNAF Division 4Vn).

Subarea 5

A. Status of the Fisheries

Except for herring, there was no commercial fishing.

B. Special Research Studies

For Environmental and Biological Studies (herring) see Section C of the Research Report.

Table 4. German nominal catches in Subareas 2 (1965 - 1970) and 3 (1969 - 1970) in tons, (including industrial fish = fish converted to fish meal on board).

			COD			REDFISH			OTHER FISH			TOTAL		
	Year	Days fished	Catch	Catch per day fished	% industrial	Catch	Catch per day fished	% industrial	Catch	Catch per day fished	% industrial	Catch	Catch per day fished	% industrial
Subarea 2	1965	1 323	41 556	31.4	13.3	2 891	2.2	1.2	1 151	0.9	60.0	45 598	34.5	13.8
	1966	2 132	63 610	29.8	7.8	2 750	1.3	13.2	1 541	0.7	46.4	67 901	31.8	8.9
	1967	1 251	30 589	24.5	8.4	1 616	1.3	17.1	310	0.2	80.0	33 115	26.5	9.3
	1968	1 489	53 186	35.7	1.5	301	0.2	4.7	747	0.5	24.8	54 234	36.4	1.9
	1969	2 099	71 735	34.2	3.4	400	0.2	28.5	1 088	0.6	25.8	73 223	34.9	3.8
	1970	1 585	48 232	30.4	2.1	650	0.4	29.5	945	0.6	50.4	49 827	31.4	3.3
Subarea 3 (Div. 3 K)	1969	-	257	-	-	4	-	-	1	-	-	262	-	-
	1970	414	9 937	24.0	3.1	587	1.4	7.2	103	0.2	69.9	10 627	25.7	4.0
Subarea 2 + 3	1970	1 999	58 169	29.1	2.3	1 237	0.6	18.9	1 048	0.5	52.3	60 454	30.2	3.4

Table 5. Discarded fish in Subareas 2 and 3 in tons, 1970 (1969 in brackets).

	COD	REDFISH	OTHER FISH	ALL SPECIES
Div. 2 H	42 (905)	1 (17)	2 (207)	45 (1129)
Div. 2 J	592(2362)	82 (40)	221 (565)	895 (2967)
Total	634(3267)	83 (57)	223 (772)	940 (4096)
Div. 3 K	- (-)	35 (--)	15 (-)	50 (--)

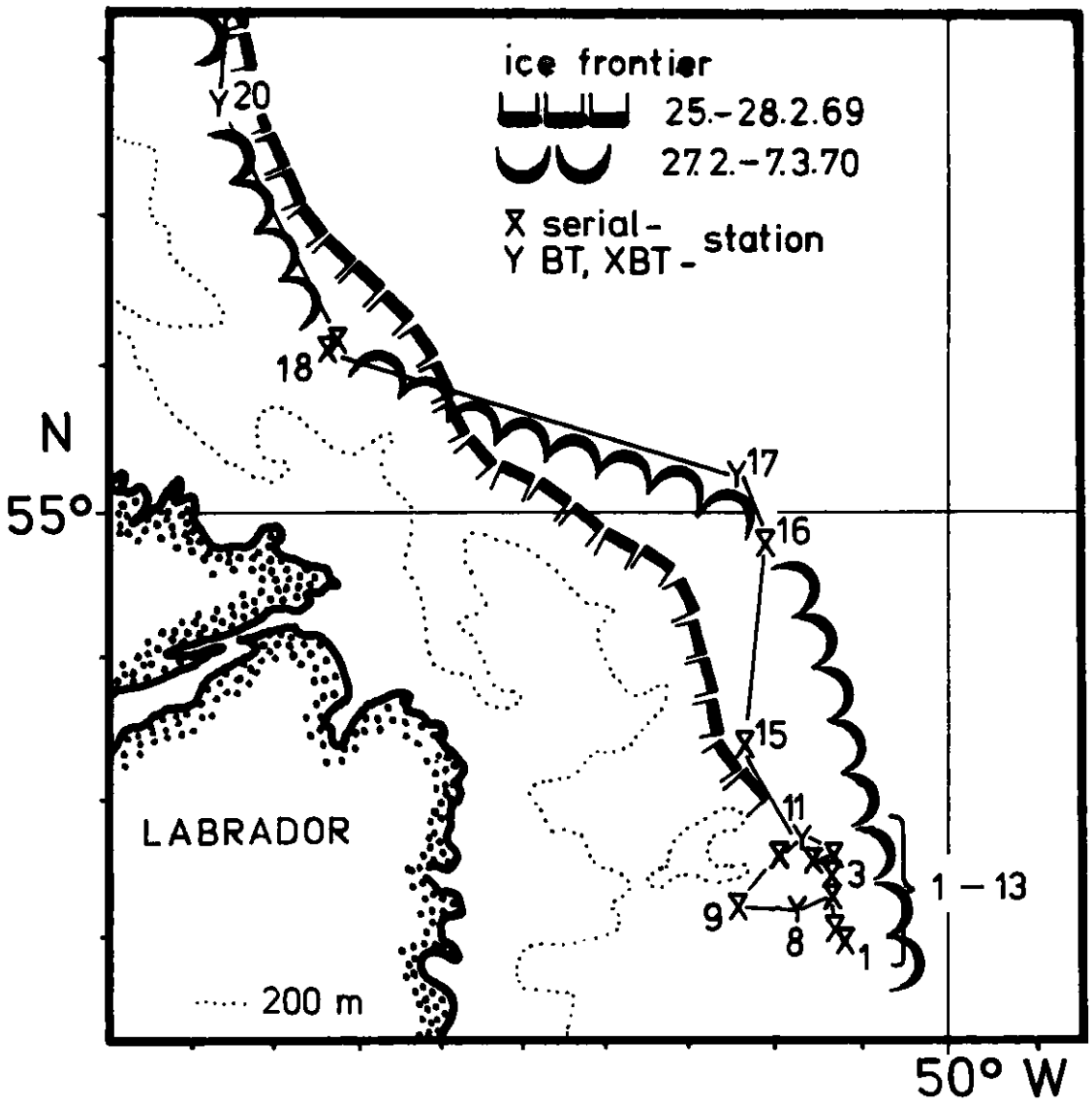

ice frontier
25.-28.2.69
27.2.-7.3.70
X serial-
Y BT, XBT - station
Y20
18
Y17
16
15
11
3
1 – 13
9
8
1
N
55°
LABRADOR
200 m
50° W

Fig. 7.

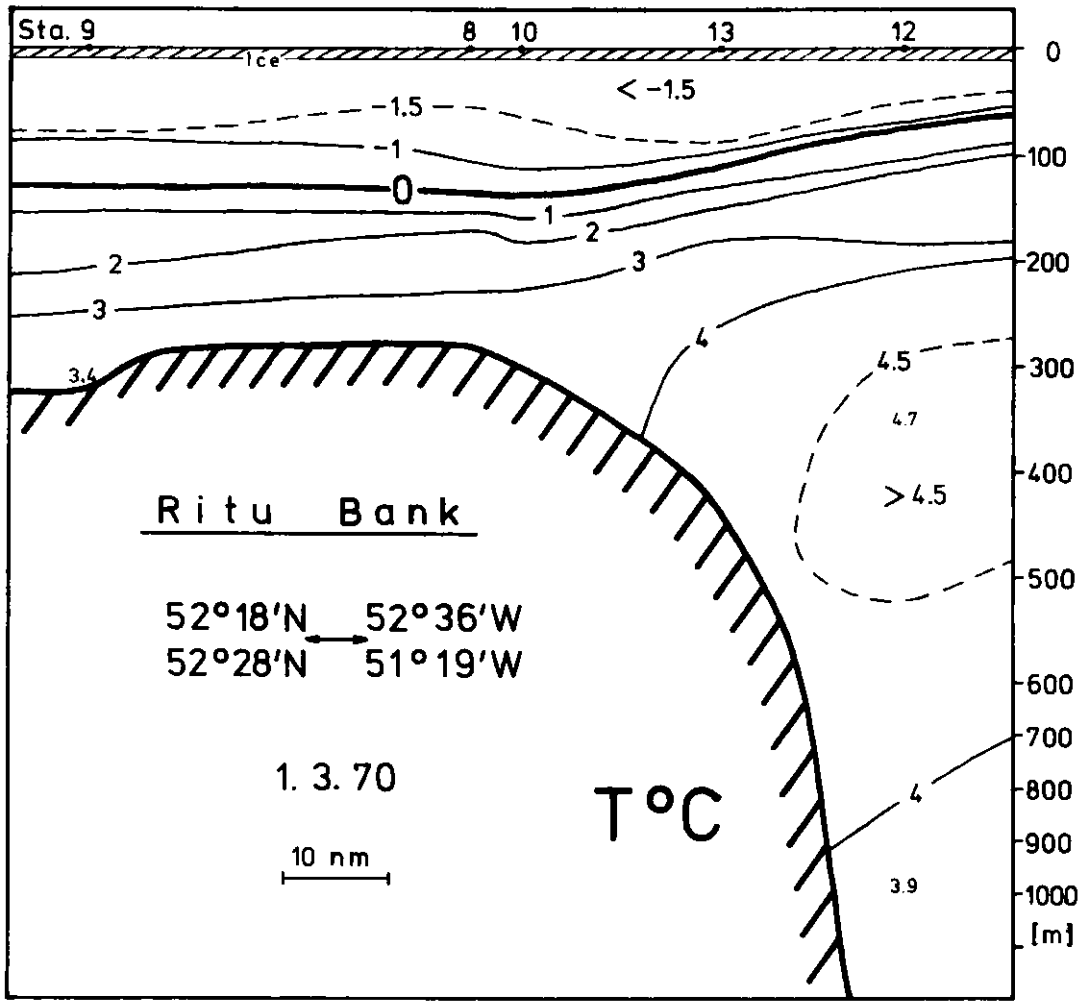

Sta. 9
8
10
13
12
Ice
0
< -1.5
-1.5
-1
0
1
2
3
100
200
300
400
500
600
700
800
900
1000
[m]
4
4.5
4.7
> 4.5
3.4
3.9
Ritu Bank
52°18'N 52°36'W
52°28'N 51°19'W
1. 3. 70
T°C
10 nm

Fig. 8.

C. Subareas 4, 5 and 6 (herring only)

by K. Schubert

A. Status of the Fisheries

A total of 30 freezer stern trawlers operated with pelagic nets in Subarea 4 (12), 5 (28) and 6 (1) from January to May and July to December mainly for herring. Fig. 9 shows the operations from the end of July to December 1970. The total catch in 1970 in these three Subareas amounted to 94,436 tons. In the Subarea 4 the catch was 5,149 tons in winter and spring and only 425 tons in November/December. The effort in these Subareas decreased from 607 fishing days in 1969 to 183 fishing days. The catch-per-day for the whole year in Subarea 4 decreased from 35.4 tons to 30.5 tons.

In Subarea 5 the catch increased from 69,423 tons to 88,561 tons. This increasing was due to our greater effort which increased from 1,932 fishing days to 2,086 fishing days. The catch-per-day increased from 35.9 tons to 42.5 tons.

In Subarea 6A only 211 tons were fished in April. The effort amounted to 9 fishing days, the catch-per-day 23.4 tons (Table 6).

Fig. 9 shows the fishing area of 5 German freezer trawlers on 10 cruises in Subareas 4 and 5. Whereas Fig. 10 shows the catch-per-day in baskets (50 kg) on average of about 5 days of 12 German freezer trawlers in 30 trips in Div. 5Ze.

B. Special Research Studies

From Div. 5Y 2,530 herring were measured from June to August (Table 7). The average length increased from 28.75 cm in June to 31.92 cm in August. In June more smaller herring were met. The length varied from 19.0 cm to 37.0 cm with peaks at 29.0 cm (June), 32.0 cm (July) and 33.0 cm (August).

No data until now are available on maturity stages, age composition and meristic characters.

From Div. 5Ze 19 samples and 25,150 measurements were examined. The average length varied between 17.0 cm to 38.0 cm with peaks at 27.0 cm (June/July) and 28.0 cm (August/September).

Maturity stage 4 was predominant in July, whereas in the first half of August stage 4 and in the second half of this month stage 5 formed the bulk of the samples. In the beginning of September stage 5 was predominant, whereas later in this month the herring were spawning (stage 6)(Table 8).

The average number of vertebrae varied between 56.35 and 56.40, the average number of gillrakers fluctuated between 49.59 and 49.80. The meristic characters for the spawning stock (stage 6) were: 56.33 vertebrae, 49.77 gillraker and 14.22 keel scales (Table 9 and 10).

Predominant in the month July to September was the 1966 year-class. In all months the 1965 and 1967 year-classes were of some importance too. The

proportion of herring older than 5 years was very small (Table 8).

Table 11 shows the mean length and mean l_1 for age (cm).

Table 6. Nominal catch, effort, catch-per-unit effort and discards of German freezer trawlers, Subareas 4, 5 and 6, in 1970 (including industrial fish).

Subarea	4Vn					4Vs						4W			4				
Month	I	III	XI	XII	Total	I	II	III	IV	V	Total	XI	XII	Total	Total				
Nominal catches (tons)																			
Herring	900	214	135	100	1349	1855	81	107	1759	233	4035	25	165	190	5574				
Total	964	235	135	101	1435	2002	81	117	1760	233	4193	25	166	191	5819				
Effort																			
Days fishing	29	11	5	11	56	68	4	5	34	6	117	3	7	10	183				
Catch per day (tons)																			
Herring	31.0	19.5	27.0	9.1	24.1	27.3	20.3	21.4	51.7	38.8	34.5	8.3	23.6	19.0	30.5				
Total	33.2	21.4	27.0	9.2	25.6	29.4	20.3	23.4	51.8	38.8	35.8	8.3	23.7	19.1	31.8				
Discards (tons)																			
Herring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

Subarea	5Y							5Ze						5Zw		5	6A	
Month	I	III	VIII	IX	XI	XII	Total	VIII	IX	X	XI	XII	Jahr	IV	Jahr	Total	IV	Jahr
Nominal catches (tons)																		
Herring	245	149	400	165	275	3639	4873	7085	31087	25125	12691	7630	83618	70	70	88561	211	211
Total	283	150	400	165	275	7500	8803	7117	31368	25152	12764	7767	84168	109	109	93080	404	404
Effort																		
Days fishing	14	3	11	5	8	200	247	173	795	403	279	186	1836	3	3	2086	9	9
Catch per day (tons)																		
Herring	17.5	16.6	36.4	33.0	34.4	18.2	19.7	41.0	39.1	62.3	45.5	41.0	45.5	23.3	23.3	42.5	23.4	23.4
Total	20.2	20.0	36.4	33.0	34.4	37.5	35.6	41.1	39.5	62.4	45.7	41.8	45.8	36.3	36.3	44.6	44.9	44.9
Discards (tons)																		
Herring	-	-	8	-	-	-	8	142	125	535	-	-	802	-	-	810	-	-
Total	-	-	8	-	-	372	380	157	320	720	-	-	1197	-	-	1577	-	-

Table 7. Length composition (°/₀₀), 1970 (R - Research vessel).

Area	5Y			5Ze			
Month	VI	VII	VIII	VI	VII	VIII	IX
Sample	R	R	R	R	R	R	R
cm							
17.0	-	-	-	-	+	-	-
17.5	-	-	-	-	+	-	-
18.0	-	-	-	1	-	-	-
18.5	-	-	-	5	+	-	-
19.0	1	-	-	8	1	-	-
19.5	13	-	-	10	3	-	-
20.0	4	-	-	7	7	-	+
20.5	3	-	-	5	11	-	+
21.0	3	-	-	4	13	-	1
21.5	1	-	-	3	14	+	2
22.0	7	-	-	7	12	-	4
22.5	18	-	-	19	20	+	3
23.0	10	-	-	37	25	+	4
23.5	9	1	-	38	38	3	9
24.0	24	4	-	51	41	9	19
24.5	25	3	-	55	55	13	28
25.0	30	7	-	49	50	20	48
25.5	33	8	1	81	63	31	60
26.0	33	11	1	90	63	41	73
26.5	39	15	-	109	79	68	79
27.0	51	28	2	112	85	84	95
27.5	57	35	2	107	95	104	91
28.0	67	47	8	75	85	114	110
28.5	68	50	27	51	65	102	81
29.0	67	74	52	28	45	96	65
29.5	79	76	65	29	34	53	35
30.0	63	56	87	6	21	48	32
30.5	51	46	74	4	17	34	19
31.0	33	64	98	3	11	20	18
31.5	54	64	86	1	10	22	14
32.0	45	84	101	3	11	28	18
32.5	45	95	86	-	9	30	18
33.0	27	66	121	2	8	31	21
33.5	24	67	72	-	5	24	15
34.0	7	47	61	-	3	16	15
34.5	4	23	33	-	1	6	9
35.0	1	16	18	-	+	2	7
35.5	3	8	4	-	-	1	4
36.0	1	5	-	-	+	-	2
36.5	-	-	-	-	-	-	1
37.0	-	-	1	-	-	-	+
37.5	-	-	-	-	-	-	+
38.0	-	-	-	-	-	-	+
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Number	668	913	949	945	8,014	3,568	12,623
Mean (cm) Length	28.75	31.05	31.92	26.27	26.81	28.94	28.24

Table 8. 1970 Age composition (°/₀₀)

Area		5Ze				
Month		VII	VIII	VIII	IX	IX
Sample		C	C	R	C	R
year-class	Age					
1969	1	-	-	-	-	-
1968	2	-	5	-	-	29
1967	3	149	220	31	104	171
1966	4	579	573	495	396	411
1965	5	115	93	167	171	135
1964	6	55	37	89	171	61
1963	7	39	33	51	61	65
1962	8	29	11	20	30	15
1961	9	8	11	75	30	40
<1961	>9	26	17	72	37	73
Total		1,000	1,000	1,000	1,000	1,000
Number		383	785	293	164	275

1970 Sexual maturity (°/₀₀)

Area	5Ze				
Month	VII	VIII	VIII	IX	IX
Sample	C	C	R	C	R
stages					
1	-	-	-	-	-
2	53	110	10	-	70
3	178	103	7	-	4
4	741	759	377	-	60
5	28	28	606	-	834
6	-	-	-	1,000	14
7	-	-	-	-	18
8	-	-	-	-	-
Total	1,000	1,000	1,000	1,000	1,000
Number	397	799	300	163	285

R - Research vessel
C - Commercial fishing

Table 9. Mean numbers in relation to stages of maturity.

Area Month Sample		vertebral counts 5 Z e VII C	VIII C	VIII R	IX C	IX R	gill rakers 5 Z e VII C	VIII C	VIII R	IX C	IX R	keeled scales 5 Z e IX C
Stages 1	$\bar{x}$ s^2 n	-	-	-	-	-	-	-	-	-	-	-
2		56.40 0.366 20	56.50 0.463 88	56.33 0.334 3	-	56.75 0.305 20	49.14 2.830 21	48.84 2.504 88	48.00 4.000 3	-	48.45 3.218 20	-
3		56.36 0.409 70	56.27 0.422 82	56.50 0.500 2	-	56.00 - 1	49.93 3.169 70	49.39 3.231 82	51.50 0.500 2	-	48.00 - 1	-
4		56.34 0.450 296	56.30 0.454 605	56.37 0.433 113	-	56.17 0.407 17	49.69 2.723 291	49.68 2.819 603	49.65 3.054 113	-	49.94 1.435 17	-
5		56.36 0.268 11	56.41 0.357 22	56.28 0.482 180	-	56.38 0.509 237	49.27 2.225 11	50.09 2.091 21	49.87 2.768 182	-	49.95 2.756 237	-
6		-	-	-	56.33 0.371 162	56.50 0.333 4	-	-	-	49.77 2.662 163	49.00 2.000 4	14.22 0.728 95
7		-	-	-	-	56.60 0.300 5	-	-	-	-	48.20 2.710 5	-
8		-	-	-	-	-	-	-	-	-	-	-
Total	$\bar{x}_2$ s^2 n	56.35 0.430 397	56.35 0.485 797	56.32 0.460 298	56.33 0.371 162	56.40 0.489 284	49.69 2.005 393	49.59 2.896 794	49.78 2.863 300	49.77 2.662 163	49.80 2.785 284	14.22 0.728 95

C = Commercial fishing
R = Research vessel

Table 10. Mean numbers for year-class.

Area / Month / Sample		vertebral counts					gill rakers					keeled scales
				5 Z e					5 Z e			5 Z e
		VII C	VIII C	VIII R	IX C	IX R	VII C	VIII C	VIII R	IX C	IX R	IX C
year-class 1969	Age 1 $\bar{x}$ s^2 n	-	-	-	-	-	-	-	-	-	-	-
68	2	-	56.75 0.270 4	-	-	56.75 0.223 8	-	47.75 2.270 4	-	-	48.00 4.571 8	-
67	3	56.40 0.355 57	56.39 0.451 173	56.44 0.553 9	56.25 0.470 16	56.40 0.467 47	49.19 3.624 57	48.93 2.440 172	49.56 0.603 9	49.50 3.083 16	49.19 1.942 47	13.75 0.508 8
66	4	56.31 0.499 220	56.34 0.499 448	56.30 0.447 145	56.36 0.300 64	56.23 0.559 112	49.83 2.568 217	49.87 2.970 448	50.08 2.924 145	49.80 2.257 65	50.35 2.482 113	14.41 0.641 32
65	5	56.55 0.301 44	56.29 0.521 72	56.43 0.629 49	56.43 0.483 28	56.54 0.317 37	49.98 2.976 43	49.40 2.669 72	49.45 2.631 49	49.46 2.933 28	49.46 4.095 37	14.27 0.643 15
64	6	56.38 0.255 21	56.38 0.463 29	56.48 0.520 25	56.26 0.356 27	56.59 0.268 17	49.62 1.455 21	49.45 1.550 29	49.54 2.587 26	49.93 2.884 28	49.87 1.981 16	14.47 0.825 19
63	7	56.13 0.268 15	56.23 0.347 26	56.27 0.215 15	56.30 0.243 10	56.39 0.378 18	50.00 2.143 15	49.11 3.067 26	49.13 1.553 15	50.00 5.778 10	49.72 2.217 18	13.87 0.698 8
62	8	56.18 0.367 11	56.11 0.363 9	56.17 0.572 6	56.20 0.210 5	56.75 2.260 4	49.27 0.526 11	49.86 1.147 7	49.17 6.972 6	50.60 0.840 5	50.75 4.270 4	13.67 1.390 3
61	9	56.33 0.334 3	56.33 0.264 9	56.33 0.439 21	56.00 0.500 5	56.55 0.493 11	50.00 3.000 3	49.11 2.363 9	49.45 2.269 22	49.20 2.460 5	49.91 1.092 11	14.25 0.270 4
< 61	>9	56.40 0.729 10	56.46 0.954 13	55.95 0.398 21	56.17 0.972 6	56.60 0.472 20	48.90 1.879 10	50.00 2.667 13	49.71 0.718 21	49.83 2.172 6	49.50 2.276 20	13.60 0.840 5
Total	$\bar{x}$ s^2 n	56.35 0.438 381	56.35 0.485 783	56.31 0.464 291	56.32 0.369 161	56.40 0.454 274	49.71 2.803 377	49.57 2.888 780	49.77 2.890 293	49.76 2.665 163	49.82 2.829 274	14.22 0.735 94

C = Commercial fishing
R = Research vessel

Table 11. Mean length and mean l_1 for age (cm).

Area / Month / Sample			length: 5 Z e VII C	VIII C	VIII R	IX C	IX R	l_1: 5 Z e VII C	VIII C	VIII R	IX C	IX R
yaer-class 1969	Age 1	$\bar{x}$	-	-	-	-	-	-	-	-	-	-
		s^2										
		n										
68	2	$\bar{x}$	-	22.25	-	-	21.75	-	-	-	-	11.50
		s^2		0.917			0.794					-
		n		4			8					1
67	3	$\bar{x}$	24.87	24.77	26.00	26.74	25.03	10.88	11.63		13.00	13.00
		s^2	1.169	1.071	0.500	1.070	0.868	6.573	3.410	-	0.500	0.500
		n	57	173	9	17	47	8	15		2	2
66	4	$\bar{x}$	27.13	27.27	27.20	27.79	27.63	10.04	10.41	10.88	11.00	11.33
		s^2	0.937	1.014	0.988	1.368	1.170	2.896	4.085	2.859	10.306	3.427
		n	222	449	145	65	113	48	86	8	10	12
65	5	$\bar{x}$	28.91	28.77	28.83	29.86	29.38	10.50	11.25	9.50	10.50	12.17
		s^2	1.345	0.897	0.851	1.454	1.155	7.273	4.794	-	18.000	5.089
		n	44	73	49	28	37	12	8	1	2	6
64	6	$\bar{x}$	30.02	30.22	30.38	31.29	30.50	10.33	11.50	10.50	13.50	13.50
		s^2	1.773	1.495	0.827	1.435	0.875	9.372	7.000	-	6.500	-
		n	21	29	26	28	17	6	3	2	5	1
63	7	$\bar{x}$	31.30	31.43	31.10	32.10	31.83	13.25	12.00	9.50	11.50	12.50
		s^2	1.031	0.874	1.126	0.951	0.595	0.917	6.972	-	0.667	2.000
		n	15	26	15	10	18	4	10	1	4	4
62	8	$\bar{x}$	32.23	32.28	32,17	32.50	32.75	12.00	11.50		8.50	12.00
		s^2	0.425	0.701	0.289	1.000	0.937	4.750	-	-	8.000	0.500
		n	11	9	6	5	4	2	2		2	2
61	9	$\bar{x}$	31.83	32.50	31.77	32.70	32.59	16.50		12.50		11.50
		s^2	0.334	0.250	0.973	0.710	0.892	-	-	2.000	-	-
		n	3	9	22	5	11	1		2		1
< 61	> 9	$\bar{x}$	33.40	33.04	32.69	33.00	33.30	12.00	12.75	12.50	11.00	11.64
		s^2	0.768	0.287	0.564	0.350	0.927	0.500	4.937	1.000	4.750	3.480
		n	10	13	21	6	20	2	4	3	2	7
Total		$\bar{x}$	27.68	27.29	28.74	29.38	28.39	10.54	10.84	11.15	11.46	11.86
		s^2	4.947	4.760	4.962	5.175	8.382	4.914	4.543	2.500	7.653	2.927
		n	383	785	293	164	275	83	128	17	27	36

C = Commercial fishing
R = Research vessel

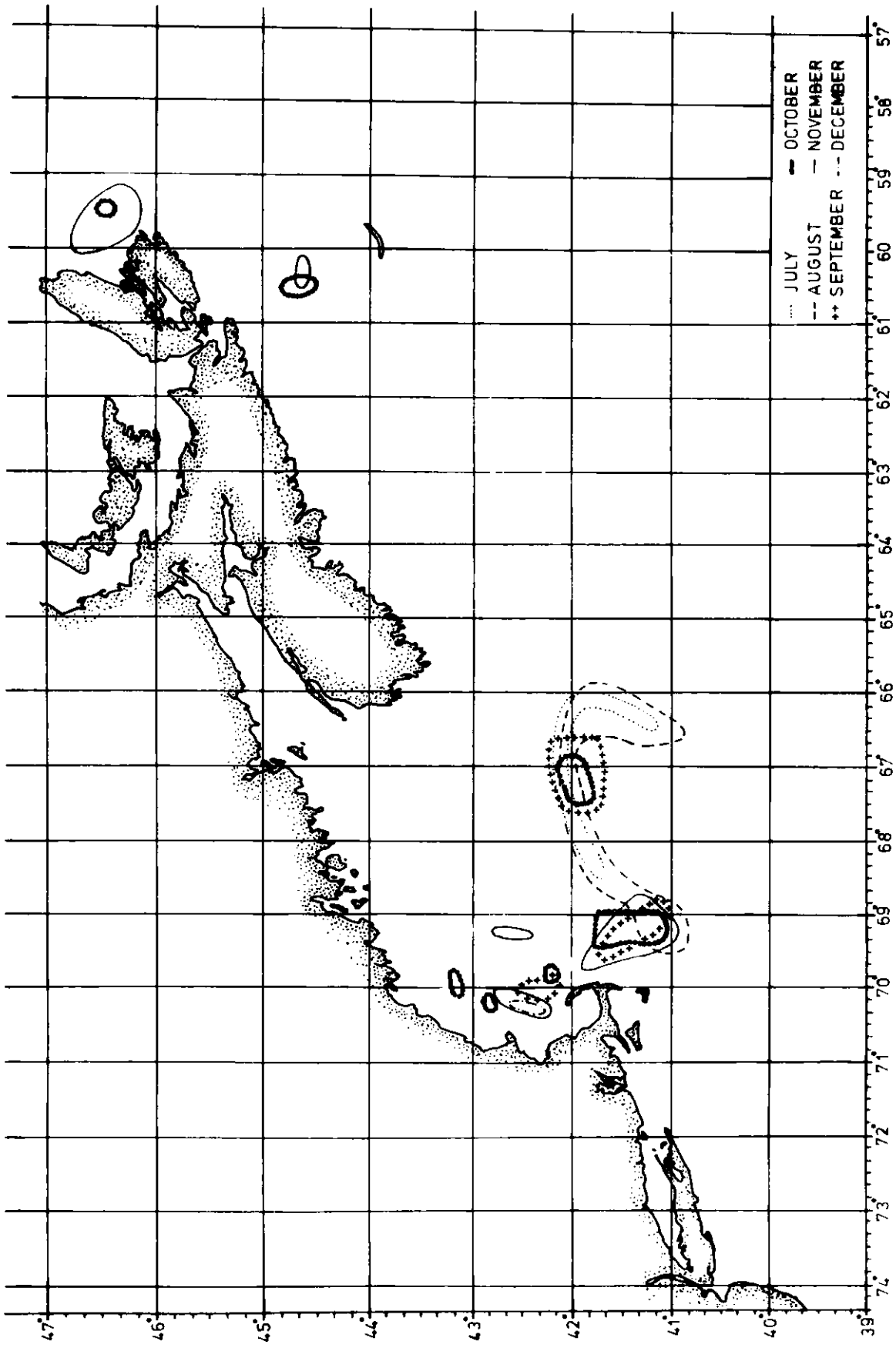


Fig. 9. Fishing area of 5 German freezer trawlers (10 cruises) in Subareas 4 and 5 (1970).

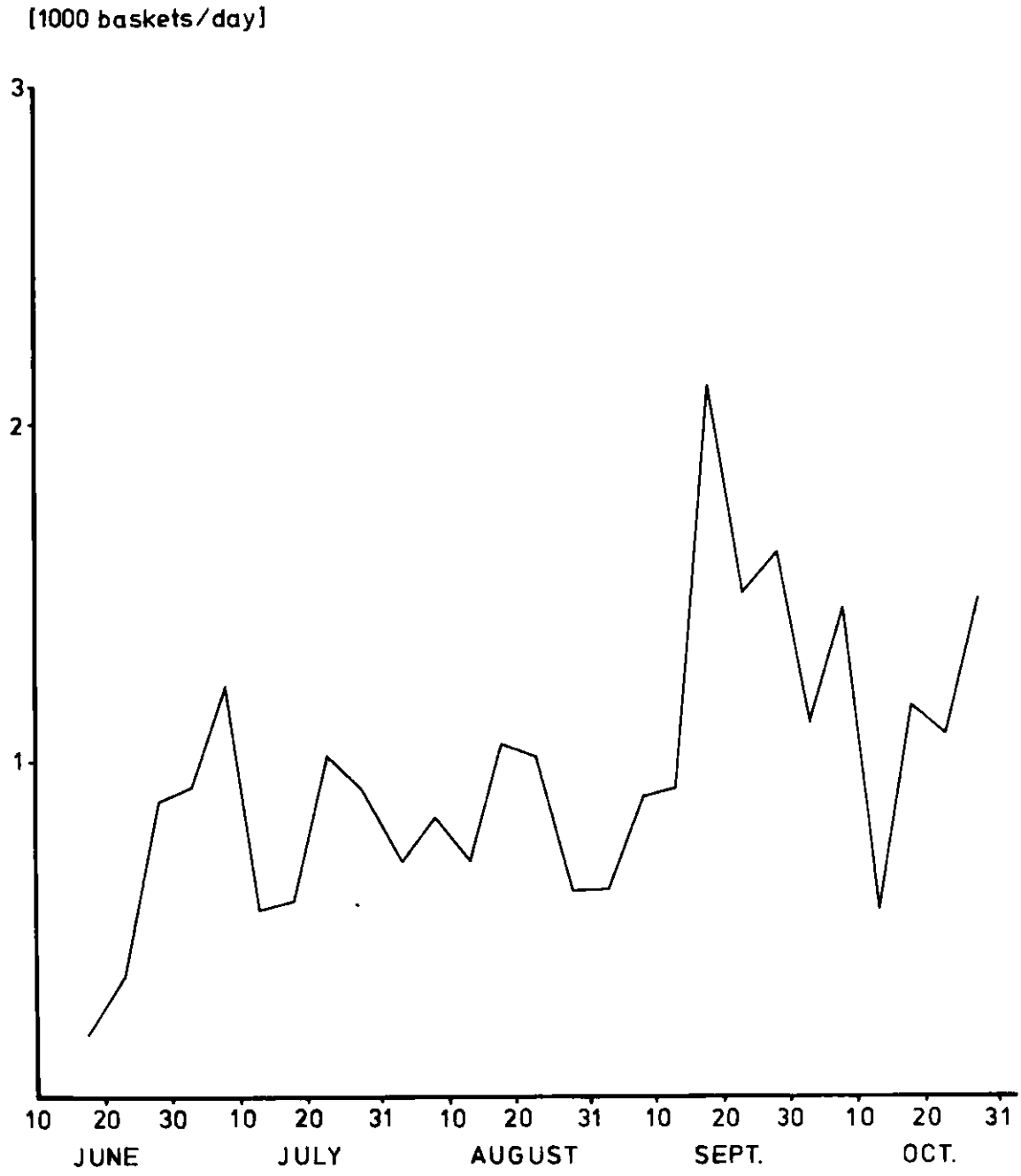


Fig. 10. Herring - catch-per-day (baskets) on an average of about 5 days of 12 German freezer trawlers in 30 trips in 5Ze (1970).

V. Japanese Research Report, 1970

by Ikuo Ikeda

Japanese exploratory fishery in the ICNAF Area started in 1968 with a single trawler and continued in 1969 in Subareas 5, 6 and some other areas. In 1970, Japan joined the Convention and released the operation for 16 commercial trawlers in the Convention Area. Over 50% of the total catch was from Statistical Subarea 6. The catch of 10,938 tons in Subarea 5 was from Div. 5Zw and 5Ze and consisted mainly of squids, butterfish and herring. Squids were caught in 5Zw and Subarea 6. Herring was mainly from 5Ze.

Table 1. Summary of Japanese trawl fishery from 1967 to 1970.

Year	Total catch in tons	Remarks
1967	452	Subarea 6 only. Main spp.: butterfish, argentine.
1968	14,271	Exploratory trawler. Main spp.: butterfish, squids, redfish, argentine. SA 1: 137 tons, SA 2: 190 tons, SA 3: 1,672 tons, SA 4: 2,012 tons, SA 5: 724 tons, SA 6: 6,536 tons.
1969	19,669	Exploratory trawler. Main spp.: squids, butterfish, argentine. SA 1: 7 tons, SA 2: 1 ton, SA 3: 801 tons, SA 4: 1,936 tons, SA 5: 8,789 tons, SA 6: 8,133 tons.
1970*	36,627	Main spp.: squids, butterfish, argentine. SA 3: 3,629 tons, SA 4: 3,502 tons, SA 5: 10,938 tons, SA 6: 18,558 tons.

* preliminary figure.

Subarea 3

A. Status of the Fisheries

The Japanese trawl fishery in Subarea 3 is still in the exploratory stage and the main species caught are argentine and redfish. Fishing grounds for argentine were Div. 3M, 3Ps and 3L.

Table 2. Japanese catch in Subarea 3.

Year	1968	1969	1970*
Hours fished	1,043	410	
Total catch (tons)	1,672	801	3,629
Argentine	145	106	1,958
Redfish	774	533	1,460
Cod	574	83	49
Haddock	6	1	6
Flatfishes	38	21	20

* preliminary figure.

B. Special Research Studies

I. Biological Studies

Length measurements for redfish, cod and argentine were made on board trawlers. Size compositions of redfish are shown in Fig. 1, by divisions for spring and autumn respectively. Fig. 1 shows that Div. 3M in spring and Div. 3L in autumn have similar distribution with two peaks, 28-29 cm and about 35 cm in fork length. The fish included in the peak at the younger age were mostly immature. It is suggested that recruitment to the fishery in Div. 3M occurred in spring and in Div. 3L in autumn.

Subarea 4

A. Status of the Fisheries

Japanese trawlers in this Subarea caught mainly agrentine. Main fishing locality was the continental slope off Browns Bank (Div. 4X).

Table 3. Japanese catch in Subarea 4.

Year	1968	1969	1970*
Hours fished	1,075	896	
Total catch (tons)	2,012	1,936	3,502
Argentine	1,086	1,256	2,282
Redfish	524	251	452
Mackerel	19	1	2
Herring	9	14	55
Silver hake	76	213	111
Cod	21	39	305
Haddock	18	20	9
Flatfishes	28	21	15
Squids	94	-	2

* preliminary figure.

B. Special Research Studies

I. Biological Studies

Length measurements for argentine, redfish and other few species were made on board commercial trawlers.

Argentine. Size compositions by divisions and by months are shown in Fig. 2. Modal length in winter is generally greater than that in summer in both Div. 4W and 4X. Studies of diurnal movement and the relationship among depth, temperature and catch were also carried out. Analyzing catch data at approximately 42°N, 65°30'W in winter, shows that the species make strong diurnal movement, bottom in the daytime and mid-layer at night, since the mean value of catch-per-effort in daytime was 4.65 tons per hour against the value at night of 1.17 tons per hour. The relation among depth, bottom temperature and the catch of argentine per effort (per hour) in Browns Bank is shown in the following table.

Table 4. Catch-per-unit of effort (in tons) of argentine by depth zone and bottom temperature.

Depth (in m)	Bottom temperature (°C)														
	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0
150					3.50										
175			1.68	2.56	1.79	2.25	5.51		4.13				3.00		2.47
200	5.02		3.11	6.29	3.90	2.65	3.78	5.28			3.00				
225	2.90	6.16	4.45	5.02	4.32	3.35	5.09	4.20	11.19	4.64	4.37	3.87			
250							4.14								
275															

From the table it is assumed that argentine concentrations ranged from 5.0°C to 10.0°C bottom temperature and in the depth zone of 175 to 250 m, especially in 200 - 250 m.

Subarea 5

A. Status of the Fisheries

Japanese trawlers operated mainly on Georges Bank. About half of the total catch was squids, mainly the short finned squid, *Illex illecebrosus*, and common American squid, *Loligo pealeii*. Herring catch in 1970 more than doubled from the previous year. Butterfish catches increased almost 40%. Fishing activity for butterfish in 1970 was conducted mainly in Subarea 6.

Table 5. Japanese catch in Subarea 5.

Year	1968	1969	1970*
Hours fished	540	8,216	
Total catch (tons)	724	8,789	10,938
Argentine	-	976	883
Redfish	0	61	66
Butterfish	328	1,291	1,816
Mackerel	1	197	465
Herring	1	527	1,290
Silver hake	52	229	195
Cod	2	45	22
Haddock	3	9	7
Flatfishes	2	79	115
Squids	113	3,902	4,802

* preliminary figure.

B. Special Research Studies

I. Biological Studies

Herring. Length measurements were made for the fish caught in January and in June. Wintering fish at a depth of 77 m had a mean fork length of 21.3 cm with the range from 14 cm to 27 cm and fish of early summer at 250 m depth had a mean length of 31.0 cm, from 24 cm to 36 cm.

Butterfish. 682 individuals from 140-200 m depth on Georges Bank in February were measured. Mean fork length of 18.01 cm in Div. 5Ze was slightly larger than that of 17.64 cm in Div. 5Zw. The fish caught at 250 m in Div. 5Ze in November were composed of small fish whose mean length was 16.29 cm.

Squids. From Div. 5Ze in February, 700 individuals were measured. From January to February from Div. 5Zw, 498 individuals were measured. The compositions of mantle length from these samples are shown in Fig. 3. In February it seems that Div. 5Zw was more abundant in large squids compared with Div. 5Ze.

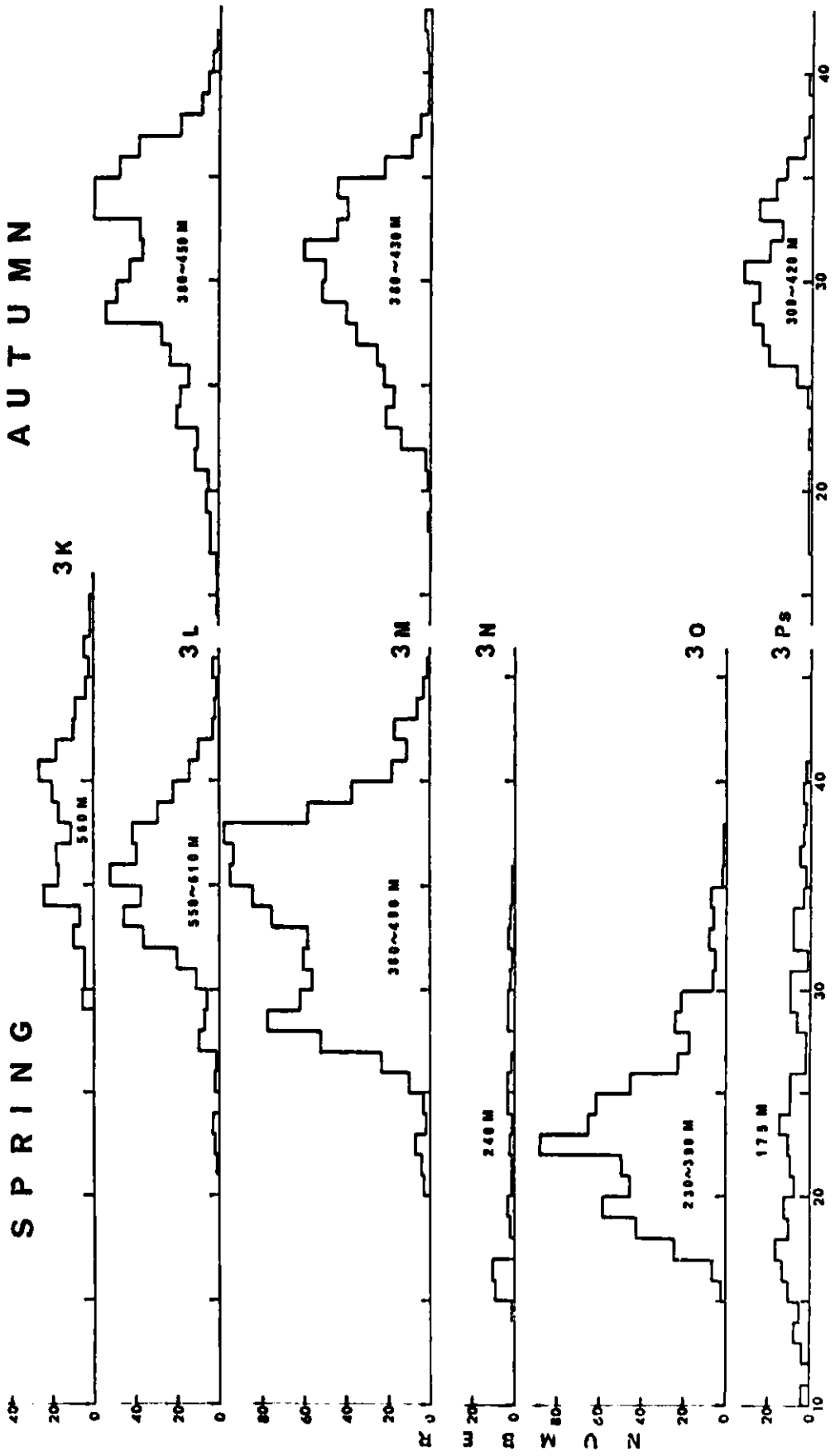


Fig. 1. Size composition of redfishes in Subarea 3.

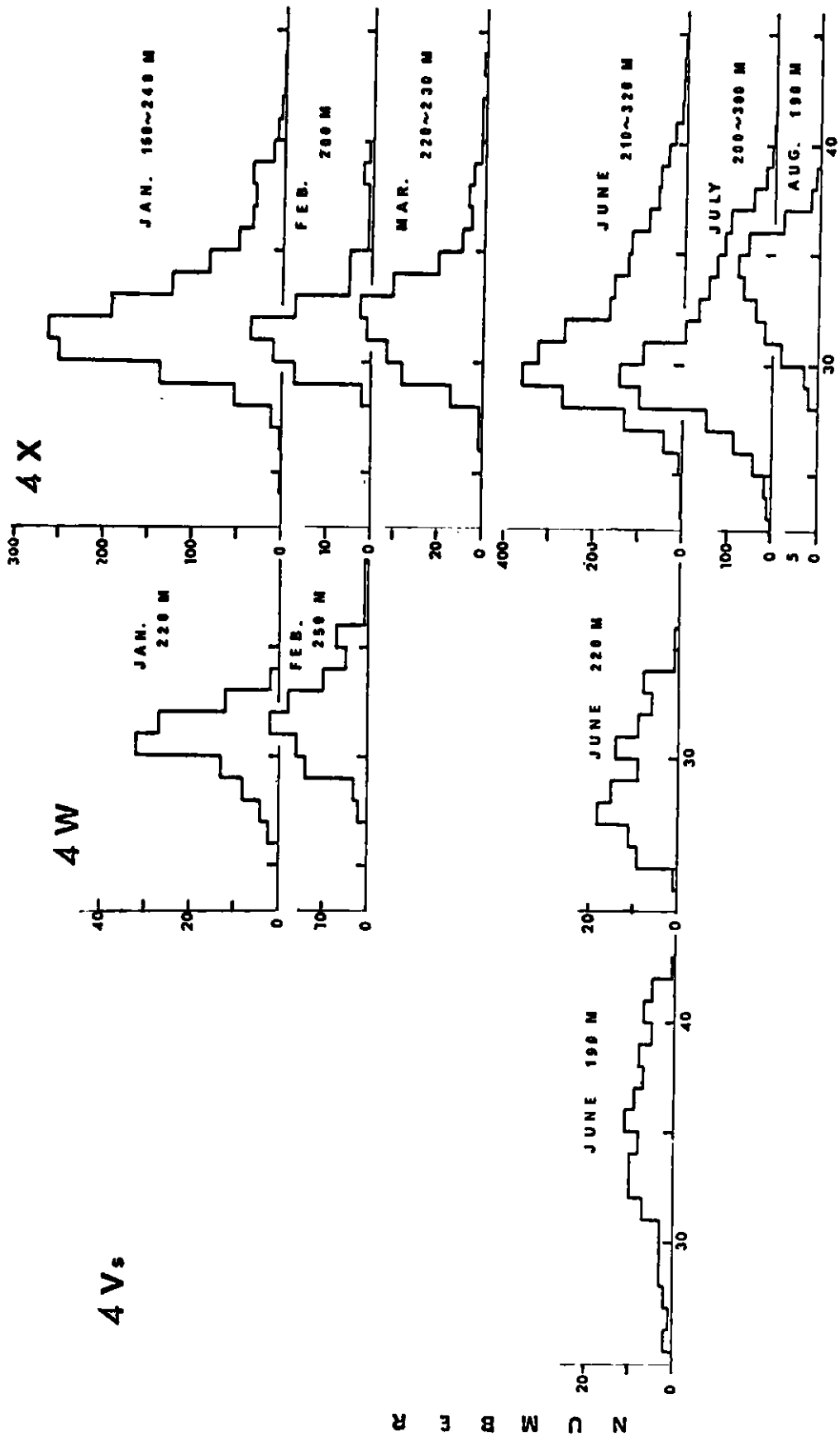


Fig. 2. Size composition of argentine by divisions and by months.

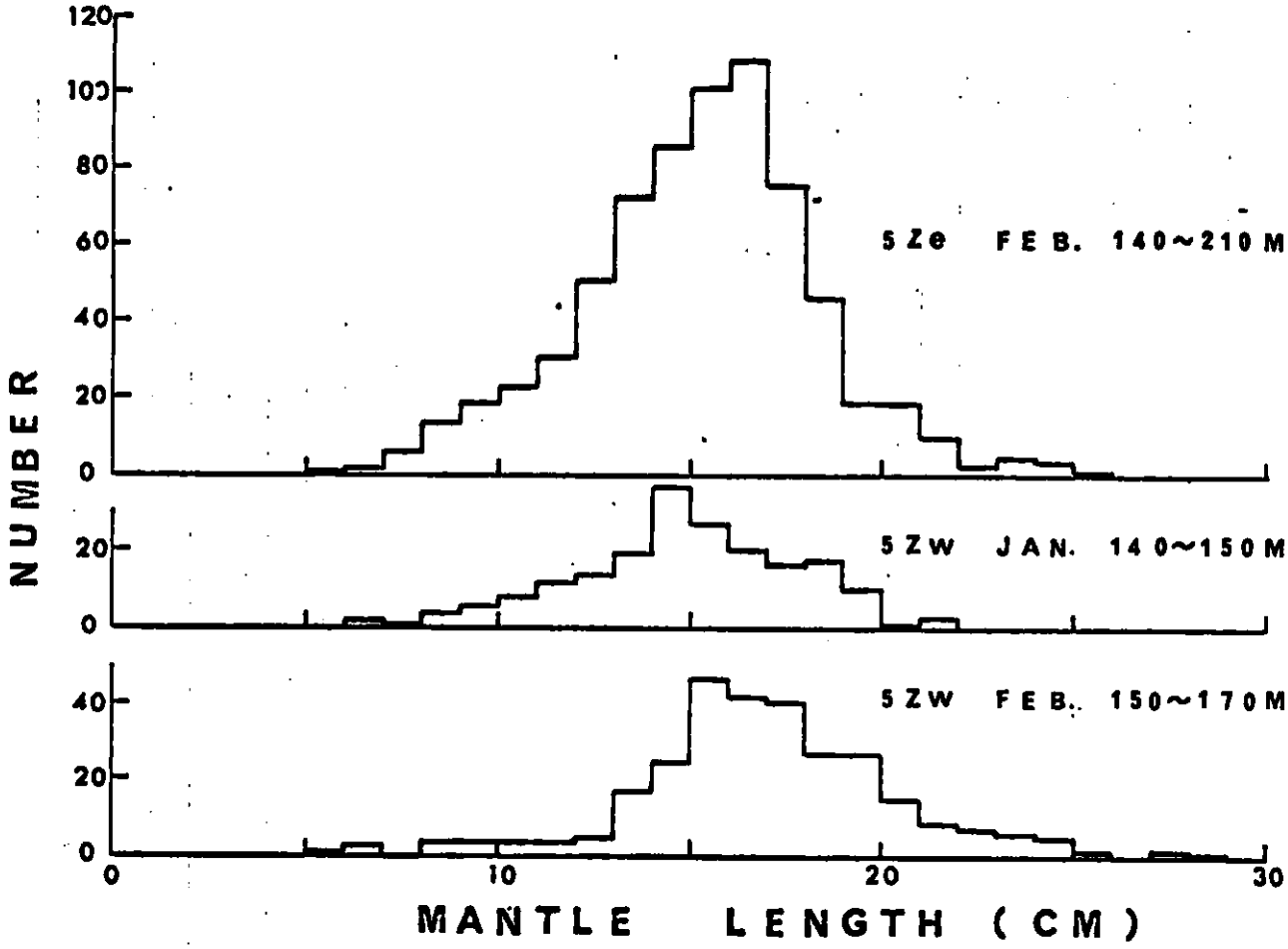


Fig. 3. Size composition of squids in Div. 5Z.

VI. Polish Research Report, 1970

by F. Chrzan

Total Polish catches in the ICNAF Area increased from 159,863 tons in 1969 to 170,973 tons in 1970. This was due, first, to an increase in the landings of mackerel and herring from Subarea 5. On the other hand, a considerable decrease in cod catches was noted in Subarea 2 and redfish catches in Subarea 3.

In Subareas 2 and 3, 26 factory trawlers of 2,850 gross tons each operated mainly for cod during winter and spring. These vessels made 41 trips to the ICNAF Area while in 1969, 23 trawlers made 63 trips. The smaller number of fishing trips in 1970 was because a rather large number of Polish factory trawlers operated beyond the ICNAF Area in the summer and autumn seasons.

In Subareas 4 and 5, 9 large freezer trawlers of 3,100 gross tons each and 8 smaller freezer trawlers of 1,900 gross tons each operated. Moreover, 10 side motor trawlers and 30 steam trawlers participated in fishing operations, mainly in Subarea 5. They made a total of 126 trips as compared with 111 trips made by freezer vessels and side trawlers in 1969.

Similarly, as in previous years, the side trawlers operated with the mother ships, thus reducing the loss of time for voyages between fishing grounds and their home ports. The comparative data for the years 1970 and 1969, with respect to major species and their percent relation in the catches, are given in Table 1.

Table 1.

Species	1970		1969	
	Tons	%	Tons	%
Redfish	5,846	3.4	14,083	8.8
Cod	49,587	29.0	76,680	48.0
Flatfish	4,502	2.7	2,196	1.4
Greenland halibut	8,270	4.8	5,440	3.4
Mackerel	41,036	24.0	13,448	8.3
Herring	56,050	32.8	37,223	23.3
Other species	5,682	3.3	10,793	6.8
Total	170,973	100.0	159,863	100.0

The above data show that Polish fisheries were interested mainly in the catches of herring, cod and mackerel. A considerable increase in landings of the latter species was noted.

Subarea 1

Actually the Polish commercial fishing fleet did not operate in Subarea 1. There was only one vessel for several days in June in search of cod concentrations, but none of the hauls made by it was a success. In spite of this sampling was performed.

I. Cod

In Div. 1C, 990 cod specimens were measured. Their length ranged from 30 to 89 cm, mean length was 51.1 cm. From otolith readings, it appeared that over 80% were fish of V and VI age-groups.

In Div. 1D, 1,900 cod were measured and their length ranged from 24 to 110 cm. Most of the cod specimens were in the length range 60-75 cm. According to otolith readings, over 85% of the cod were 5 to 9 years old.

In Div. 1E, 300 fish were measured which were caught at a depth of about 450 m. Their length ranged from 30 to 100 cm, mean length - 59.5 cm. About 80% of the cod were fish 5 to 8 years old. More detailed data will be found in the contribution by Zukowski and Ernst (Res.Doc. 71/103).

II. Redfish

In Div. 1E, 522 redfish (type *marinus*) were measured. The length of these fish ranged from 25-68 cm; mean length - 36.1 cm. For age determination 200 fish were sampled.

Subarea 2

A. Status of the Fisheries

A total of 15 factory trawlers operated in Subarea 2 from January until April and then in December. The best results were obtained by these vessels in the period from January until March, first in Div. 2H and later in Div. 2J. From May until November because of a low fishing yield, Polish vessels only visited the Labrador fishing grounds sporadically. The catch and fishing effort in Subarea 2 are given in Table 2.

Table 2.

ICNAF Div.	Catch in metric tons					Hours fishing	Days fished
	Redfish	Cod	Greenland halibut	Flat-fish	Other Species		
2G	-	-	32	-	-	48	4
2H	146	5,675	638	10	-	4,028	350
2J	1,375	30,673	919	1,211	12	10,519	1,090
Total	1,521	36,348	1,589	1,221	12	14,595	1,444

It was still possible to carry on fishing in January in Div. 2G, but in the second half of that month the ice floes drifting down caused fishing vessels to shift to the fishing grounds in Div. 2J. Here the fishing operations were carried out until the first days of April and then stopped owing to poor fishing yield. The following were the daily yields from the fishing grounds of Div. 2J in successive months:

January - 21.6 tons
February - 44.8 tons
March - 27.1 tons
April - 20.5 tons

Generally speaking, the daily yields in 1970 were considerably lower than in 1969, while in 1969 mean yield obtained in the months January-April amounted to 35.5 tons, in 1970 it was only 32.1 tons per day fished.

Because of the decrease in fishing yield on the fishing grounds off Labrador, a smaller number of vessels operated there in 1970 than in 1969. In total, the fishing effort (number of hours fished) decreased by 33% in comparison to that in 1969.

B. Special Research Studies

I. Cod

In Subarea 2, a total of 12,466 cod specimens were measured and 1,514 otoliths read for age. The observations on length and age composition of cod were carried out on the fishing grounds at various depths. The length of cod in the catches ranged from 21 to 89 cm. Most of the cod landed, however, were of the length 24-59 cm, the age of which was determined to be 3 to 7 years (1967-1963 year-classes).

II. Redfish

In Div. 2H, 2,171 redfish (type *mentella*) were measured and 400 otoliths read for age. The length of these fish ranged from 19 to 52 cm. Fish of the length range 28-45 cm - their mean length being 28.5 cm - occurred most often in the catches. The age ranged from 4 to 31 years with mean age 13.7 years.

In Div. 2J, 1,179 redfish (type *mentella*) were measured and 440 otoliths read for age. The length of these fish ranged from 19 to 48 cm; mean length was 32.4 cm. The fish were between 5 and 23 years of age and the mean age was 12.4 years.

III. American plaice

In autumn, only 197 fish were measured in Div. 2J. They were of the length 24-49 cm and their mean length was 36.2 cm. The age of these fish was determined to be 4 to 16 years. In total, 54% of American plaice cuaght were 7, 8 and 9 years of age.

IV. Greenland halibut

In Div. 2H, 1,270 fish were measured. The fish caught here were of the length 37-105 cm and their mean length was 68.7 cm. Most of the fish in the catches were 55-69 cm (60%).

Subarea 3

A. Status of the Fisheries

In this Subarea, 16 factory trawlers operated from February to October. The best fishing results were obtained from March to May. The catch and fishing effort are given in Table 3.

Table 3.

ICNAF Div	Catch in metric tons					Hours Fishing	Days Fished
	Redfish	Cod	Greenland Halibut	Flatfish	Other Species		
3K	3,702	12,340	6,665	3,095	25	18,930	1,272
3L	67	194	12	150	-	518	47
3M	15	53	-	17	1	42	3
3N	-	-	-	8	-	15	1
3Ps	154	-	1	-	1	171	14

The data in this table show that fishing operations were conducted mainly in Div. 3K. In consecutive months of fishing the daily yields for vessels operating in Div. 3K were as follows:

February	-	39.4 tons
March	-	25.6 tons
April	-	19.3 tons
May	-	19.1 tons
June	-	18.8 tons
July	-	19.8 tons
August	-	13.4 tons
September	-	11.4 tons
October	-	10.4 tons

It might be interesting to compare mean fishing yield for factory trawlers operating in Subarea 3. In the last three years mean yield per hour fishing was as follows: 1968 - 1.33 tons; 1969 - 1.58 tons and in 1970 - 1.35 tons. The decrease of fishing yield in 1970 seems to be apparent only since in 1969 very few vessels operated on the fishing grounds of this subarea in the period of lowest yields obtained.

B. Special Research Studies

I. Cod

Most observations on cod in Subarea 3 were carried out in Div. 3K. Here 14,458 cod were measured and 1,703 otoliths read for age. In general, the cod caught in Div. 3K were 24-89 cm in length and 2-14 years of age. The year-classes 1965, 1964 and 1963 made up 77% of the catches.

More details concerning cod will be found in the contribution prepared by Stanek: "Some changes in the stock of cod of Labrador and Newfoundland area in 1970" (Res.Doc. 71/104).

II. Redfish

In Div. 3K, 2,619 redfish (type *mentella*) were measured and 433 otoliths read for age. Length of these fish ranged from 19 to 52 cm. Most often in the catches fish of the length range 30-48 cm occurred. The fish were between 5-36 years of age; mean age was 17.8 years.

III. Greenland halibut

In Div. 3K, 852 fish were measured. These fish were 31-89 cm in length; mean length was about 55 cm. Most abundant were length-classes 45-65 cm.

Subarea 4

A. Status of the Fisheries

In Subarea 4, there operated: 1 factory trawler, 2 freezer trawlers 3,100 gross tons each and 1 side motor trawler. The factory trawler carried out fishing operations from August to October, while freezer trawlers fished herring from January to March. The side motor trawler fished mackerel and herring in July. Fishing effort and fishing results are given in Table 4.

Table 4.

ICNAF Div.	Catch in metric tons					No.hours fishing	No.days fished
	Redfish	Cod	Herring	Mackerel	Other spec.		
			Factory trawler				
4Vn	20	7	6	-	1	48	5
4Vs	337	4	-	-	3	382	28
			Freezer trawlers				
4Vs	-	-	1,093	-	440	392	42
4W	-	-	33	8	5	32	4
			Side motor trawler				
4W	-	-	39	41	-	58	9
Total	357	11	1,171	49	449	912	88

The above data show that the factory trawler fishing redfish obtained only 12.2 tons per day. Much better fishing results were obtained by freezer trawlers with the following catch per day: in January - 40 tons; in February - 43.6 tons and in March - 20.2 tons. Good fishing results were also obtained by the side trawler which in July obtained an average of 9 tons of herring and mackerel per day.

B. Special Research Studies

I. Herring

Sampling in Div. 4W on Emerald Bank was performed in July aboard *R/V Wieczno*. 1,152 herring were measured and age determined for 171 specimens of this species. Among herring caught with bottom trawl, the 1963 year-class predominated making up 52.6% of the catch. Mean length of these fish was 31.8 cm. The next in the catch was the 1962 year-class, which made up 16.4% of the landings. Mean length of these herring was 32.9 cm.

C. Hydrography

Hydrographic observations were carried out on the Scotian Shelf in July. An increase of surface temperature was noted starting from the coastal zone (7°C) up to the region of the Continental Shelf accompanied by an increase of salinity from 29.7 to 32.3°/$_{oo}$. Also the recorded temperature of the water was 1-4°C at 50-100 m and salinity 32-33°/$_{oo}$. These figures show that the water had its origin from the Labrador Current.

On the bottom, over elevated places of the banks, the temperature of the water reached 4°C while in the hollow places between the banks - up to 7°C. In the furrows the salinity amounted to 34.5°/$_{oo}$. Minimum oxygen content in the bottom layer was 3 ml/l.

In the Fundian Channel between Browns Bank and Georges Bank toward the end of July a stream of warm water of the temperature 9°C and salinity 34.5°/$_{oo}$ was noted moving westwards. In the western part of this Channel, the temperature of the water dropped to 5.5°C and salinity to 33.5°/$_{oo}$.

Also zooplankton was sampled on the Scotian Shelf. Zooplankton in particular samples amounted from 0.2 to 41.6 grams per 1m^2 of sea surface. In plankton samples Copepoda, Chaetognatha and Thaliacea were predominant.

Subarea 5

A. Status of the Fisheries

In Subarea 5, there operated 5 factory trawlers, 9 large freezer trawlers (of 3,100 gross tons each), 8 smaller freezer trawlers (of 1,900 gross tons each), 10 side motor trawlers (800 tons each) and 30 steam side trawlers (675 tons each). The side trawlers operated along with mother ships. The data on catch and fishing effort for these vessels are given in Table 5.

Table 5.

ICNAF Div.	Catch in metric tons				Hours Fishing	Days Fished
	Cod	Herring	Mackerel	Other Species		
			Factory trawlers			
5Y	-	43	-	-	33	2
5Ze	67	3,241	139	439	2,139	191
5Zw	2	66	587	5	201	22
			Freezer trawlers of 3,100 gross tons			
5Ze	122	12,303	8,433	397	6,512	840
5Zw	26	33	1,518	589	498	101
			Freezer trawlers of 1,900 gross tons			
5Ze	122	13,795	22,134	1,208	15,587	1,244
			Side motor trawlers			
5Ze	175	5,530	3,420	886	6,494	978
5Zw	33	19	469	107	336	70
			Side steam trawlers			
5Ze	94	19,359	3,798	1,210	31,205	3,458
5Zw	-	486	489	366	1,305	122
Total	641	54,875	40,987	5,207	64,310	7,028

Not all types of vessels operated throughout the year in Subarea 5. Steam trawlers and smaller freezer trawlers were fishing here during all months of the year, whereas, *e.g.* factory trawlers operated during the first half of the year on the cod fishing grounds. The months fished and the fishing yields for particular types of vessels are given in Table 6.

Table 6.

	Yield per hour (in kg)				
	Factory trawlers	Freezer trawlers 3,100 gr.t	Freezer trawlers 1,900 gr.t	Side motor trawlers	Side steam trawlers
January	-	-	2,871	-	562
February	-	-	3,603	-	759
March	-	-	3,567	-	936
April	-	-	3,252	-	987
May	-	-	1,664	-	923
June	-	2,611	1,357	1,768	614
July	353	2,562	1,646	3,307	728
August	699	2,216	1,104	1,161	549
September	2,534	4,177	2,260	1,646	1,250
October	1,864	3,466	1,811	1,131	508
November	969	3,729	2,287	1,353	853
December	-	645	4,577	1,150	845
Mean	1,774	3,341	2,392	2,383	794

The figures show that the highest yields were obtained by large freezer trawlers. The smaller freezer trawlers and side motor trawlers obtained almost the same average fishing yields.

B. Special Research Studies

I. Herring

On Georges Bank the sampling was conducted in the period from May to August. 18,894 herring were measured and 3,037 otoliths read for age. Among specimens examined, the 1966 year-class made up 46.0%, and the 1965 year-class - 22.8%. The index of total mortality (Z) for the period 1969-1970 was 0.98. This shows that within a year's period, the stock of fish was reduced by 62%.

More detailed data will be found in the contribution by B. Draganik: "Polish research studies on Georges Bank herring" (Res.Doc. 71/105).

II. Mackerel

Sampling was conducted aboard commercial fishing vessel in the period May-June and on board *R/V Wieczno* in August. A total of 11,805 fish were measured and 3,090 otoliths read for age. In the catches, fish of the length 19-46 cm occurred, though the most abundant were fish 29.0 to 31.0 cm in length. The basis of the catches was three year-classes: 1967 - 50.1%; 1966 - 21.4% and 1965 - 8.0%.

C. Hydrography

In August, observations on temperature and salinity were carried out. On Georges Shoal, the temperature of water was 16°C and its salinity 32°/$_{oo}$. In the region of Georges Bank at 75-100 m, the temperature was 6-7°C and the salinity 33-33.5°/$_{oo}$. At the greater depths, particularly on the southern side at 100-150 m, there was already found Atlantic water of the temperature 8-13°C and of salinity 35.0-35.5°/$_{oo}$. In the layers stretching below a gradual decrease of the temperature was noted downwards to the bottom. At the bottom the oxygen content was 4.5-5.0 ml/l.

In the Gulf of Maine the two water masses were found. From the south an influx of warm water of the temperature 20°C and salinity 31.5°/$_{oo}$ was noted, while from the northeast water flowed in of the temperature 13°C and salinity 32.2°/$_{oo}$. The lowest temperature of 5-6°C with salinity 32.5-33.5°/$_{oo}$ was found at 100-125 m. In the deeper layers only a slight rise of temperature up to 6°C was observed while salinity was 34.0°/$_{oo}$. Minimum oxygen content at the bottom was 4.5 ml/l.

In the plankton on Georges Bank the same animal forms occurred as on the Scotian Shelf, though plankton was more abundant here for in some particular samples it amounted from 1.0 to 300.0 g/m^2. In the biomass Thaliacea were predominant.

In the Gulf of Maine the plankton was less abundant - 3.0 to 27.1 g/m^2. Main component of the biomass was Copepoda.

Carrying on the studies on feeding of fish it was noted that herring did not feed very intensively. In the stomachs of these fish Euphausiacea and

Meganictiphanes norvegica were mainly found. On the northern part of Georges Bank, Copepoda and Chaetognatha were found.

In the stomachs of mackerel large amounts of various Euphausiacea, Chaetognatha and Thaliacea were found.

VII. Portuguese Research Report, 1970

by Manuel Lima Dias

In 1970, the Portuguese fishing fleet of side and stern trawlers (otter trawls) and dory vessels (line trawls) took cod from Subareas 1, 2, 3, and 4 in the amounts in tons shown in Table 1 and Fig. 1.

Table 1.

Subareas	Line Dory Vessel	Trawl Side	Trawl Stern	Total	Total Line & trawl
1	5,229	801	2,677	3,478	8,707
2	-	25,024	16,989	42,013	42,013
3	25,337	57,983	7,554	65,537	90,874
4	205	18,582	2,274	20,856	21,061
Total	30,771	102,390	29,494	131,884	162,655

Total landings of 162,655 metric tons of cod were, once more, lower than in the preceding year (182,349 tons). The decrease by trawl was 569 tons and by line 9,126 tons. Except in Subarea 1, landings by the side trawlers were greater than by the stern trawlers.

The trawlers operated in four Subareas but fished mainly in 3 and 2 over the four quarters of the year (Fig. 2). Dory vessels visited Subareas 1, 3 and 4 and made major catches in Subarea 3 (25,337 tons) as against only 5,434 tons from the other two Subareas. The trawlers fished best in Subareas 3 and 2, with 65,537 tons and 42,013 tons, respectively.

The best line fishery occurred in July and September (Subarea 3) and the best trawler fishing (side and stern) in April (Subarea 3). The highest trawler catch was in the 1st quarter, 46,022 tons (27,147 tons landed in Subarea 2).

The side trawlers fished intensively in Subarea 3 (57,983 tons) with 42,574 tons in Div. 3L.

The present report in addition to reviewing the status of fisheries, presents also data on lengths, ages, maturity and probable age at first maturity obtained from random sampling on board commercial trawlers before discarding the undersized fish.

Detailed information on the samples for length and age are included in the ICNAF *Sampling Yearbook*.

Subarea 1

A. Status of the Fisheries

The trawlers fished cod in Div. 1B, 1C, 1D and 1E during the 2nd, 3rd and 4th quarters of the year with best catches in the 2nd quarter (3,243 metric tons).

The highest catch was made in Div. 1C (1,290 tons) and the smallest in Div. 1F (190 tons). The dory vessels fished only in Div. 1B, 1C and 1D, mainly in Div. 1C (3,894 tons) during the 2nd and 3rd quarters of the year.

Subarea 2

A. Status of the Fisheries

Only the trawlers fished in this Subarea (42,013 tons) with best cod catches from the side trawlers. Of the Divisions visited (2G, 2H and 2J) Div. 2J had the highest catches, 38,583 tons, against only 3,009 tons and 421 tons from Div. 2H and 2G, respectively.

Catches by quarters were best in the 1st quarter with 27,147 tons (15,971 tons from the side trawlers and 11, 176 tons from the stern ones).

B. Special Research Studies

Samples of cod for biological studies were collected from the trawler fleet in Div. 2J between 13 and 20 February. Several samples were obtained for measurements of the fishes and others for otoliths too. A total of 1,174 fishes were measured and 424 otoliths were collected of which 300 were studied. Fishing depths varied from 210 to 300 m. Mean length was 53.4 cm and mean age 6.6 years. The ages ranged from 5 to 12 years (Fig. 3) and lengths ranged from the 40 to 79 3-cm classes (Fig. 3).

Growth is shown below:

Year-class	Age-group	Length (cm)	No. of fishes
1965	V	43.4	(34)
1964	VI	49.7	(111)
1963	VII	56.7	(117)
1962	VIII	63.4	(30)
1961	IX	67.9	(7)
1960	X	-	-
1959	XI	-	-
1958	XII	73.0	(1)

The majority of the fishes sampled in the Div. 2J (males and females) were in the resting or recovering and developing stages. Fish in the spawning stage were 22% males and only 1% females (Fig. 4).

The study of age at first maturity shows, as usual, a very high percentage of immature fish. Where it was possible to detect in some otoliths, age at first maturity was 6, 7 and 8 years, mainly in the females.

Subarea 3

A. Status of the Fisheries

Total cod landings were as follows: dory vessels - 25,337 tons; side trawl - 57,983 tons; stern trawl - 7,554 tons.

The dory fleet made better catches in Div. 3L with 21,782 tons almost the total landed in this Subarea. The trawlers fished mainly in this same Division with 65,537 tons landed, from which 57,983 tons were from side trawl. The best fishery by quarters occurred, for dory vessels and trawlers, in the 2nd and 3rd with 28,924 tons and 18,103 tons respectively.

The trawlers also operated yet in Div. 3K, 3M, 3N and 3P with somewhat poor landings; the dory vessels fished also in Div. 3M, 3N, 30 and 3P with small landings.

B. Special Research Studies

Samples of cod for biological study were collected from the trawler fleet in Div. 3L and 3M as follows:

Div.	Samples	Date	Depth	No. Lengths	No. Ages
3L	A	25-26 March	260	300	-
"	B	6-20 April	200-230	1,724	350
"	C	5-23 May	145-250	897	225
"	D	6-10 June	200-270	1,900	-
Total				4,521	1,050
3M	E	19-30 March	410	1,150	

a) Length composition

Lengths (Fig. 5) ranged from 28 to 115 3-cm classes; mean lengths were in sample A - 57.8; B - 56.7; C - 58.3; D - 53.5; E - 58.8.

b) Age composition

Ages ranged from 3 to 30 years. Only one fish was 30 years old. The main range was from 3 to 16 years.

In April and May, VI and VII age-groups were dominant, in June the V and VI age-groups, with the VII age-group also important.

Mean ages were in sample B - 6.5; C - 6.6; D - 6.1.

c) Growth

Average length (cm) of cod caught by trawl, sampled during the 2nd quarter:

		Division 3L Lengths (cm)			
Year-class	Age-group	April	May	June	No. of fish
1967	III	37.0	37.0	37.0	(1)
1966	IV	43.0	42.8	42.6	(28)
1965	V	47.1	47.3	46.9	(178)
1964	VI	54.3	54.4	53.3	(331)
1963	VII	60.5	60.4	59.5	(333)
1962	VIII	66.3	66.5	65.2	(111)
1961	IX	72.1	73.3	71.9	(33)
1960	X	75.9	77.5	77.1	(15)
1959	XI	77.7	78.2	81.5	(6)
1958	XII	74.8	80.6	69.5	(6)
1957	XIII	99.5	100.2	103.0	(3)
1956	XIV	97.0	97.0	-	(1)
1955	XV	-	-	-	-
1954	XVI	103.0	103.0	103.0	(1)

1940	XXX	-	115.0	115.0	(1)

d) Stage of maturity

Fig. 6 shows that most of the females observed during the 2nd quarter were in the resting or recovering stage; in April as well as in May and June, a small percentage were in the developing stage. The spawning stage was also observed, but only significantly in April and May. The males were in the resting or recovering stage; a low percentage were in the spawning stage; the post-spawning stage was observed in May (25%) and June (very small percentage).

e) Age at first maturity

Only a very low percentage of the males and females aged showed otolith rings of first maturity (mainly in the ages 7, 8 and 6 - Fig. 6). About 90% of the observations were from immature fish or from samples where it was not possible to decide, with a reasonable degree of certainty, the age at first maturity.

Subarea 4

A. Status of the Fisheries

Total cod landings from this Subarea amounted to 21,061 tons fished by trawlers and dory vessels as follows: line fishery - 205 tons; side trawlers - 18,582 tons; stern trawlers - 2,274 tons.

The dory vessels only fished in Div. 4R and 4S, landing 205 tons. Trawler landings were more important with 17,809 tons landed from Div. 4R and 2,326 tons from Div. 4Vn against only 721 tons from Div. 4S, 4T and 4Vs. Dory vessels landed only 11 tons in the 2nd quarter and 194 tons in the 3rd. The trawlers fished mainly during the 1st quarter (11,733 tons); other catches were not so

significant (9,051 tons in the 2nd quarter and only 72 tons in the 3rd).

B. Special Research Studies

Samples for biological studies were collected from the trawlers in Div. 4R in March and April as follows:

Div.	Samples	Date	Depth	No. Lengths	No. Ages
4R	A	5-15 March	210-300	739	250
4R	B	2-4 April	160-205	221	-
Total				960	250

a) Length composition

The lengths (Fig. 7) ranged from 37 cm to 73 cm classes, and the mean length was 56.3 cm.

b) Age composition

The age-groups ranged from IV to VIII with the 1963, 1964 and 1962 year-classes predominant in Div. 4R (VII, VI and VIII years-group - Fig. 7). Mean age was 7.1 years.

c) Growth

Fish sampled in March in Div. 4R:

Division 4R

Year class	Age-group	March - Length (cm)	No. of fish
1966	IV	39.8	(4)
1965	V	45.0	(33)
1964	VI	50.4	(83)
1963	VII	57.2	(88)
1962	VIII	60.4	(22)
1961	IX	65.5	(9)
1960	X	66.7	(4)
1959	XI	65.6	(3)
1958	XII	72.3	(2)
1957	XIII	67.3	(2)

d) Stage at maturity

Fig. 8 shows that females studied were in the resting or recovering and developing stages (60% and 40% respectively). The males were over 40% in the stages resting or recovering and developing and about 20% in the spawning stage.

e) Age at first maturity

The males and females observed were almost in the immature stage, and the study of the rings of maturity in the otoliths could not be made. Nevertheless, it was possible to observe some otoliths showing ages at first maturity of 6, 7 and 8 years.

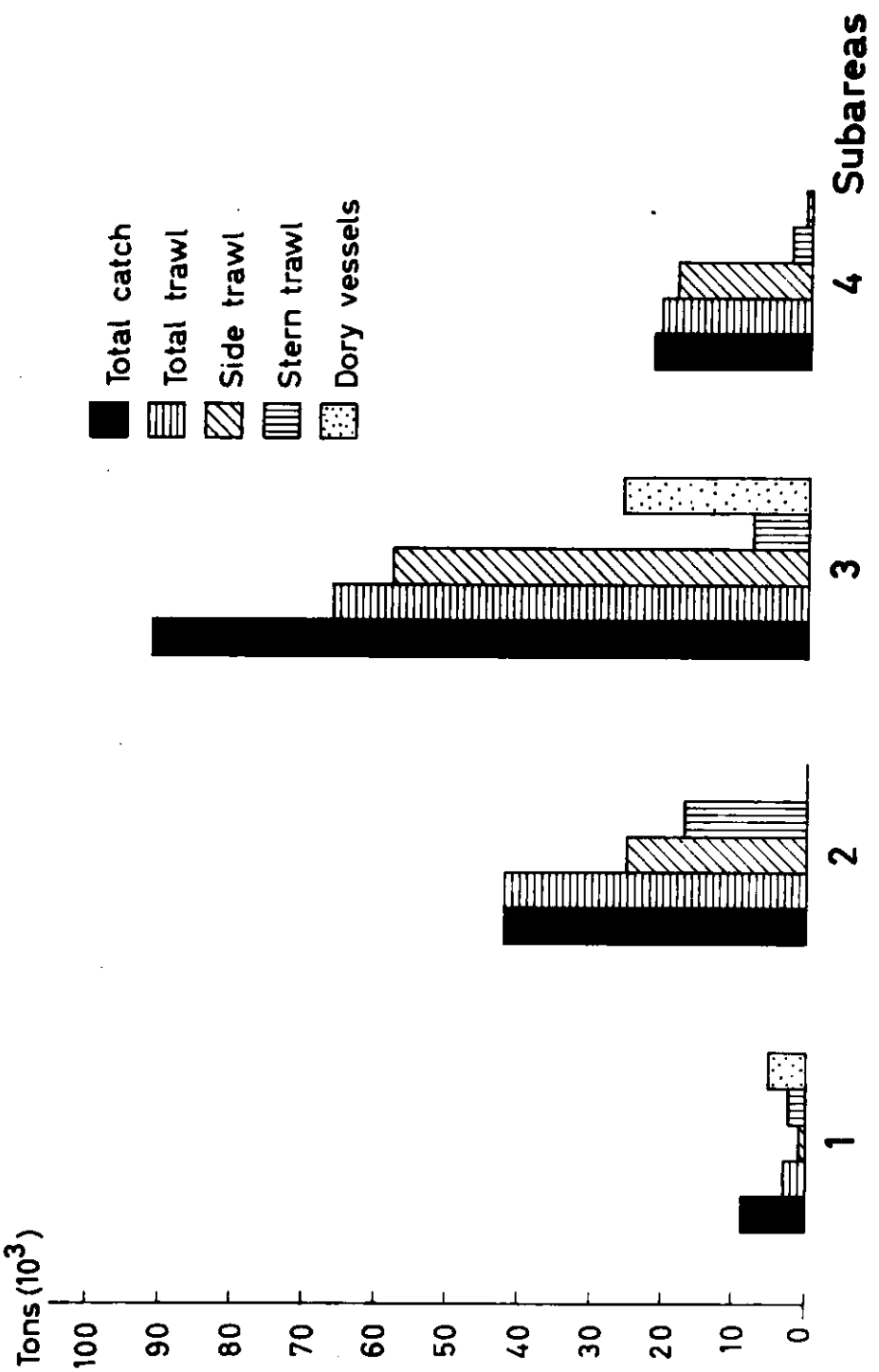


Fig. 1 - Cod catches (in tons) of Portuguese fishery fleet by subareas, 1970

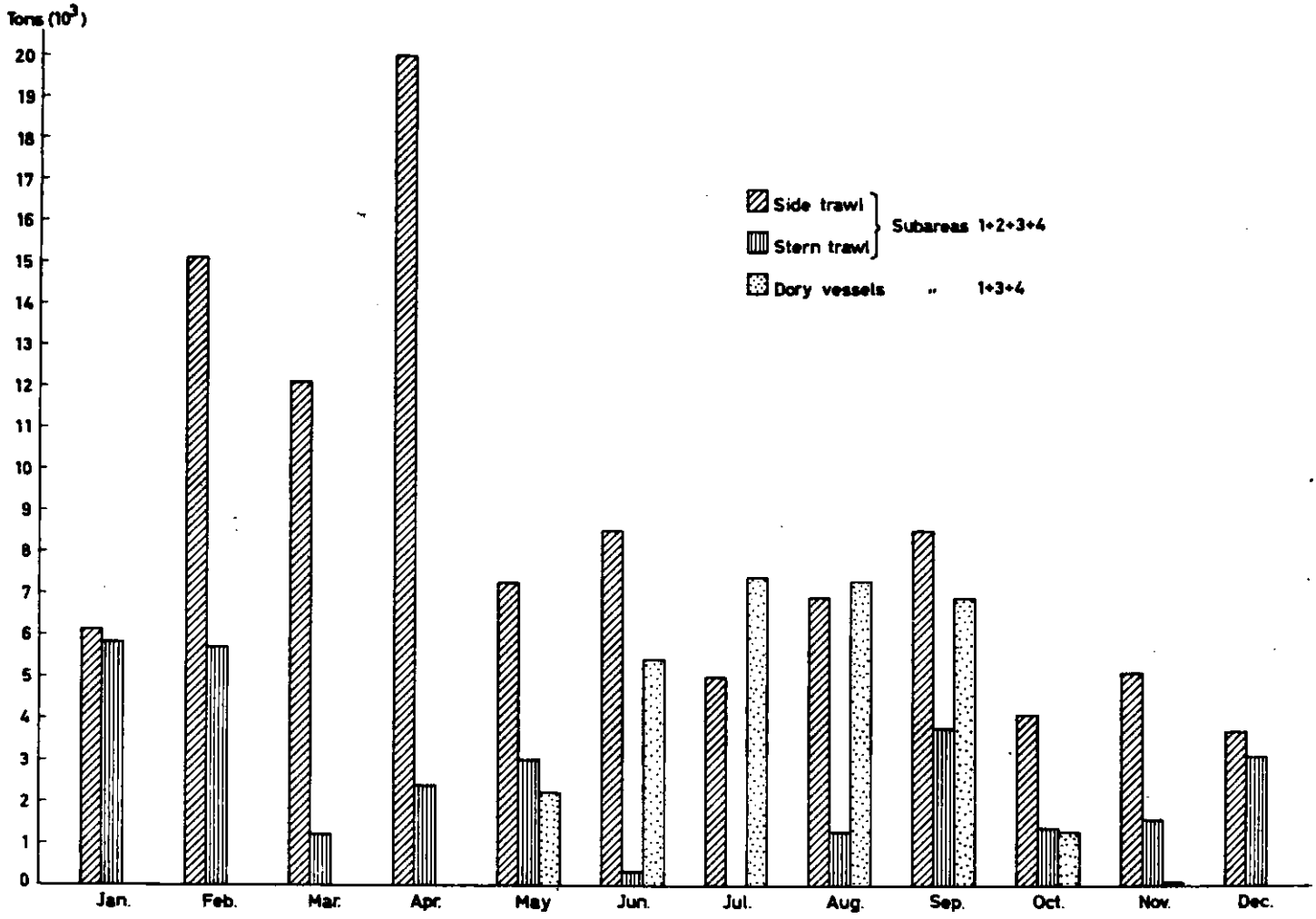


Fig. 2 - Total catches of cod (in metric tons) of Portuguese fishery fleet (trawlers and dory vessels) by months, 1970

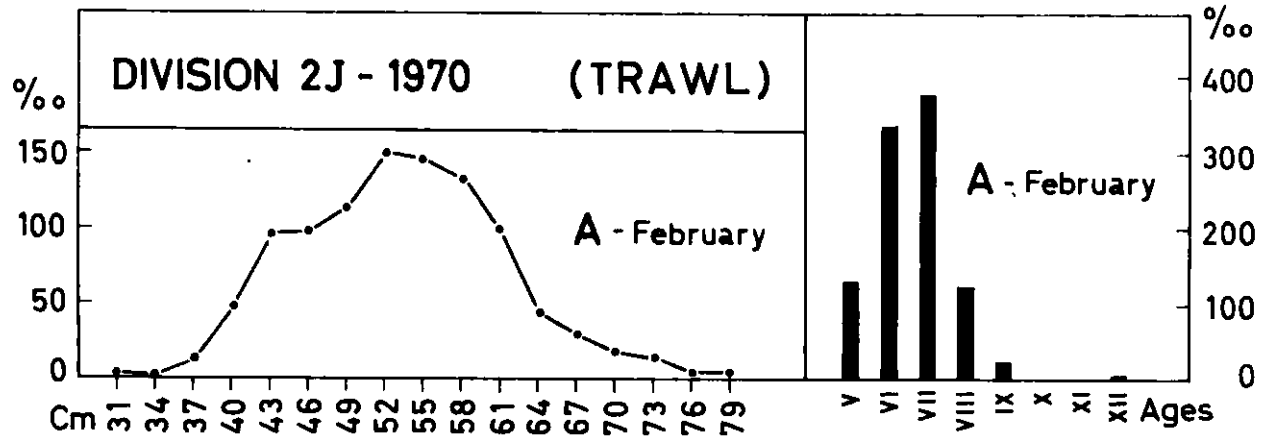


Fig. 3

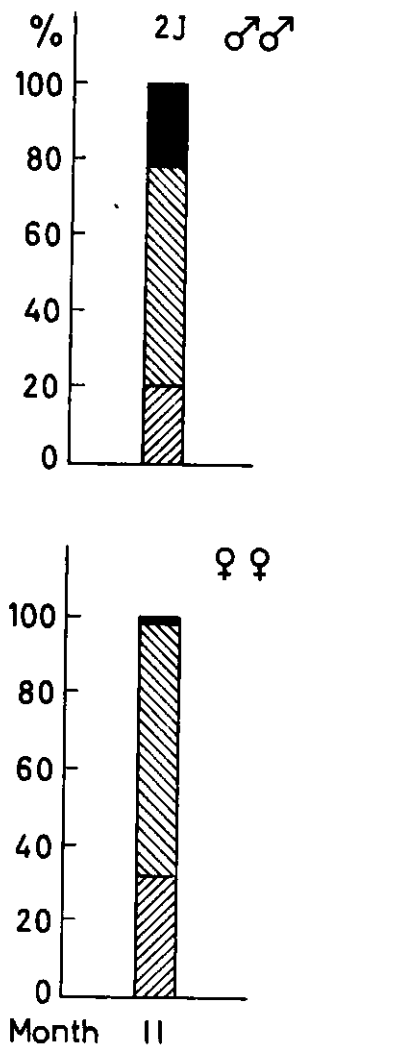

%
2J
♂♂
100
80
60
40
20
0
♀♀
100
80
60
40
20
0
Month
11
Post-spawning
Spawning
Developing
Resting or recovering

Fig. 4

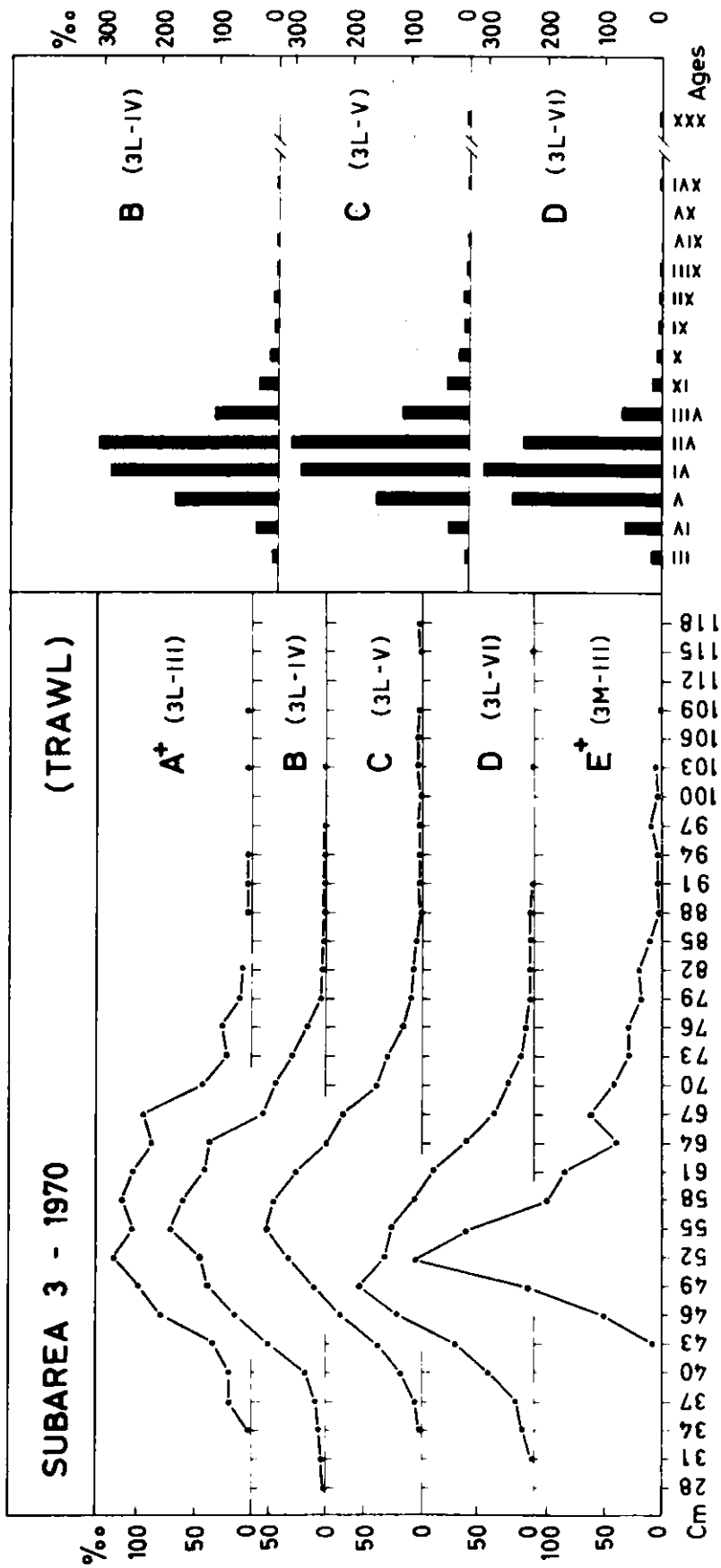

SUBAREA 3 - 1970
(TRAWL)
A+ (3L-III)
B (3L-IV)
C (3L-V)
D (3L-VI)
E+ (3M-III)
‰
Cm
B (3L-IV)
C (3L-V)
D (3L-VI)
Ages

Fig. 5

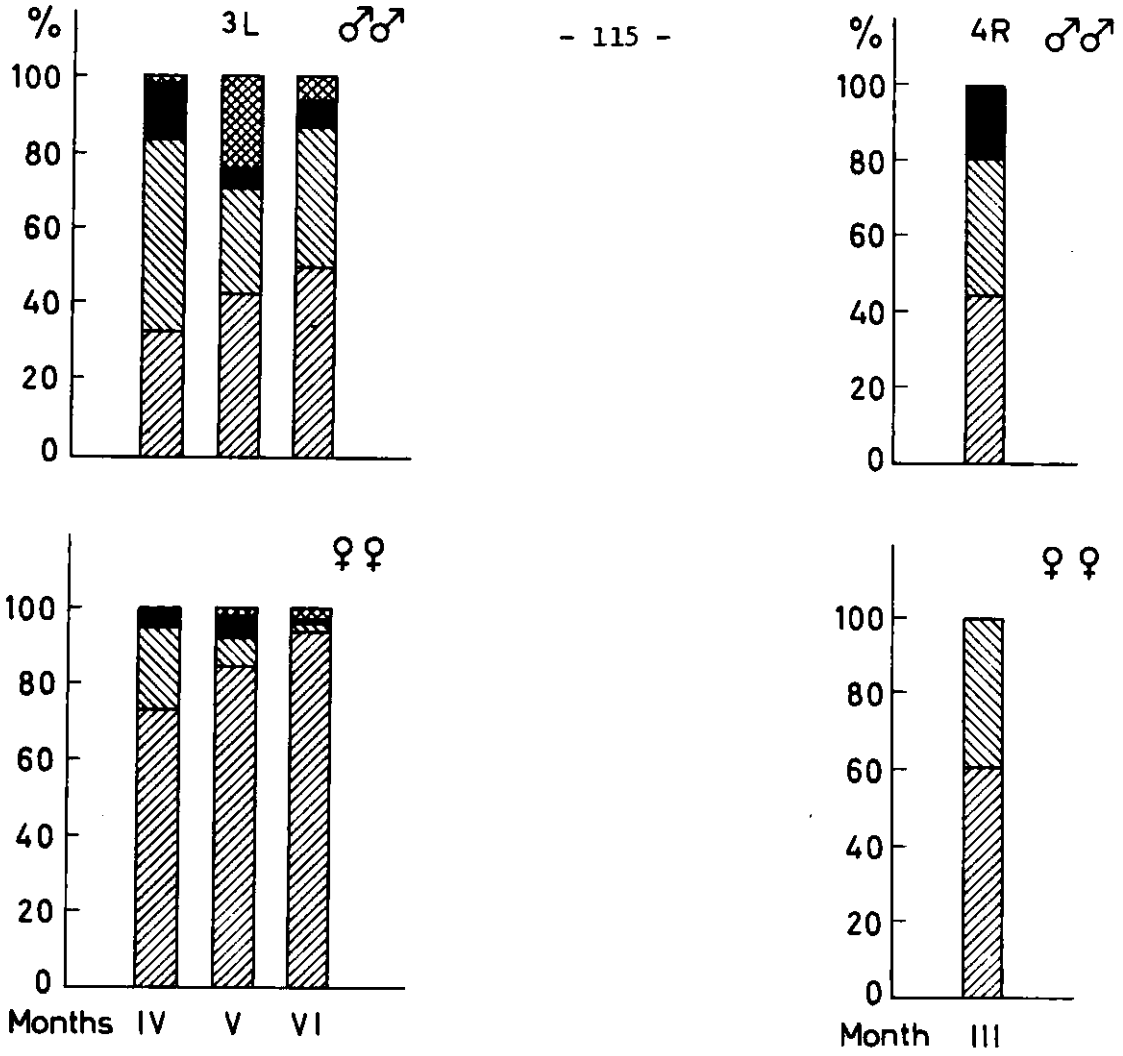


Fig. 6

Fig. 8

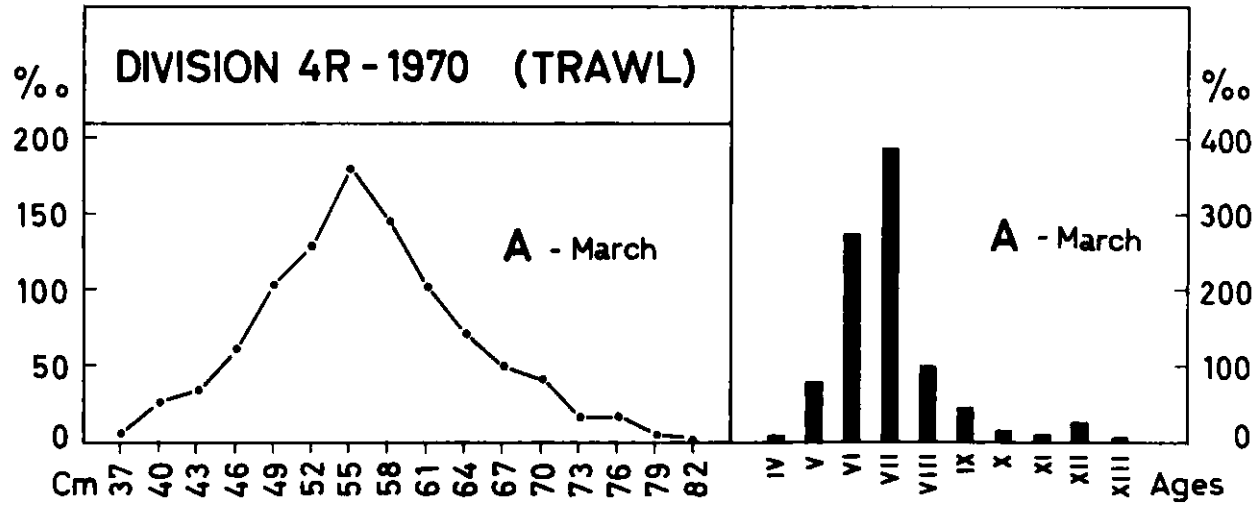


Fig. 7

VIII. Spanish Research Report, 1970

by J. Rucabado and M. G. Larrañeta

Fourteen trawlers and 138 pair trawlers (these vessels represent 69 gears) operated in the ICNAF Area during 1970. Total catch was 276,006 tons (97% cod, 2.4% haddock and 0.6% other species (white hake and pollock)). Total tonnage of the fleet was 83,605 tons and 4,053 fishermen made the crew.

Table 1. Total nominal catch by Spanish trawlers, 1969 and 1970, by subareas.

	1969			1970		
Subarea	Otter Trawlers	Pair Trawlers	Total	Otter Trawlers	Pair Trawlers	Total
1	1,856	21,925	23,781	1,303	17,502	18,805
2	33,148	4	33,152	10,469	214	10,683
3	31,367	142,038	173,405	18,493	150,030	168,523
4	3,636	44,472	48,108	18,524	51,311	69,835
5	-	15,526	15,526	-	8,162	8,162
Total	70,007	223,965	293,972	48,789	227,218	276,007

Samples of cod were taken from the *M/T Bochorno* in Subareas 2, 3 and 4, only during July-December period. Length, sex and age (by othlith reading) was recorded. No studies were carried out in Subareas 1 and 5, and no other species than cod.

Subarea 1

A. Status of the Fisheries

Main fishing was carried out by pair trawlers in Div. 1D, 1B and 1A (1D - 10,943 tons of cod). Single trawler catches (otter and stern trawlers) were negligible - 8%. Total catch decreased from 1969 in 5,776 tons.

Subarea 2

Total catch has decreased from 33,152 in 1969 to 10,862 tons in 1970. Table 2 gives the rate of decrease in the 1960's. Catches of pair trawlers increased from 4.5 to 213.6 tons. Catches were mainly in Div. 2J.

Table 2. Cod catches (metric tons) in Subarea 2.

	Trawlers	Pair Trawlers	Total
1964	45,285	-	45,285
1965	59,481	-	59,481
1966	48,071	550	48,621
1967	36,815	142	36,957
1968	32,575	278	32,853
1969	33,148	4	33,152
1970	10,469	214	10,683

B. Special Research Studies

Cod

Samples in July-August and October (6,053 cod measured and 308 age and sex determinations) show that in the last quarter great numbers of 3-year-old cod entered the fishery. The most important age-group in the catch is the 5-year-old cod (1965 year-class), as in recent past years.

The average length was 47.8 cm (53.3 in 1969) and the average age 5.27 years (ranges from 2 to 12)(5.7 in 1969).

Tables 3 and 4 give the length frequencies and age compositions.

Table 3. Length frequencies (in °/₀₀)

	Subarea 2 Quarters	
cm	III	IV
24-26	3	-
27-29	12	-
30-32	32	50
33-35	64	50
36-38	93	57
39-41	122	91
42-44	126	91
45-47	110	78
48-50	97	104
51-53	101	85
54-56	86	91
57-59	57	79
60-62	38	80
63-65	21	55
66-68	17	47
69-71	12	24
72-74	6	7
75-77	1	6
78-80	1	2
....		
90-92	-	1
Total	999	998

Table 4. Age composition (in °/₀₀)

		Subarea 2 Quarters	
Year-class	Age	III	IV
1967	3	39	247
1966	4	143	196
1965	5	359	266
1964	6	240	241
1963	7	146	28
1962	8	48	7
1961	9	18	9
1960	10	5	-
1959	11	-	-
1958	12	1	1
Total		999	996

Sex ratios (calculated directly from age samples) are grouped each two months and for immature or mature cod (more or less than 53.5 cm). A very high significant deviation from the 50% ratio is observed in cod from July-August greater than 53.5 cm. These data suggest sex segregation in summer and autumn, greater in mature cod (greater than 53.5 cm).

Table 5. Sex ratios, Subarea 2.

Cod	Sex	July-August		September-October	
		No.	%	No.	%
	Male	90	34	43	38
< 53.5 cm	Female	175	66	71	62
	Total	265	100	114	100
	Male	26	18	26	29
> 53.5 cm	Female	120	82	64	71
	Total	146	100	90	100

Subarea 3

A. Status of the Fisheries

For pair trawlers this subarea had the major fishing activity with an increase of catches (7,992 tons more). Catches of trawls (with a decrease of 50% from 1969) suggest that activity of the pair trawlers were higher than in the past. Div. 3L and 30 provided 58% of the whole catch from this subarea. Div. 3L, 30, 3Ps, provided 3,108 tons of haddock, 582 of pollock and 303 of white hake.

B. Special Research Studies

Cod

Samples from Div. 3L and 3K were made. 5,045 cod measured and 261 ages and sex determinations. Mean length 49.4 cm (56.0 in 1969) and mean age of 4.81 (5.9 in 1969). Predominant year-classes were 1965 and 1966. Modal class 1966. A high deviation of 50% ratio in segregation of sexes can be observed in cod greater than 53.5 cm in July-August. Samples from October-November do not reveal any significant sex-ratio deviations (Table 8.).

Tables 6 and 7 show length and age composition in this subarea.

Table 6. Length composition (in °/₀₀)

Subarea 3

Quarters

cm	III	IV
21-23	4	-
24-26	11	-
27-29	24	-
30-32	48	-
33-35	57	24
36-38	81	32
39-41	96	42
42-44	96	76
45-47	89	94
48-50	93	113
51-53	81	113
54-56	88	161
57-59	79	126
60-62	49	108
63-65	34	58
66-68	24	30
69-71	23	10
72-74	10	8
75-77	7	-
78-80	5	2
81-83	-	-
84-86	-	2
87-89	-	-
90-92	-	-
93-95	-	-
96-98	-	1
Total	999	1000

Table 7. Age composition (in °/₀₀)

Subarea 3

Quarters

Year-class	Age	III	IV
1968	2	40	24
1967	3	65	160
1966	4	349	210
1965	5	206	366
1964	6	138	158
1963	7	120	22
1962	8	23	15
1961	9	10	-
1960	10	6	-
1959	11	2	-
1958	12	1	-
Total		960	955

Table 8. Sex ratios, Subarea 3.

Cod	Sex	July-August		September-October	
		No	%	No	%
< 53.5 cm	Male	85	42	11	35
	Female	118	58	20	65
	Total	203	100	31	100
> 53.5 cm	Male	39	28	20	47
	Female	96	72	23	53
	Total	135	100	43	100

Subarea 4

A. Status of the Fisheries

Total catch increased to 21,727 tons, mainly due to trawlers (3,636 tons in 1969, 18,524 tons in 1970). Trawlers extended their fishing areas to Div. 4S, 4T, 4W, and greater captures were at 4R, 4Vn, 4Vs. Pair trawler catches increase at Dr. 4Vn, 4Vs and 4W.

B. Special Research Studies

Samples from Div. 4R only suggest a mode at 5-year-old cod (year-class 1965), with dominant classes 1963 to 1966. Recruitment in this subarea for 1963 and 1964 years was high, and this year-classes were dominant in 1970 catches (Tables 9 and 10.).

Table 9. Length composition (in ‰)

	Subarea 4 Quarters	
cm	III	IV
30-32	18	1
33-35	29	5
36-38	65	13
39-41	99	33
42-44	96	61
45-47	135	85
48-50	130	118
51-53	106	128
54-56	90	122
57-59	82	120
60-62	64	99
63-65	30	93
66-68	16	51
69-71	17	25
72-74	18	24
75-77	5	17
78-80	-	3
81-83	-	1
Total	1000	999

Table 10. Age composition (in ‰)

		Subarea 4 Quarters	
Year-class	Age	III	IV
1967	3	-	5
1966	4	271	134
1965	5	306	372
1964	6	245	291
1963	7	33	113
1962	8	47	38
1961	9	22	21
1960	10	5	10
1959	11	-	-
1958	12	-	-
1957	13	-	-
1956	14	-	4
Total		929	998

4,126 cod were measured and 208 ages and sex determinations carried out. Mean length decreases from 56.0 for 1969 to 47.7 in 1970, and also mean age: from 5.9 years to 4.9 in 1970.

Sex ratios during summer and autumn do not reveal any significant deviation from 50% rates (Table 11.).

Table 11. Sex ratios, Subarea 4.

Cod	Sex	July-August No	July-August %	September-October No	September-October %
< 53.5 cm	Male	29	64	47	59
	Female	16	36	33	41
	Total	45	100	80	100
> 53.5 cm	Male	17	44	52	46
	Female	22	56	62	54
	Total	39	100	114	100

Other species were haddock - 2,604 tons, pollock - 526 tons and white hake - 76 tons, mainly caught at Div. 4W and 4Vs.

Subarea 5

A. Status of the Fisheries

A decrease of total catch is observed, mainly in Div. 5Ze. Only pair trawlers had exploited this area, with poor results.

General pattern, according to Spanish sampling data, reveals in the status of the fisheries a decrease of catches (except in Subarea 4) and a diminution of more or less 1 year in the predominant year-class cod caught.

Haddock

Total catch in 1970 by subareas (metric tons):

Subarea 1	6
Subarea 3	3,109
Subarea 4	2,604
Subarea 5	845

IX. USSR Research Report, 1970

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

The total USSR catch in the ICNAF Convention Area in 1970 was 709,198 tons (Tables 1 and 1a), *i.e.* 166,067 tons lower than in 1969.

Subarea 1

A. Status of the Fisheries

In 1970 the total fish catch in this Subarea was 7,800 tons.

B. Special Research Studies

I. Environmental Studies

In August-October standard hydrographic Sections 8-A, 10-A and 11-A were worked by *R/V Perseus III* and *Procyon*. As seen from Table 2 the water temperature in the warm component of the West Greenland Current and especially in the 0-50 m layer was considerably lower than in earlier years for which comparable data are available. Only in 1959 were lower temperatures recorded along Section 10-A in August but the measurements were made half a month earlier than in 1970.

II. Biological Studies

Cod. On Banana Bank in February cod fed on animals actively swimming in mid-water and often stayed high above the bottom. In such periods mid-water trawls brought higher catches than bottom trawls. Unlike these fish the cod on Fyllas Bank in February fed mainly on benthos and formed stable concentrations close to the bottom.

Table 1. Species composition of the USSR catches in the ICNAF Area, 1969 and 1970 (tons).

Species	1970					1970 Total	1969 Total
	I	II	III	IV	V		
Herring	-	-	-	72,013	39,173	111,186	166,072
Argentine	-	-	-	1,615	999	2,614	5,707
Cod	849	49,829	59,997	2,531	364	113,570	190,883
Haddock	-	-	157	672	103	932	300
Pollock	-	-	23	476	51	550	227
Silver hake	-	-	-	168,916	28,997	197,913	113,149
Red hake	-	-	-	1,165	6,515	7,680	46,409
Grenadier	5,980	468	22,396	-	-	28,844	12,401
Flatfish	132	6,268	31,921	5,705	4,445	48,471	82,690
Greenland halibut	444	2,497	5,195	-	-	8,136	10,323
Redfish	231	4,296	58,278	13,218	-	76,023	77,531
Wolffish	-	536	260	2	-	798	311
Ocean pout	-	-	-	20	895	915	20,085
Scup	-	-	-	-	93	93	214
Alewife	-	-	-	10	13,135	13,145	25,147
Mackerel	-	-	5	3,987	56,457	60,449	51,622
Butterfish	-	-	-	3	396	399	9,494
Sea robin	-	-	-	-	-	-	1,758
Angler fish	-	-	839	2,123	477	3,439	7,109
Dogfish, scate	-	-	946	3,862	6,880	11,688	19,825
Gobies	-	-	103	-	2,230	2,333	-
Atlantic saury	-	-	-	-	1,054	1,054	-
Menhaden	-	-	-	6	-	6	-
Other fish	175	1,529	5,591	6,486	2,872	16,653	2,762
Squid	-	-	4	830	655	1,489	1,247
Other mollusks	-	-	-	408	410	818	-
Total	7,811	65,423	185,715	284,048	166,201	709,198	875,265

Table 1a. Species composition of the USSR catches in Northwest Atlantic, 1969 and 1970 (tons).

Species	Total ICNAF Area		Baffin Island		Area 6		Total N. W. Atlantic	
	1969	1970	1969	1970	1969	1970	1969	1970
Herring	166,072	11,186	-	-	38,210	22,406	204,282	133,592
Argentine	5,707	2,614	-	-	5	-	5,712	2,614
Cod	190,882	113,570	-	29	-	-	190,882	113,599
Haddock	300	932	-	-	-	-	300	932
Pollock	227	550	-	-	-	-	227	550
Silver hake	113,149	197,913	-	-	7,138	3,044	120,287	200,957
Red hake	46,409	7,680	-	-	4,099	834	50,508	8,514
Grenadier	12,401	28,844	2,642	545	-	-	15,043	29,389
Flatfish	82,690	48,471	-	-	898	132	83,588	48,603
Greenland halibut	10,323	8,136	813	215	-	-	11,136	8,351
Redfish	77,531	76,023	-	-	90	-	77,621	76,023
Wolffish	311	798	-	-	-	-	311	798
Ocean pout	20,085	915	-	-	431	-	20,516	915
Scup	214	93	-	-	260	72	474	165
Alewife	25,147	13,145	-	-	10,380	5,954	35,527	19,099
Mackerel	51,622	60,449	-	-	37,563	68,026	89,185	128,475
Butterfish	9,494	399	-	-	1,613	8	11,107	407
Sea robin	1,758	-	-	-	145	258	1,903	258
Angler fish	7,109	3,439	-	-	180	-	7,289	3,439
Dogfish, scate	19,825	11,688	-	-	2,453	588	22,278	12,276
Gobies	7,465	2,333	-	-	468	320	7,933	2,653
Atlantic saury	-	1,054	-	-	-	-	-	1,054
Menhaden	-	6	-	-	-	-	-	6
Other fish	24,256	16,653	81	10	3,276	666	27,613	17,329
Squid	1,247	1,489	-	-	158	-	1,405	1,489
Other mollusks	1,041	818	-	-	-	-	1,041	818
Total	875,265	709,198	3,536	799	107,367	102,308	986,168	812,305

Table 2. Average water temperature (°C) in the warm component of the West Greenland Current.

Date	Section	Depth (m)			
		0-50	0-200	50-200	200-500
August 3, 1959	10-A	2.40	1.52	1.11	3.40
August 19, 1963	10-A	3.82	2.62	2.20	3.32
August 8-9, 1964	10-A	3.31	2.01	1.48	3.51
August 10-12, 1967	10-A	3.08	1.36	0.56	4.14
August 14-16, 1970	10-A	2.57	1.62	1.30	4.03
August 3, 1964	11-A	4.09	4.24	4.25	4.90
August 16-18, 1969	11-A	2.20	2.00	1.90	4.36
August 4-5, 1970	11-A	1.95	1.48	1.29	4.06
Sept. 13, 1961	8-A	7.52	6.85	6.66	5.52
Sept. 23-24, 1963	8-A	4.26	5.63	6.14	5.59
Sept. 1-2, 1970	8-A	3.86	4.24	4.37	4.73
Oct. 19-21, 1962	8-A	6.32	6.12	6.06	5.04
Oct. 30-31, 1963	8-A	4.96	5.45	5.62	5.26
Oct. 27-29, 1964	8-A	6.61	6.53	6.52	5.39
Oct. 16-19, 1965	8-A	6.59	6.27	6.17	5.60
Oct. 25-26, 1970	8-A	2.82	4.07	4.49	5.13

In April the cod on the western slopes of Frederikshaab and Danas Banks stayed at the depth of 350 to 400 m but sometimes formed concentrations in mid-layers.

Very dense cod concentrations were located on Nanortalik Bank in August. These might have been cod of the East Greenland stock which moved west of Cape Farewell to feed. In their growth rate the cod caught on Nanortalik Bank were considerably inferior to those of other West Greenland banks. In August the mean length of six-year-olds was 55.6 cm on Nanortalik Bank and 60.5 cm on Danas Bank; the mean length of seven-year-olds was 61.5 cm on Nanortalik Bank and 69.7 cm on Danas Bank.

The size and age composition of cod in trawl catches is shown in Fig. 1. It is evident that the cod of two year-classes were numerically predominant: those of 1965 (particularly in the north) and those of the 1963 year-class (mainly in the south). The cod older than 7 years formed only an insignificant part of the catches.

Subarea 2

A. Status of the Fisheries

The annual catch is given in Table 3.

Table 3. Annual catch in Subarea 2 (metric tons).

Division	Total catch by all types vessels					Total
	Cod	Redfish	Flatfish	Greenland halibut	Other	
2G	9	-	-	4	-	13
2H	924	98	93	80	40	1,235
2J	48,896	4,198	6,175	2,413	2,493	64,175
Subarea 2	49,829	4,296	6,268	2,497	2,533	65,423

B. Special Research Studies

I. Environmental Studies

In late October hydrographic Section 8-A was made by *R/V Procyon*. Along the AB portion of the section over the Labrador shelf (between 53°40'N, 55°44'W and 54°50'N, 53°32'W) the water temperature was slightly lower than the average long-term normal (Table 4.). In the winter of 1971/72, the negative anomalies along the AB portion of Section 8-A are expected to increase still further.

II. Biological Studies

1. Cod

a) Length composition. As seen from Table 5 the main part of the trawl catches was made up by the cod ranging from 48 to 62 cm; age analysis showed that they belonged to the 1961, 1962 and 1963 year-classes. All these year-classes (particularly the latter) were slightly above the average level as shown by the young Labrador cod surveys in the preceding years (Table 8.).

Table 4. Average water temperature (°C) along the AB portion of Section 8-A across Hamilton Inlet Bank (1 November).

Depth (m)	1962	1964	1965	1966	1967	1968	1969	1970
0-50	1.58	0.98	1.30	2.41	2.00	2.29	0.82	1.34
50-200	1.34	-0.18	1.06	1.44	0.89	-0.18	0.36	0.31
0-200	1.49	0.17	1.13	1.72	1.19	0.50	0.50	0.60
200-500	1.70	0.98	-	2.47	0.95	0.31	1.64	-

The length compositions given in Table 5 show, apart from the major peak, a minor peak caused by the high abundance of small cod of the 1965, 1966 and 1967 year-classes. Young fish survey data show the latter two year-classes to be highly abundant.

The changes in the length composition from January to April are related to seasonal migrations of the Labrador cod. In January both immature and pre-spawning cod concentrate on the continental slope of South Labrador. In late February and March almost all mature cod move northward to the main

spawning grounds, which accounts for a decrease in the mean length of the cod remaining in South Labrador. Usually at this time there is also a decrease in the catch per hour trawling. In April the big spent cod move back southward and the mean length of cod in trawl catches (as well as the productiveity of trawl fisheries) increases again.

b) Marking. 2,907 cod were marked with hydrostatic tags and released in Div. 2J.

c) Total fishing and natural mortality. Total mortality rates (Z) for each year from 1961 to 1968 were calculated from the numbers (%) of fish of different ages in the mean catch per hour trawling by Soviet BMRT-type vessels in the first six months of the year in Div. 2J.

Table 5. Length composition of cod in trawl catches (°/₀₀) at South Labrador (Div. 2J), 1970.

Length (cm)	January	February	March	April
18-20	-	-	-	1
21-23	1	1	5	14
24-26	4	5	35	34
27-29	5	10	60	18
30-32	16	25	77	17
33-35	35	51	82	21
36-38	58	74	93	33
39-41	106	93	93	45
42-44	100	87	75	50
45-47	95	89	60	56
48-50	113	108	71	92
51-53	106	111	75	112
54-56	111	118	78	135
57-59	98	87	68	120
60-62	64	63	46	94
63-65	38	37	33	61
66-68	23	20	19	42
69-71	16	10	13	25
72-74	6	6	6	12
75-77	3	2	4	8
78-80	2	2	3	6
81-83	-	-	1	1
84-86	-	1	1	1
87-89	-	-	1	1
90-92	-	-	1	1
Total (°/₀₀)	1,000	1,000	1,000	1,000
Number of fish	7,487	10,022	9,977	3,905
Mean length (cm)	49.72	48.92	45.00	51.9

The total mortality rates were calculated only for the fish fully retained by the trawl (*i.e.* those at the age of over 5-6 years). The total mortality rate varied from 0.473 to 0.777 with a mean of 0.670, which corresponds to the total annual removal of 48.82%.

The natural mortality rate (M) was calculated by the method of successive approximations (Beverton and Holt). The total fishing effort was transformed to the Spanish and Portuguese standard. The natural mortality rate was found to lie between 0.080 and 0.343 with the mid-point at 0.22.

d) Cod fishery forecast. In 1972 the winter cod concentrations on the continental slope of Labrador are expected to be very dense and the trawling fleet is likely to work much more effectively than in 1970 and 1971. The catch-per-hour trawling is likely to be close to the 1968 level. This forecast is based on the following:

i) the cod of the strong 1966 and 1967 year-classes will reach the commercial size and make a considerable contribution to the stock;

ii) increasing negative anomalies of the water temperature over the shelf and the continental slope of Labrador will force cod to pass to deeper water layers, which will result in denser commercial concentrations (for details see the USSR Research Report, 1969 in ICNAF *Redbook* 1970, Part II, p. 116-120);

iii) in the earlier half of 1971, especially in February and March, the ice conditions in the Labrador area were very severe, which restricted the removal of cod by fisheries.

Subarea 3

A. Status of the Fisheries

The annual catch is given in Table 6.

Table 6. Annual catch in Subarea 3 (metric tons).

Division	Total catch by vessels of all types						
	Cod	Grenadier	Redfish	Flatfish	Greenland halibut	Other	Total
3K	28,278	22,267	6,083	11,768	4,704	2,648	75,748
3L	194	72	185	395	183	23	1,052
3N	20,238	57	12,926	17,749	105	1,738	52,813
3O	8,100	-	12,795	1,611	194	2,306	25,006
3P	2,693	-	24,153	336	9	1,195	28,386
3M	494	-	2,136	62	-	14	2,706
Subarea 3	59,997	22,396	58,278	31,921	5,195	7,924	185,715

B. Special Research Studies

I. Environmental Studies

Water temperature observations were made from *R/V's Perseus III, Rossiya* and *Procyon* along standard Sections 7-A, 6-A, 4-A, 3-A, 1-A and 44-A.

Table 7 shows water temperatures in May at the stations of Section 3-A which were occupied in the cold component of the Labrador Current and at the stations of Section 4-A occupied at the junction of bank waters of the Labrador and the North Atlantic Currents. It is evident from Table 7 that there was an intensification of the cold component of the Labrador Current in 1970.

Table 7. Average water temperature (°C) in the 0-200 m layer along Sections 3-A and 4-A (15 May).

Year	Section 3-A		Section 4-A	
	Temperature	Anomaly	Temperature	Anomaly
1968	1.85	+ 1.36	2.25	+ 0.54
1969	0.80	+ 0.31	3.46	+ 1.75
1970	0.44	- 0.05	2.05	+ 0.34

II. Biological Studies

1. Cod

a) Young fish survey. As in previous years a young cod survey was made in Subarea 3 (by *R/V's Perseus III* and *Rossiya*). Div. 3K contains young fish of the Labrador stock brought at the larval stage by the Labrador Current from the north. The abundance of 3-year-old fish in Div. 3K provides the best estimation of the strength of a Labrador cod year-class (Table 8.). The comparison of this year's results of the young fish survey with those of previous years confirms that in the Labrador cod fluctuations are much less pronounced than, for example, in the Grand Bank cod. It is also evident from Table 8 that in Div. 3K three-year-old (and four-year-old) fish of the 1966 and 1967 year-classes were fairly numerous.

Table 8. Average catch (numbers) of young cod at the age of 1 to 4 years per hour trawling with a survey trawl.

Year-class	1 Year			2 Years			3 Years			4 Years		
	3K	3N	3O	3K	3N	3O	3K	3N	3O	3K	3N	3O
1958	-	-	-	-	-	-	-	-	-	10	1	0
1959	-	-	-	-	-	-	21	8	1	15	1	1
1960	-	-	-	5	3	0	11	1	2	11	1	0
1961	1	1	1	3	4	3	20	5	1	24	4	1
1962	1	1	7	2	8	2	15	18	2	6	1	1
1963	1	1	1	1	5	1	36	30	1	17	7	3
1964	1	41	24	3	137	13	8	73	42	28	16	7
1965	1	1	1	1	14	12	15	23	20	22	60	9
1966	1	2	15	3	27	17	27	37	34	36	10	4
1967	1	1	2	8	3	4	32	32	14	-	-	-
1968	1	6	18	6	109	28	-	-	-	-	-	-
1969	1	2	4	-	-	-	-	-	-	-	-	-

On the southern slopes of Grand Bank (Div. 3NO) the 1968 year-class was very prominent (its high abundance was suggested in the USSR Research Report to the 20th ICNAF meeting).

b) Cod fishery forecast. In 1972 the commercial stock of cod on the southern Grand Bank (and on St. Pierre Bank) is expected to be considerably replenished due to the high abundance of the 1968 year-class. The efficiency of cod fisheries is likely to increase.

c) The removal by fishing and the abundance of cod on Flemish Cap Bank. Konstaninov (ICNAF *Redbook* 1970, Part III, p. 49-55) described the relationship between the removal by fishing and the subsequent efficiency of the Flemish Cap cod fisheries. Fig. 2 shows that the higher the total cod catch in the four-year period the lower, as a rule, is the catch per hour trawling in the subsequent (fifth) year. However it is also evident from Fig. 2 that in recent years the total cod catch on Flemish Cap followed a downward trend. Thus the efficiency of trawl fisheries may be expected to tend to increase. In fact, in February-March 1971 trawlers of some countries reported very good cod catches on Flemish Cap Bank (final efficiency data are not available yet).

2. Haddock

The vertebral number analysis shows that throughout almost the whole of the past decade the haddock found on Grand Bank were predominantly those born on St. Pierre Bank. At the age of 2-3 years these fish migrate from St. Pierre Bank to Grand Bank crossing the coastal branch of the Labrador Current. Only in 1969 and 1970 it was not unusual to find young haddock of local origin, which seems to be an indication of the restoration of the Grand Bank haddock stock. However the St. Pierre haddock are still predominant on Grand Bank. As seen from Table 9, the 1966 and 1967 year-classes were relatively good and in 1970 the numbers of adult haddock in the trawl catches on the southern Grand Bank appeared to be somewhat higher.

Table 9. Average catch (numbers) of young haddock at the age of 1 to 3 years per hour trawling with a survey trawl.

Year-class	1 Year		2 Years		3 Years	
	3NO	3P	3NO	3P	3NO	3P
1963	-	-	-	-	2	17
1964	-	-	4	55	6	153
1965	1	13	1	41	1	4
1966	3	110	8	191	1	20
1967	1	183	1	16	1	2
1968	4	25	8	10	-	-
1969	4	35	-	-	-	-

3. Redfish

A study of size, age and sexual maturity of deep-water redfish (*Sebastes mentella Travin*) on the southern Grand Bank confirmed that:

i) the major part of the redfish catches is always made up by mature fish, the females being bigger and older than males;

ii) the mean length and age of redfish do not change even with a

decline in the abundance of the intensively fished stock;

iii) length composition curves always appear to have two peaks, which suggests that redfish of medium size may not stay close to the bottom and are less available for bottom trawls than small and big fish.

Some data on the size-age composition of the *S. mentella* are presented in Tables 10 and 11.

Table 10. Length composition of *S. mentella* (°/₀₀) in Div. 3N in June 1970.

Length (cm)	Males	Females
19	-	1
20	17	1
21	17	3
22	62	14
23	92	34
24	116	27
25	134	31
26	65	27
27	86	43
28	103	38
29	72	41
30	103	54
31	34	71
32	31	132
33	10	112
34	14	112
35	7	101
36	10	51
37	14	37
38	10	24
39	-	14
40	-	10
41	3	9
42	-	7
43	-	4
48	-	1
Total (°/₀₀)	1,000	1,000
Number of fish	292	764
Mean length (cm)	26.87	31.77

4. Marking

2,572 fish were tagged with hydrostatic tags in Subarea 3 (mainly in Div. 3L) including 1,056 yellowtail flounders, 807 American plaices, 660 cods, 17 haddocks, 16 witch flounders, 5 Greenland halibuts and 1 spiny dogfish.

Table 11. Age composition of *S. mentella* (°/₀₀) in Div. 3N in June 1970.

Year-class	(Age)	Males	Females
1963	(7)	13	-
1962	(8)	67	24
1961	(9)	280	49
1960	(10)	280	78
1959	(11)	133	102
1958	(12)	147	203
1957	(13)	40	213
1956	(14)	27	154
1955	(15)	13	83
1954	(16)	-	39
1953	(17)	-	10
1952	(18)	-	15
1951	(19)	-	5
1950	(20)	-	15
1949	(21)	-	-
1948	(22)	-	5
1947	(23)	-	5
Total (°/₀₀)		1,000	1,000
Number of fish		75	206
Mean age (years)		10.27	12.82

Subarea 4

A. Status of the Fisheries

The annual catch is shown in Table 12.

Table 12. Annual catch in Subarea 4 (metric tons)

Division	Total catch by vessels of all types							
	Flatfish	Cod	Redhake	Silver hake	Redfish	Herring	Other	Total
4V	318	45	23	5,111	4,135	12,456	543	22,631
4W	5,286	2,476	1,120	158,902	8,699	59,103	10,543	255,129
4X	101	10	22	4,903	384	454	414	6,288
Subarea 4	5,705	2,531	1,165	168,916	13,218	72,013	20,500	284,048

1. Silver hake

As in 1969, there was a considerable increase in the silver hake catches on the Nova Scotian shelf in 1970. The 1970 silver hake catch was 168,900 tons against 46,300 tons in 1969 and 3,400 tons in 1968 (Table 13.). This is the highest silver hake catch on record since 1962. A decline in catches in 1964-1968 was followed by a considerable increase in 1969-1970.

Variations in silver hake catches are attributed to considerable fluctuations of abundance and fishing effort. The fishing effort increased in the years when the abundance of silver hake was high and decreased when it was low, the fleet transferring its effort to other species or other areas.

Table 13. Silver hake catches in Div. 4W in 1962-1970 (thousands of tons).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch	8.0	123.0	81.0	50.0	10.3	2.5	3.4	46.3	168.9

Silver hake were fished by big over-1,800 ton trawlers in Div. 4W on the slopes of Emerald, Middle and Sable Island Banks and in the Nova Scotian channel mainly from March through October. More often than in earlier years silver hake concentrations were observed on the eastern slopes of Banquereau Bank and the southern slopes of Browns Bank. Hake were represented in catches by 20 to 40 cm long fish, with over 70% of the catch consisting of 26 to 33 cm long fish. For the period from March to December the mean length was 28.2 cm. The bulk of the catch was made up by the three-year-old fish of the good 1967 year-class (35.9%) and the four-year-old fish of an equally good 1966 year-class (33.1%), with 11.6% of the catch consisting of two-year-olds and 10.1% of five-year-olds (Table 14.).

Table 14. Percentage age composition of silver hake catches in Div. 4W in 1968-1970.

Year	Age									Total (%)	Mean age
	1	2	3	4	5	6	7	8	9		
1968	0.3	11.1	31.9	34.9	15.7	5.3	0.7	0.1	-	100.0	3.7
1969	6.1	6.1	34.0	35.7	12.7	3.6	1.2	0.6	-	100.0	3.6
1970	7.0	11.6	35.9	33.1	10.1	1.4	0.5	0.3	0.1	100.0	3.4

In 1971 the bulk of the catch is expected to consist of the abundant 1967 year-class at the age of 4+ and the 1968 year-class at age 3+ which, according to the trawl survey in the August of 1970, is also an abundant year-class. The abundance and catches of silver hake in 1971 are likely to remain at a high level. There is evidence indicating that in 1972 silver hake concentrations are also likely to be considerable.

2. Haddock

There was no specialized haddock fishery in 1970. They were caught in very small quantities in fishing for other species. The catch was 600 tons which is 0.22% of the total USSR catch in Subarea 4 in 1970.

Table 15. Haddock catches in Subarea 4 in 1962-1970 (thousands of tons).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch	2.6	3.7	5.5	45.5	20.6	0.7	0.6	0.2	0.6

No changes are expected in 1971. Haddock are likely to be caught incidentally in silver hake and other fisheries.

3. Argentine

The 1970 argentine catch declined and was 1,600 tons against 4,100 tons in 1969 (Table 16.). The decline in argentine catches is explained by the closure of the Browns Bank area in spring to protect haddock from being caught on spawning grounds. As haddock are known to stay at depths less than 70 m during this period while argentine are to be found at the depth of 150-250 m the establishment of the boundary of the area closed to fisheries along the 100 m isobath would make it possible to fish dense argentine concentrations on the slopes of Browns Bank without doing any harm to haddock concentrations on spawning grounds.

Table 16. Argentine catches in Subarea 4 in 1963-1970 (thousands of tons).

Year	1963	1964	1965	1966	1967	1968	1969	1970
Catch	8.1	4.9	5.6	15.0	4.2	1.6	4.1	1.6

The argentine stock is abundant enough to support a specialized fishery and to provide for better catches.

4. Herring

The 1970 herring catch was 70,200 tons, *i.e.* 4,600 tons more than in 1969 (Table 17.).

Table 17. Herring catches in Subarea 4 in 1962-1970 (thousands of tons).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch	0.9	2.7	2.7	5.9	2.2	0.6	2.8	65.6	70.2

Herring were mainly fished from late February to mid May on the eastern slopes of Banquereau Bank and the northern slopes of Emerald Bank. In 1970 there was a redistribution of herring fishery. In 1969 the main portion of the catch was obtained on Banquereau Bank where herring were fished successfully with pelagic trawls from vessels of the RTM *Atlantic* type and with purse seines from the SRT- and SRTR-type vessels.

In 1970 herring concentrations on Banquereau Bank were smaller and the major portion of the catch came from the Emerald Bank area where herring were fished by SRT- and SRTR-type vessels using purse seines.

On Banquereau Bank the bulk of the herring catch consisted of 33-38 cm long fish (88%), with the mean length of 35.4 cm. The Emerald Bank catches were dominated by smaller 27 to 35 cm long herring (86%) with the mean length of 30.2 cm.

The major part of the catch on Banquereau Bank consisted of 7+ to

14+ age-groups whereas on Emerald Bank most of the fish caught belonged to age-groups of 4+ to 9+ (Table 18.). Thus, herring in these two areas differ significantly in size and age compositions. Herring occurring on Banquereau Bank and on Emerald Bank in winter and in spring are likely to belong to different populations, which is also supported by the results of the otolith structure analysis of herring samples from these areas.

5. Mackerel

Mackerel were obtained as by-catch in groundfish fisheries. The 1970 catch was 4,000 tons, *i.e.* there was practically no change as compared to 4,100 tons caught in 1969. The information available at present on stock abundance and the areas of commercial concentrations of mackerel is inadequate to give any judgement on fishery prospects.

B. Special Research Studies

I. Environmental Studies

Four seasonal hydrographic surveys were conducted in Subarea 4 in 1970 covering shelf waters from St. Pierre Bank to Browns Bank inclusive. The surveys were conducted in January, April, August and October. Observations included water temperature and salinity measurements at standard depths. Figures 3 and 4 show the Halifax section and that across Cabot Strait as an example illustrating seasonal patterns of water temperature distribution. The results of surveys indicate that in all seasons of 1970 water temperatures in Cabot Strait were higher than in 1969 and those in the Sambro Deep and Emerald Bank area were lower than or close to the 1969 values.

Table 18. Percentage age composition of herring catches in Subarea 4 in 1969–1970.

Area	Year	Age													Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Banquereau Bank	1969	-	0.7	2.4	6.7	11.5	19.9	9.6	10.2	14.6	11.4	8.0	4.8	0.2	-	100.0
	1970	-	-	-	-	0.2	1.1	6.8	9.7	17.8	17.5	17.2	14.4	9.8	5.5	100.0
Emerald Bank	1969	-	-	0.2	2.1	18.8	36.3	18.0	12.7	8.1	2.6	1.6	0.1	-	-	100.0
	1970	0.1	0.2	2.5	16.0	27.7	13.6	26.5	6.2	4.9	1.4	0.9	-	-	-	100.0

II. Biological Studies

1. Herring

To identify herring stocks a comparison was made of the otoliths of herring caught in March-April 1970 on Banquereau and Emerald Banks. It was found that 45% of the herring sampled in the Emerald Bank area had otoliths with a wide winter growth zone consisting of several laminated rings. On Banquereau Bank the proportion of fish with such otolith structure was 64%. Pronounced differences were also found in the ratio of the otolith's length to its width (l/d). In the Emerald Bank area this ratio in the 26 to 37 cm long herring was 2.1-2.2 and in the Banquereau Bank area the ratio in the 24 to 38 cm long fish was 2.3-2.5 (Table 19.). These data suggest that different stocks are fished on Banquereau Bank and on Emerald Bank in winter and spring.

Subarea 5

Annual catches are presented in Table 20.

Table 19. Otolith length to width ratio (1/d) and the body length of herring on Banquereau and Emerald Banks.

Area		Length of herring														
		24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Emerald Bank	1/d	-	-	2.1	2.1	2.1	2.2	2.2	2.1	2.1	2.2	2.2	2.1	2.1	2.2	-
	number of fish	-	-	2	8	16	27	14	3	20	24	17	20	3	1	-
Banquereau Bank	1/d	2.4	2.4	2.5	2.4	2.5	2.4	2.4	2.4	2.4	2.3	2.3	2.4	2.4	2.5	2.5
	number of fish	4	11	6	7	5	7	5	9	8	9	15	17	16	4	1

Table 20. Annual catch in Subarea 5 (metric tons).

Division	Total catch by vessels of all types								Total
	Flatfish	Cod	Red hake	Silver hake	Herring	Alewife	Mackerel	Other	
5Ze	1,432	224	1,815	20,548	31,651	4,126	25,237	8,488	93,521
5Zw	3,013	140	4,700	8,449	7,522	9,009	31,220	8,627	72,680
Subarea 5	4,445	364	6,515	28,997	39,173	13,135	56,357	17,115	166,201

A. Status of the Fisheries

1. Silver hake

The 1970 silver hake catch on Georges Bank and on the Nantucket shoal was 29,000 tons, which is the lowest USSR catch on record since the beginning of this fishery.

Table 21. Silver hake catches in Subarea 5 in 1962-1970 (thousands of tons).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch	41.9	107.4	167.3	281.4	121.4	70.6	43.9	66.8	29.0

The decline in catches is explained by a further decrease in stock abundance and by some reduction in fishing effort.

The decrease in stock abundance may be attributed to the recruitment in recent years of a number of poor year-classes. The major part of the 1970 catch was taken from April to September on the shelf slopes between Black and Bur Canyons and from the Nantucket Shoal. There was practically no specialized fishery for silver hake and they were caught along with red hake, mackerel, herring, alewife and other species. The main portion of the catch consisted of 25 to 35 cm long fish with the mean length during the entire period of fishery of 28.6 cm. The predominant age-groups were one- to six-year-olds. On the average the proportion of age-group 1+ was 16.5%, that of age-group 2+ was 13.3%, age-group 3+ contributed 18.2%, age 4+ made up 27.6% and age 5+ - 15.8%.

Table 22. Percentage age composition of silver hake catches in Subarea 5 in 1968-1970.

Year	Age										Total (%)	Mean age
	1	2	3	4	5	6	7	8	9	10		
1968	1.8	3.4	37.6	34.6	15.5	4.4	1.4	0.9	0.4	-	100.0	3.8
1969	1.3	14.6	33.2	25.5	14.5	5.2	4.0	1.2	0.5	-	100.0	3.8
1970	16.5	13.3	18.2	27.6	15.8	3.8	2.9	1.4	0.3	0.2	100.0	3.5

Unlike in previous years there was a considerable increase in the proportion of one-year-olds belonging to the 1969 year-class. The results of abundance survey in the autumn of 1970 indicated that the 1969 year-class was slightly better than other year-classes but on the whole the stock remains at a low level.

Restrictions of the silver hake fishery in the winter and spring of 1970 and a considerable reduction of catches in 1967-1970 do not seem to have resulted in any increase in the stock abundance because the stock has declined due to natural causes rather than under the effect of fishery. Restrictions of silver hake fisheries do not seem to give any positive results. The stock may improve if good year-classes should recruit to the fishery as has been recently observed at Nova Scotia.

2. Haddock

The catch of haddock on Georges Bank was only 100 tons. Haddock were caught incidentally in fisheries for other species (Table 23.). At present the stock of haddock consists of poor year-classes and there are no indications of the improvement of the stock in the nearest two years.

Table 23. Haddock catches in Subarea 5 in 1962-1970 (thousands of tons).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch	1.1	2.4	5.5	81.9	48.9	2.3	1.4	+	0.1

3. Red hake

In 1970 the red hake catch decreased sharply and was only 6,500 tons against 45,000 tons in 1969 (Table 24.).

Table 24. Red hake catches in Subarea 5 in 1963-1970 (thousands of tons).

Year	1963	1964	1965	1966	1967	1968	1969	1970
Catch	3.5	3.6	58.5	82.9	37.6	4.3	45.0	6.5

The main reason for the decrease in catches is the same as in the silver hake fishery, *i.e.* a decline in stock abundance due to the recruitment of poor year-classes. Another reason is a limitation of the fishery in the earlier part of the year. In 1970 red hake were largely fished on the Nantucket shoal and on the shelf slopes. The catches consisted largely of 30 to 39 cm long fish (76%). They were aged 2 to 6 years, with three-year-olds (63.8%) and four-year-olds (29.2%) predominating.

Table 25. Percentage age composition of red hake caught in Subarea 5 in 1968-1970.

Year	Age									Total
	1	2	3	4	5	6	7	8	9	
1968	-	11.0	22.3	29.4	17.9	10.3	4.2	1.4	3.5	100.0
1969	3.4	17.5	35.8	35.4	7.6	0.3	-	-	-	100.0
1970	-	2.5	63.8	29.2	4.2	0.3	-	-	-	100.0

The results of the autumn trawl survey in 1970 indicated that the abundance of the red hake stock was at a low level.

4. Herring

In 1970 herring catches on Georges Bank and on the Nantucket shoal decreased to 39,200 tons as compared to 100,500 tons in 1969 and 127,000 tons in 1968.

Table 26. Herring catches in Subarea 5 in 1962-1970 (thousands of tons).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970
Catch	151.1	97.3	130.7	36.3	117.3	123.6	127.0	100.5	39.2

The main reason for the decline in catches is the decrease in commercial concentrations due to lower stock abundance. The lower catch was also the result of the vessels transferring their effort to mackerel which provided better catches. Herring were largely fished by bottom trawls from April through October. The bulk of the catch was taken in the western part of Subarea 5 in April-May and on Georges Bank in July-October. The major part of the catch consisted of herring at ages 4+ to 8+; 20.2% of the catch consisted of the 1966 year-class at age 4+, 26.5% of the 1965 year-class aged 5+, 14.7% of the 1964 year-class and 15.4% of the 1963 year-class.

Table 27. Percentage age composition of herring caught in Subarea 5 in 1968-1970.

Year	Age											Total
	2	3	4	5	6	7	8	9	10	11	12	
1968	0.2	4.1	9.0	20.3	19.5	39.1	7.6	0.2	-	-	-	100.0
1969	+	5.1	14.3	33.6	21.1	15.1	9.3	1.4	0.1	+	+	100.0
1970	2.0	4.8	20.2	26.5	14.7	15.4	10.9	4.8	0.6	0.1	-	100.0

All year-classes making up the basis of the commercial stock are weak with the exception of the 1966 year-class which seems to be of moderate strength. Judging by the catches of juvenile herring in the western Gulf of Maine in 1969 the 1967 and 1968 year-classes at the age of 2+ and 1+ were poor and therefore no substantial improvement in stock abundance and catches on Georges Bank can be expected until 1972.

5. Mackerel

Since 1968 the mackerel catch in Subarea 5 has followed an upward trend and the 1970 catch of 56,400 tons is the highest figure on record (Table 28.).

Table 28. Mackerel catches in Subarea 5 in 1963-1970 (thousands of tons).

Year	1963	1964	1965	1966	1967	1968	1969	1970
Catch	0.9	0.5	2.5	5.4	11.9	34.0	47.5	56.4

An increase in the mackerel catch can be attributed partly to a sharp increase in the sotck abundance in the past three years and partly to the intensification of fishing for mackerel following a decline in herring stocks. Mackerel were mainly fished with bottom trawls on the Nantucket shoal and Georges Bank from April through December.

The length of the mackerel in catches ranged from 20 to 42 cm, with the bulk of the catch made up by the 28 to 34 cm long fish (76%). The mean langth was 30.8 cm. The rich 1966 and 1967 year-classes contributed about 81.7% of the catch (Table 29.).

Table 29. Percentage age composition of mackerel caught in Subarea 5 in 1969-1970.

Year	Age											Total
	1	2	3	4	5	6	7	8	9	10	11	
1969	-	79.9	15.7	4.4	-	-	-	-	-	-	-	100.0
1970	2.8	1.5	61.6	20.1	5.9	1.0	1.1	1.5	2.9	1.5	0.1	100.0

As mackerel may live to reach the age of 9-11 years the 1966 and 1967 year-classes are likely to be abundant in catches in 1971.

B. Special Research Studies

I. Environmental Studies

In 1970 four seasonal hydrographic surveys were made on Georges Bank and in the southern Gulf of Maine. The surveys were conducted in January, April, August and November.

Figures 5 and 6 show the water temperature distribution in two typical sections in the Georges Bank area (across the East Passage and along 70°W). In all seasons the subsurface temperatures in the Gulf of Maine, the East Passage and in the Georges Bank area were lower than in 1969. On the southern slopes of Georges Bank the summer and autumn temperatures were higher than in 1969.

II. Biological Studies

1. Georges Bank herring spawning studies

In September and October 1970 studies of the spawning of herring were continued on northern Georges Bank. Investigators from USA and Canada participated in the studies on board *R/V Albatross IV*. The *R/V Albatross IV* had the submergible *Pisces* on board.

Spawning ground surveys included:

a) Observations on the distribution of spawning concentrations.

b) Location of spawning grounds.

c) Estimation of spawning ground areas, the amount of eggs laid, survival of eggs and loss through predation.

d) Observations over the distribution and drift of larvae after hatching.

It was found that in 1970 spawning extended over a longer period than in previous years, starting early in September and continuing to late October. The spawning grounds located over northern Georges Bank were almost the same as in previous years. The total area with eggs was estimated to be 1.9 square kilometers, the amount of eggs laid was 6,900 tons and the spawning population was 12,000 tons. As compared to previous years there was a considerable reduction in the area of eggs and in the amount of eggs laid. The spawning population was estimated to be 1,180,000 tons in 1964, 530,000 tons in 1965, 150,000 tons in 1966, 130,000 tons in 1968, 60,000 tons in 1969 and only 12,000 tons in 1970. Unfortunately there is no information on the amount of herring spawning on other spawning grounds.

Egg survival appeared to be high. The proportion of dead eggs in all samples was not found to be over 1.0%. Considerable cod concentrations were observed on the spawning grounds. The analysis of stomach contents indicated that cod were feeding heavily on herring eggs. Somewhat smaller numbers of flounder, skate, haddock, starfish, sea urchin, Polychaeta and hermit crabs were also observed on herring spawning grounds.

To study larval drift and environmental conditions, ichthyoplankton and zooplankton samples were taken and temperature and salinity were measured after the hatching of larvae from mid-October. In late October larvae were found to drift eastward from the spawning grounds.

2. Yellowtail flounder

On the basis of the material collected during the Joint USSR-US Groundfish Survey, a comparison was made of the abundance and distribution of the yellowtail flounder populations in southern New England and on Georges Bank. In southern New England yellowtail flounder occurred over the area of 14,000 sq. miles in 1968, 15,000 sq. miles in 1969 and 12,000 sq. miles in 1970.

In southern New England the absolute abundance estimated with the use of the catchability coefficient of 0.39 applied by R. Edwards (1968) was 167,600,000 fish in 1968, 160,000,000 in 1969 and only 100,000,000 in 1970. On Georges Bank the area of occurrence did not change significantly and in 1968 to 1970 varied between 10,400 sq. miles and 11,400 sq. miles. The 1968 population of 66,800,000 fish dropped to 40,200,000 in 1970. The comparison of the populations in these two areas showed that in southern New England yellowtail flounder was 2.5 times more abundant than on Georges Bank.

3. Joint groundfish survey

From August to October 1970 groundfish survey and trawl comparison experiments were conducted by USSR and US investigators. The total number of hauls made by the Soviet *R/V Kvant* was 330 including 70 experimental hauls. The trawl survey covered the area from Banquereau Bank to Cape Hatteras.

Statistical Area 6

A. Status of the Fisheries

There was practically no change in the total USSR catch in Statistical Area 6 in 1970 (102,300 tons) as compared to the 1969 catch of 107,300 tons

(Table 30.). However there were significant changes in the catches by species.

Table 30. USSR catches in Statistical Area 6 in 1963-1970 (thousands of tons).

Species	Year							
	1963	1964	1965	1966	1967	1968	1969	1970
Silver hake	4.2	16.9	17.3	92.9	18.6	15.0	7.2	3.0
Red hake	0.8	8.4	11.7	25.7	14.9	1.9	4.1	0.8
Herring	0.5	0.2	1.9	2.8	3.2	16.1	38.2	22.4
Mackerel	0.3	0.1	0.1	1.2	6.1	7.3	37.5	68.1
Other	2.1	2.6	2.4	8.4	4.3	12.4	20.3	8.0
Total	7.9	28.2	33.4	131.0	47.1	52.7	107.3	102.3

1. Silver hake

In 1970 the silver hake catch followed a downward trend and was only 3,000 tons against 7,200 tons in 1969, 15,000 tons in 1968, 18,600 tons in 1967 and 92,900 tons in 1966. The declining catch is attributed to a decrease in abundance due to the poor 1966 and 1967 year-classes which formed the basis of the commercial stock.

Another reason for the decline in the USSR silver hake catch is the introduction of the closed season from 1 January to 15 April because prior to the introduction of this measure Soviet vessels used to fish for silver hake in the first quarter of the year. The data of the trawl survey conducted in the autumn of 1970 indicate that in 1971 the abundance of silver hake will remain at a low level.

2. Red hake

The 1970 red hake catch dropped to 800 tons for the same reasons as the silver hake catch, *i.e.* the depression of the stock abundance and the closure of the area.

The autumn survey data indicate that in 1971 the abundance of red hake will remain at a low level.

3. Herring

The 1970 herring catch dropped to 22,400 tons against 38,100 tons in 1969. The drop in the catch is largely attributed to a decline in stock abundance. Herring caught in Statistical Area 6 belong to the same stock as those fished on Georges Bank. No increase in abundance and catches may be expected in the nearest future. Herring were fished at depths of 40 to 70 m from Long Island to Norfolk. The herring caught were predominantly at ages 5+ to 9+ (Table 31.).

Table 31. Percentage age composition of herring catches in Statistical Area 6 in 1968-1970.

Year	Age								Total
	2	3	4	5	6	7	8	9	
1968	0.8	1.2	4.4	26.9	37.4	27.7	1.6	-	100.0
1969	0.2	6.2	10.3	30.2	18.8	16.6	16.1	1.6	100.0
1970	-	2.9	7.8	29.7	15.3	14.9	14.5	14.9	100.0

4. Mackerel

In recent years commercial concentrations in winter and spring have increased substantially which contributed to an increase in catches. The 1970 catch of 68,000 tons was the highest on record as compared to 37,500 tons in 1969 and 7,300 tons in 1968 (Table 30.).

Mackerel were fished from February to early May. The major part of the catch was taken at Norfolk in February and May, over the shelf from Norfolk to Hudson Canyon in April and at Hudson in May.

The mackerel occurring in Statistical Area 6 in the earlier part of the year belong to the same stock as those fished in Subarea 5.

The catches were dominated by the good year-classes of 1966 and 1967 (Table 32.).

Table 32. Percentage age composition of mackerel catches in Statistical Area 6 in 1970.

Age	1	2	3	4	5	6	7	8	9	10	Total
%	7.9	3.1	63.3	19.2	2.5	0.8	0.6	1.2	1.1	0.3	100.0

The average proportion of the 1967 year-class at age 3+ was 63.3% and that of 1966 at age 4+ was 19.2%. In 1971 the abundance of these year-classes is expected to remain at a high level.

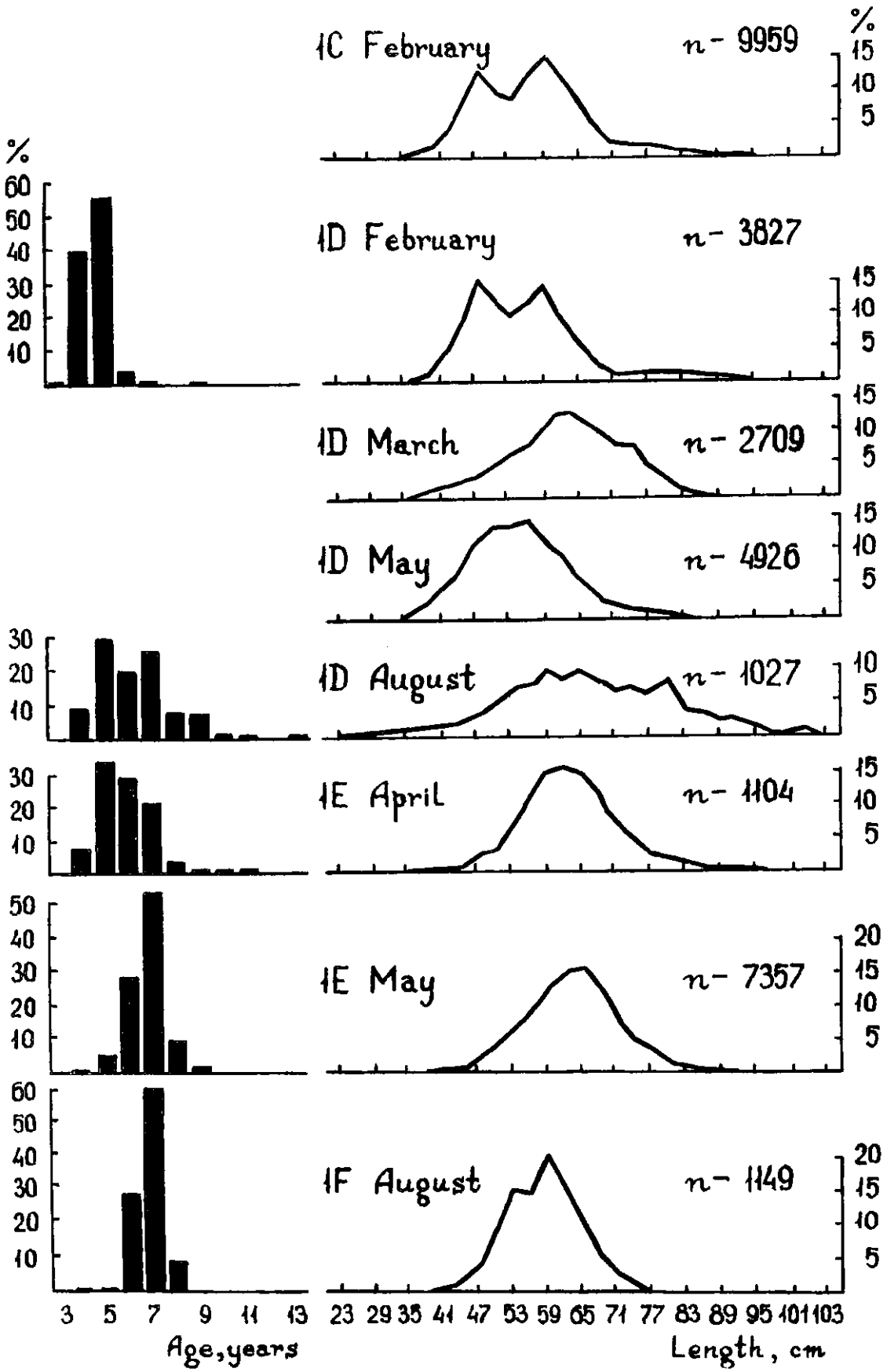


Fig. 1. Size and age composition of cod by Divisions in Subarea 1 in 1970.

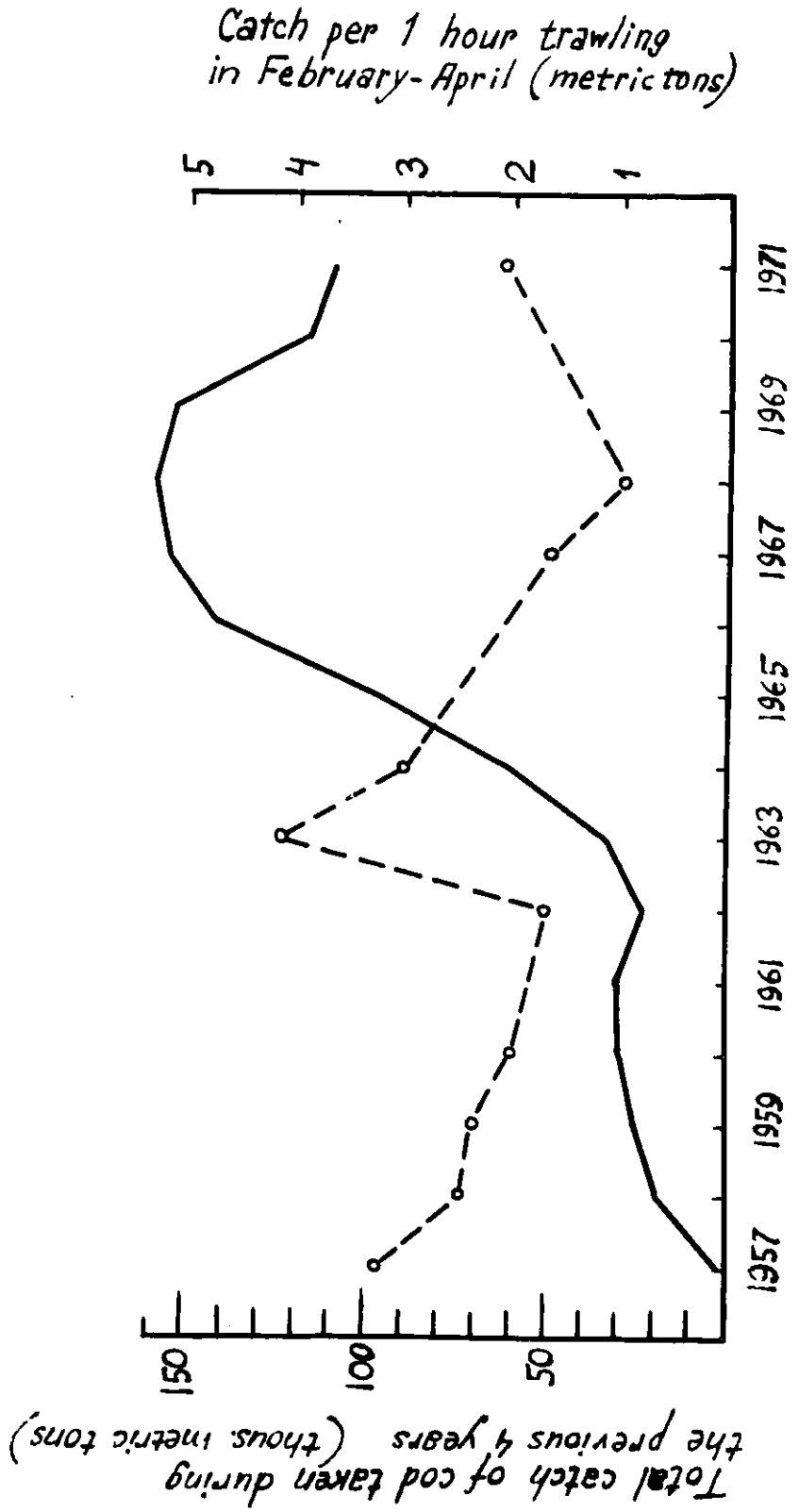


Fig. 2. Catch-per-hour trawling by USSR BMRT-type trawlers over southwestern Flemish Cap Bank in February-April (dotted line) and the total international cod catch on Flemish Cap Bank in the four preceding years (solid line).

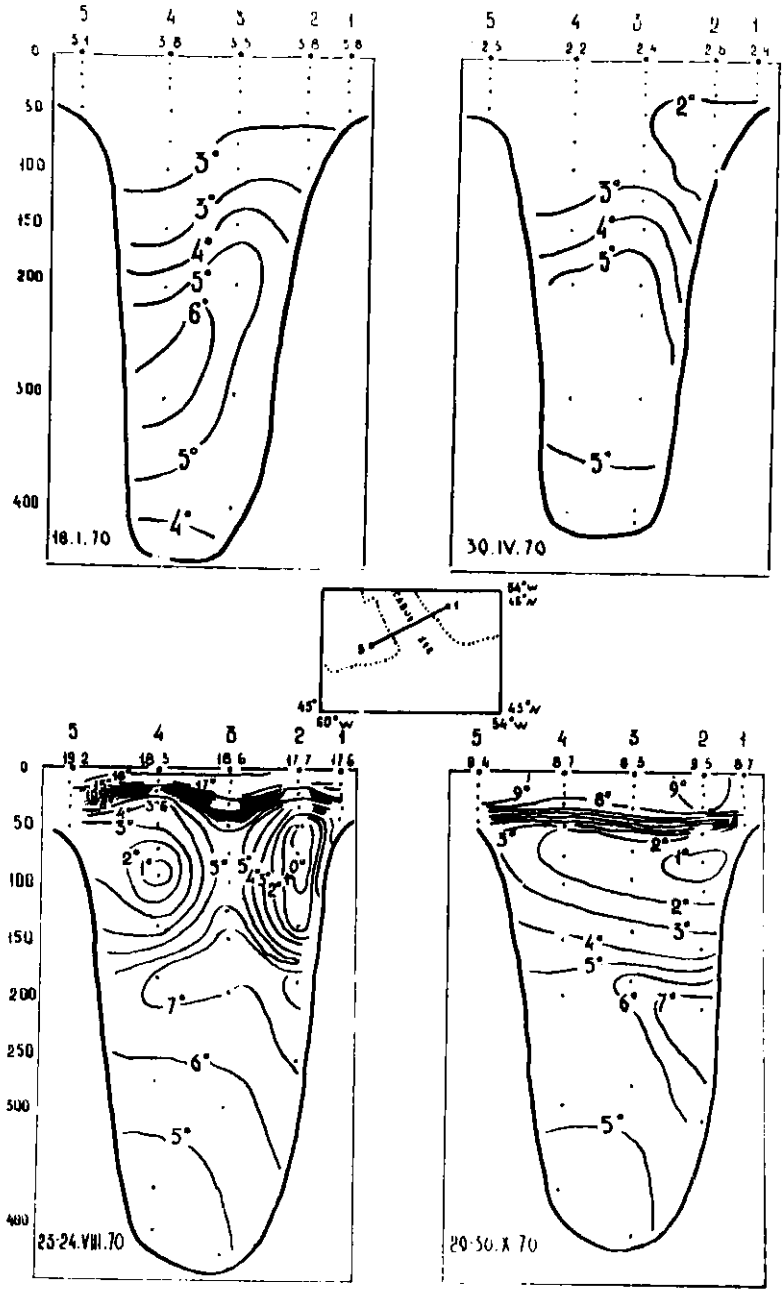


Fig. 3. Water temperatures in the Cabot Strait section in 1970.

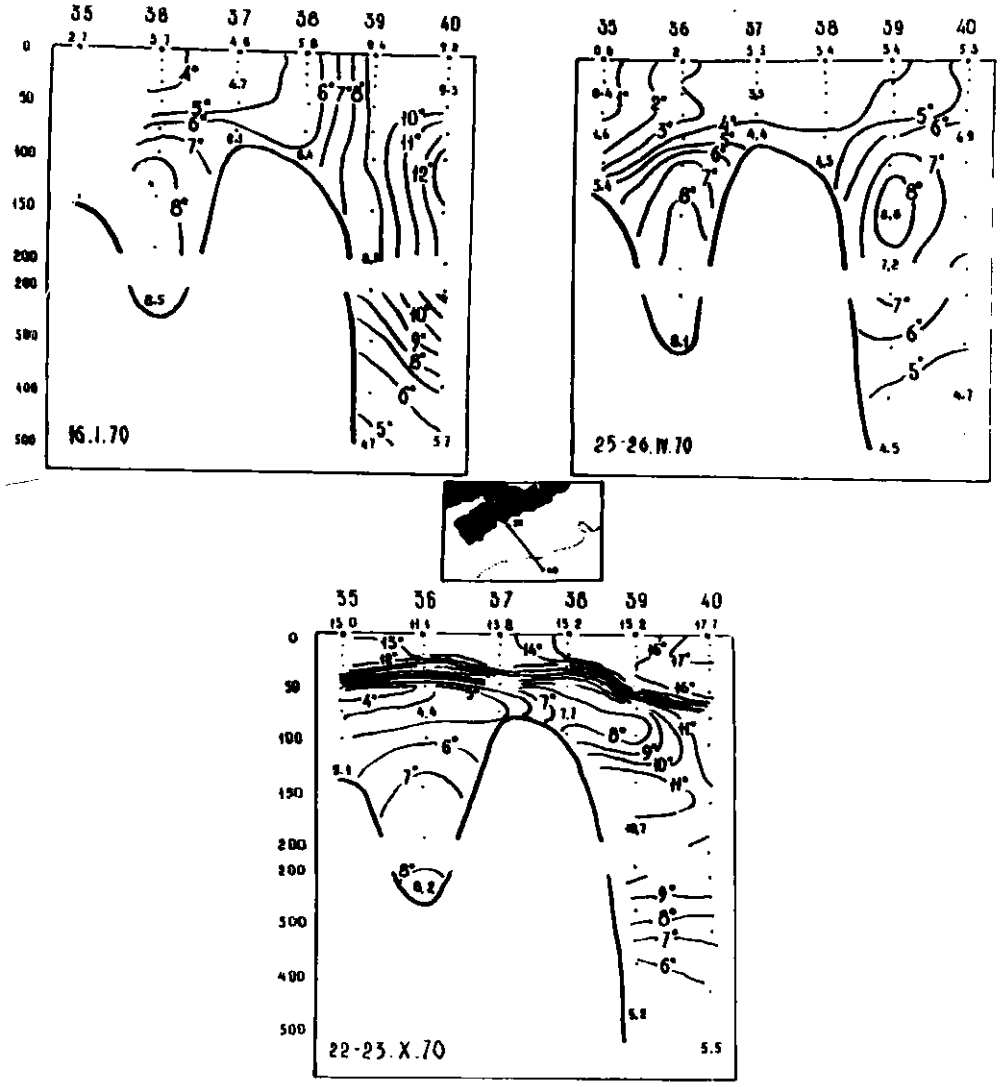


Fig. 4. Water temperatures in the Halifax section in 1970.

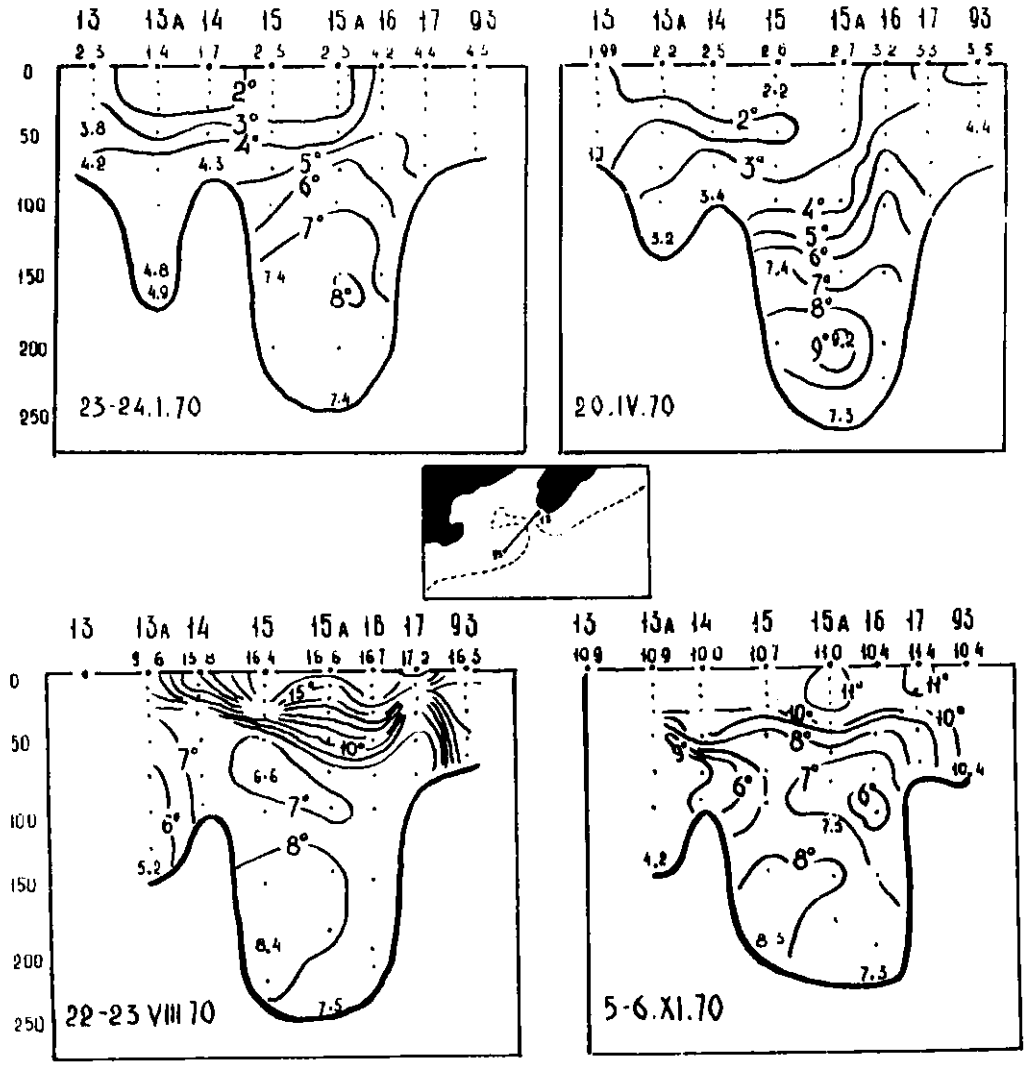


Fig. 5. Water temperatures in the East Passage section in 1970.

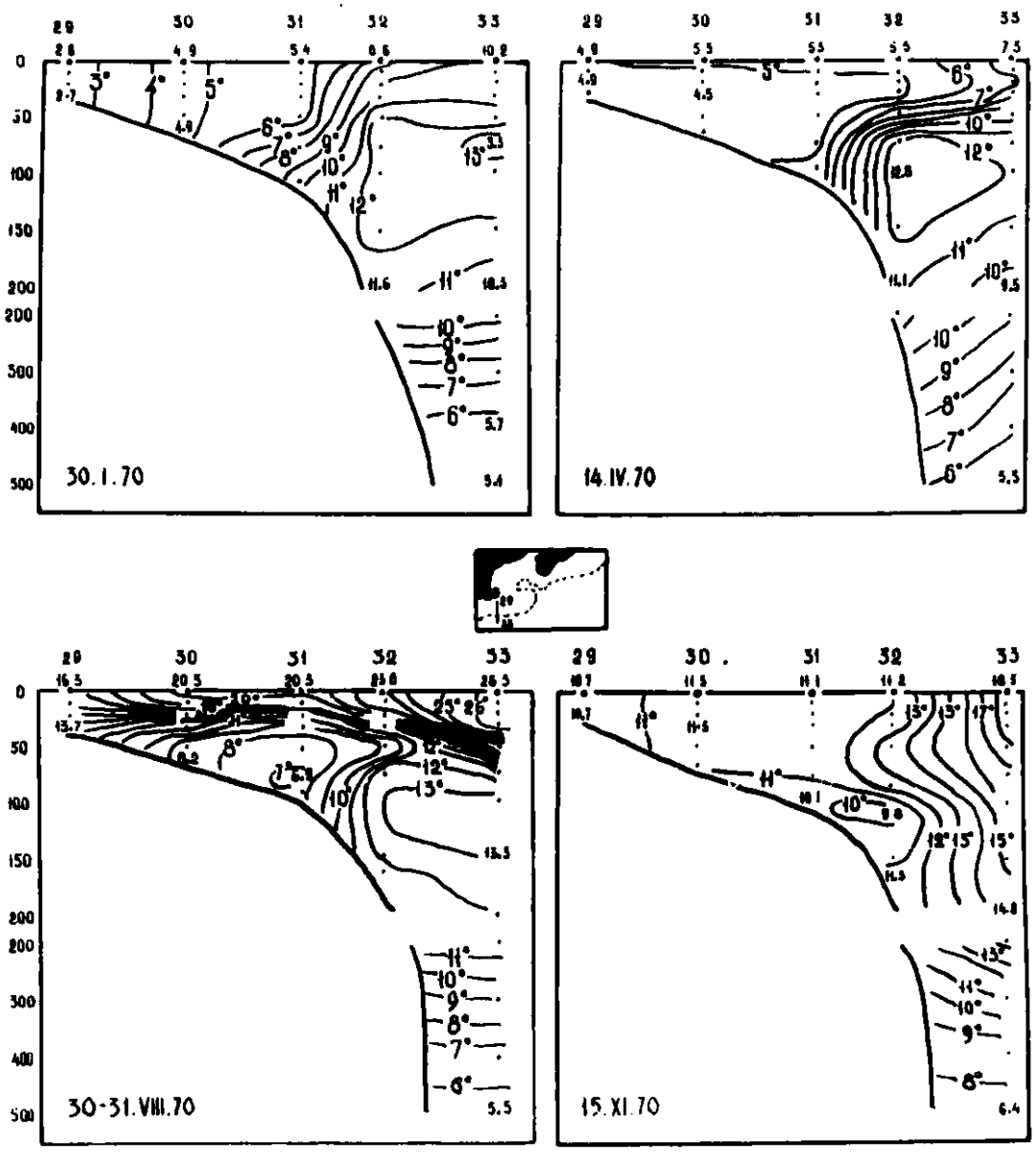


Fig. 6. Water temperatures in the Cape Cod section in 1970.

X. United Kingdom Research Report, 1970

Subareas 1 - 3

A. Status of the Fisheries

Fishing effort in the northwest Atlantic remained small in 1970 - 4,600 hours compared with 4,300 in 1969 - owing to the continued good fishing in the northeast Arctic. Wet-fishers voyaged there at the end of the year and accounted for about one-quarter of the total effort. Most of the stern freezer-trawlers were in the area at the beginning of the year.

As shown below, total catches of cod amounted to only 5,300 tons, 800 tons more than in 1969. Over half of the catch came from Subarea 1, about 40% from Subarea 2 and the remainder from Subarea 3. The amount of fishing was again too small to premit valid comparison with earlier years.

Year	ICNAF Subareas 1	2	3	Total
	Landings (statute tons)			
1969	444	1,746	2,307	4,497
1970	2,760	2,107	424	5,291
	(1,670)*			(1,670)*
	Hours fished			
1969	338	1,335	2,618	4,291
1970	2,034	709	1,897	4,640
	(1,108)*			(1,108)*
	Number of arrivals			
1969	3	6	8	
1970	14	5	5	
	(10)*			

* Wet-fishers included in total.

Sampling of commercial catches from the ICNAF area was slightly improved, especially in respect of the end-of-year fishing at the west coast of Greenland (Subarea 1).

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B. Special Research Studies

I. Environmental Studies

The survey with Continuous Plankton Recorders, operated from the Oceanographic Laboratory, Edinburgh, continued in 1970 on the same basis as in other years. It was financed by the British Natural Environment Research Council.

Recorders are towed at a depth of 10 m, at monthly intervals, along stand-

ard routes by cutters of the US Coastguard and merchant ships from Denmark, Iceland and the United Kingdom. During 1970, recorders sampled for 1,370 miles in Subarea 1, 3,420 in Subarea 2 and 16,915 in Subarea 3. This sampling forms part of the laboratory's standard survey of the North Atlantic Ocean and the North Sea. Further details may be obtained on application to the Director, Oceanographic Laboratory, Craighall Road, Edinburgh EH6 4RQ.

The spring outbreak of phytoplankton was below average in the oceanic region of Subarea 3 but diatoms were abundant over the Grand Banks in April and May.

Numbers of copepods were close to the long-term mean (1962-69) in the northern oceanic Subarea 2; they were above average during the first half of the year in both the oceanic and coastal parts of Subarea 3 and below average from July to November.

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II. Biological Studies

UK scientists continued their studies of the West Greenland salmon fishery in 1970 and, during the period late August to mid-November, five scientists took part in the investigations at Greenland. The main items in the program were a comparison of drift-netting and long-lining as a method of catching salmon in West Greenland (carried out in collaboration with Canada), investigations of the viability of salmon caught and tagged from gill nets and further serological studies on salmon blood.

The results of the comparative tests of methods of catching salmon indicated that more fish were caught by drift-netting than by long-lining and, though the preportion of taggable fish was higher in the long-line catch, it did not compensate for the larger numbers of fish caught by drift nets. It would therefore seem that drift-netting should be adopted as the means of catching salmon in the international tagging experiment which is now being considered. In the gill-net experiment, the live fish caught were placed in keep nets for periods of at least 24 hours. Some of the fish were tagged before impoundment, others were impounded untagged. The main result obtained was that the period of impoundment provided an indication of the chances of survival in that, if salmon in various physical states were impounded for 24 hours or more, at the end of the period they were either very active or dead.

Two of the 43 salmon tagged at West Greenland from long lines during 1969 have been recaptured, one locally (at Ikertoq, within 40 n. mi. of the tagging site) and one from the River Wye (England). No recaptures have yet been recorded from the fish tagged from the gill-net catches in 1969.

As in previous years, a number of recaptures have been recorded of fish tagged as smolts in UK rivers in 1969 but one recapture at West Greenland in 1970 deserves special mention. This was a salmon which was tagged near the Faroes at the beginning of April 1970 and caught at Frederickshåb some six months later.

Smolts were again tagged in home waters during the spring of 1970. In England and Wales, a total of 11,813 (7,320 wild and 4,493 hatchery-reared) was tagged and in Scotland a total of 39,907 (32,071 wild and 7,836 hatchery-reared).

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Subareas 4 and 5

A. Status of the Fisheries

There was no UK fishery in Subareas 4 and 5 in 1970.

B. Special Research Studies

I. Environmental Studies

The Continuous Plankton Recorder survey was also operated in Subareas 4 and 5 in 1970 on the same basis as in other years (see under Subareas 1-3). Recorders sampled for 4,385 miles in Subarea 4 and for 660 in Subarea 5.

Diatoms were abundant in the coastal regions of the two subareas in April but numbers were low for the remainder of the year. Copepods were less abundant than usual except in August and November in Subareas 4 and 5. Young stages of the populations of *Sebastes* spp. found in American shelf and slope waters were scarce everywhere.

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XI. United States Research Report, 1970

by R. C. Hennemuth and J. A. Posgay

The United States landed fish from all ICNAF Statistical Subareas and conducted research in Subareas 1, 2, 3, 4, 5, and 6.

Table 1 gives a summary of US finfish and sea scallop landings for each Subarea for 1969 and 1970.

Table 1. United States finfish and sea scallop landings for 1969 and 1970 (metric tons, round weight).

Species	Year	1	2	3	4	5	6[1]	Total
Haddock	1970	1	1	-	2,319	9,850	1	12,172
	1969	9	26	-	1,830	18,879	13	20,757
Cod	1970	278	502	55	615	22,039	101	23,590
	1969	200	342	40	448	24,513	426	25,969
Redfish	1970	-	-	-	9,541	15,530	-	25,071
	1969	5	7	33	13,264	12,038	-	25,347
Pollock	1970	-	-	-	385	3,577	-	3,962
	1969	5	14	-	569	3,507	2	4,097
Yellowtail	1970	-	-	-	21	31,893	1,428	33,342
	1969	-	-	-	19	33,014	3,886	36,919
Silver hake	1970	-	-	-	-	19,369	257	19,626
	1969	-	-	-	-	20,333	3,165	23,498
Red hake	1970	-	-	-	-	4,281	248	4,529
	1969	-	-	-	-	4,926	759	5,685
Sea herring	1970	-	-	-	-	30,483	700	31,183
	1969	-	-	-	-	30,747	1,585	32,332
River herring	1970	-	-	-	-	1,346	12,726	14,072
	1969	-	-	-	-	882	24,352	25,234
Menhaden	1970	-	-	-	-	5,065	224,813	229,878
	1969	-	-	-	-	140	102,338	102,478
Other finfish species	1970	1	2	-	352	37,902	32,761	71,018
	1969	13	2	3	237	43,611	32,673	76,539
Total finfish	1970	280	505	55	13,233	181,335	273,035	468,443
	1969	232	391	76	16,367	192,590	169,199	378,855
Sea scallop	1970	-	-	-	-	12,938	[2]	-
	1969	-	-	-	-	12,211	15,794	28,005

[1] Landings incomplete for 1970
[2] Not available

Subarea 1

A. Status of the Fisheries

The United States landed 277 tons of cod and one ton of haddock from the Subarea during 1970, the second year of US fishing this area. During 1969, 200 tons of cod were landed.

Subarea 2

A. Status of the Fisheries

The United States landed 502 tons of cod from this Subarea during 1970, an increase of 160 tons over 1969 landings which were the first for the United States in this subarea. One ton of haddock was also landed during 1970.

B. Special Research Studies

The United States Coast Guard studied short term variations in the Labrador Current using moored buoys from 15 July to 11 August.

Subarea 3

A. Status of the Fisheries

United States landings from Subarea 3 amounted to only 55 tons of cod, caught in Div. 3L, in 1970. In 1969 33 tons of redfish were landed.

B. Special Research Studies

The United States Coast Guard conducted oceanographic surveys in support of the International Ice Patrol in Div. 3N, L, and O from 1 April to 30 June.

Subarea 4

A. Status of the Fisheries

I. Haddock

United States landings of haddock from Subarea 4 amounted to 2,320 tons, 491 tons above 1969 landings. For the first time in 11 years, US vessels fished in Div. 4V, W, from which 577 tons were landed. US landings from Div. 4X were 87 tons lower than 1969 (Table 2). Landings from Browns Bank, the principal area fished by US vessels in Div. 4X, increased about 2,600 tons due to increased effort during November and December when the haddock quota had been reached on Georges Bank. Landings per day, however, were lower on Browns Bank and predictions are that no significant recruitment to the fisheries can be expected before 1975.

Table 2. United States haddock statistics, Div. 4X (metric tons, round fresh).

Year	Div. 4X Landings	Browns Bank Landings	Browns Bank Days Fished	Browns Bank Landings/ Day Fished
1965	3,685	1,786	275	6.5
1966	2,473	939	200	4.7
1967	5,014	2,059	381	5.4
1968	3,156	2,278	506	4.5
1969	1,830	1,305	389	3.4
1970	1,744	1,576	493	3.2

II. Cod

The United States fleet landed 615 tons of cod from Subarea 4, 167 tons greater than in 1969. This increase in landings is probably a reflection of greater haddock fishing in the area by US vessels.

III. Redfish

United States landings of redfish from the Gulf of St. Lawrence (Div. 4R, S, and T) decreased by 37% (Table 3): Redfish landings by the United States from the Scotian Shelf (Div. 4V, W, and X) increased 769 tons (Table 4). Landings per day decreased for both grounds; however, with low effort, these indices are probably not indicative of true abundance trends.

Table 3. United States redfish statistics, Div. 4R, S, T (metric tons, round fresh).

Year	Landings	Days Fished	Landings/ Day Fished
1965	17,099	803	21.3
1966	12,766	608	21.0
1967	15,482	622	24.9
1968	16,437	740	22.2
1969	12,122	689	17.6
1970	7,592	593	12.8

Table 4. United States redfish statistics, Div. 4V, W, X (metric tons, round fresh).

Year	Landings	Days Fished	Landings/ Day Fished
1965	13,082	1,246	10.5
1966	16,680	1,183	14.1
1967	6,407	593	10.8
1968	4,635	297	15.8
1969	1,142	75	15.3
1970	1,911	135	14.2

B. Special Research Studies

I. Environmental Studies

Environmental studies in Div. 4X are part of a larger program carried out in Subareas 5 and 6. They are reported under Subarea 5.

II. Biological Studies

Haddock. Assessment studies of haddock in Div. 4X have continued with further analysis of data from commercial catch-effort statistics and *Albatross IV* groundfish surveys. The 1970 year-class is judged to be poor on the basis of the autumn groundfish survey, thus recruitment to the fishery through at least 1974-75 will be low. The catch in 1970 of about 12,000 tons probably exceeded production by a substantial amount, and surplus production through the next several years will be 9,000 tons or less.

Studies on the spawning cycle and fecundity of haddock were conducted in Div. 4X and W in cooperation with the St. Andrews Biological Station of the Fisheries Research Board of Canada. On Browns Bank (Div. 4X) spawning peaked in mid-May and was complete by mid-June. By the end of April, 46% of the females in Div. 4W were spent.

Subarea 5

A. Status of the Fisheries

I. Haddock

Haddock landings in 1970 were limited by the 12,000 ton quota set by the Commission. The quota was nearly attained (97%). The 80% cutoff point was reached during October and the fishery closed for most of the third quarter. The US landed 9,850 tons, about one half the 1969 landings (Table 5). Landings per day figures in Table 5 were adjusted for effects of closure by deleting March, April and calendar quarter 4 when fishing was curtailed in 1970, and were calculated using a two-factor AOV model (see 5.B.III).

Age composition for 1970, based on the first 6 months of commercial landings, indicate that the 7- and 8-year-old fish (1963 and 1962 year-classes)

continued to represent the majority of the 1970 catch (Fig. 1). The *Albatross IV* fall groundfish survey catches indicate an extremely small 1970 year-class, which means poor production now extends to seven years (Table 6). This means that recruitment through 1972 will be very low and abundance will probably decline further under the 12,000 ton annual quota for 1971-72.

Table 5. United States haddock statistics, Subarea 5 (metric tons, round weight).

Year	Subarea 5 landings	Div. 5Y landings	Div. 5Zw landings	Div. 5Ze	
				Landings	Adjusted landings/ standard day fished
1965	57,027	4,204	26	52,797	5.6
1966	57,497	4,579	31	52,887	5.2
1967	39,580	4,852	37	34,691	4.0
1968	28,887	3,418	16	25,453	3.2
1969	18,858	2,402	15	16,441	2.5
1970	9,850	1,435	15	8,400	2.1

Table 6. Research vessel index of relative year-class abundance of Georges Bank haddock based on autumn catches of 0-group fish.

Year	Index	Year	Index
1959	9.6	1965	1.2
1960	2.4	1966	1.5
1961	1.4	1967	0.0
1962	2.6	1968	1.0
1963	12.6	1969	1.1
1964	2.0	1970	0.0

II. Cod

Cod landings by the United States in Subarea 5 decreased in 1970 after several years of increasing landings (Table 7). Although landings per day increased, it is doubtful that this represents any significant increase in abundance of stock because of changes in fishing strategy of the fleet. It is probable that the total catch by all countries (1969 total was 45,376 tons) is higher than the sustainable yield and if maintained or increased could seriously reduce abundance of this cod stock.

Table 7. United States cod landings, Subarea 5 (metric tons, round weight).

Year	Subarea 5 landings	Div. 5Y landings	Div. 5Zw landings	Div. 5Ze	
				Landings	Landings/ day fished
1965	15,011	3,780	215	11,016	0.9
1966	15,343	4,008	345	10,990	1.1
1967	18,057	5,527	684	11,846	1.0
1968	21,045	6,360	836	13,849	1.4
1969	24,175	7,823	1,143	15,209	1.7
1970	21,917	7,504	1,060	13,353	2.1

III. Silver hake

Total US landings of silver hake from Subarea 5 in 1970 decreased 1,000 tons from 1969 (Table 8). Food fish landings from the Gulf of Maine (Div. 5Y) again decreased while landings from Georges Bank (Div. 5Ze) increased. Landings from Div. 5Zw, which are predominantly for industrial use, declined slightly from 1969.

Abundance is still low in the Gulf of Maine due to poor recruitment and on Georges Bank because of heavy fishing and below average recruitment. Abundance for Div. 5Zw, as obtained from survey cruises, has shown a slight downward trend since 1968 and catches are not expected to improve in 1971.

Table 8. United States silver hake statistics, Subarea 5 (metric tons, round weight).

Year	Subarea 5 landings	Food Fish			Industrial Fish	
		Div. 5Y landings	Div. 5Ze landings	Landings/ day	Div. 5Zw landings	Landings/ day
1965	41,809	22,605	11,169	11.3	8,035	4.4
1966	40,771	21,323	16,222	12.7	3,226	1.4
1967	30,986	14,390	12,692	9.3	3,904	3.4
1968	35,919	24,706	6,451	14.0	4,762	4.0
1969	20,333	14,609	1,654	4.9	4,070	4.6
1970	19,332	11,374	4,238	3.7	3,720	2.2

IV. Redfish

United States landings of redfish from Subarea 5 in 1970 increased 3,000 tons over 1969 (Table 9). Effort continued an increase which began in 1969. Although landings per day declined from 1969, abundance is considered relatively high and prospects of good catches in 1971 are bright.

Table 9. United States redfish statistics, Subarea 5 (metric tons, round weight).

Year	Total Subarea 5 Landings	Div. 5Y (Gulf of Maine)		
		Landings	Days Fished	Landings/Day Fished
1965	6,986	5,045	742	6.8
1966	7,204	4,719	429	11.0
1967	10,442	6,746	649	10.4
1968	6,576	4,060	292	13.9
1969	12,038	9,637	824	11.7
1970	15,530	13,547	1,473	9.2

V. Yellowtail flounder

Total US yellowtail flounder landings for food increased about 1,000 tons in 1970 over 1969 landings (Table 10), because of increased effort, particularly in Div. 5Zw. Yellowtail landings for industrial purposes declined in 1970.

Commercial landings per day continued to decline and age composition data indicate that the fishery has become dependent on fewer year-classes than formerly. Groundfish survey indices substantiate a decrease in abundance in Subarea 5 (Table 11). For 1971, abundance will probably be lower especially in Div. 5Zw.

A quota of 29,000 tons on catch of yellowtail has been set by the Commission (16,000 for Div. 5Ze and 13,000 for Div. 5Zw) for 1971.

Table 10. United States yellowtial flounder statistics, Subarea 5 (metric tons, round weight).

Statistic	1965	1966	1967	1968	1969	1970
Food landings	36,218	28,656	20,819	28,645	28,739	29,445
Landings/day fished	3.1	2.0	2.2	3.0	2.7	2.5
Estimated discard	12,893	8,253	14,407	10,627	5,202	10,129
Industrial landings	972	2,364	4,587	3,939	4,265	2,095
Total catch	50,083	39,273	39,813	43,211	38,206	41,669

Table 11. *Albatross IV* autumn relative abundance index for yellowtail flounder.

Year	Div. 5Ze		Div. 5Zw	
	Nos.	Wt.	Nos.	Wt.
1965	15.0	15.7	38.7	28.0
1966	14.8	6.7	50.2	20.8
1967	18.6	13.0	57.7	31.0
1968	25.6	18.1	40.2	22.1
1969	23.1	15.9	54.7	31.7
1970	12.2	8.3	39.2	23.9

VI. Red hake

Red hake landings by the United States from Subarea 5 in 1970 were 4,281 tons, about the same as in 1969 (Table 12). The commercial catch-per-day was lower in 1970 than in 1969. Research vessel surveys in Div. 5Zw indicated a marked decrease in abundance in 1966 and recovery to date has been slow. Continued low abundance through 1971 is indicated.

Table 12. United States red hake statistics, Subarea 5 (metric tons, live weight).

Year	Subarea 5 landings	Food Fish		Industrial Fish	
		Div. 5Y landings	Div. 5Ze landings	Div. 5Zw landings	Landings/ day
1965	13,493	192	385	12,916	9.1
1966	4,280	634	845	2,801	2.3
1967	5,759	92	169	5,498	5.6
1968	6,216	82	161	5,973	7.0
1969	4,923	140	225	4,558	8.2
1970	4,281	249	100	3,698	6.3

VII. Industrial Groundfish Fishery

New England industrial groundfish landings from Subarea 5 declined for the third straight year (Table 13). The decline was attributable to market conditions and somewhat lower abundance for the hakes and yellowtail flounder. Species composition in commercial catches showed silver hake and flounders losing and eel pout gaining in importance.

Table 13. New England groundfish landings from Subarea 5 for industrial purposes (metric tons, round weight).

Year	Total Landings	Species Composition (%)				
		Silver hake	Red hake	Flounder	Eel pout	Other
1965	33,990	20.4	38.0	6.9	1.8	32.9
1966	27,461	9.6	10.2	18.2	25.0	37.0
1967	37,400	10.2	14.7	18.5	18.9	37.7
1968	34,729	9.9	17.2	16.5	24.2	32.2
1969	26,813	9.5	17.0	21.3	20.8	31.4
1970	20,696	6.3	17.9	16.7	28.3	30.8

VIII. Sea scallops

United States sea scallop landings from Georges Bank increased slightly in 1970 over 1969 landings (Table 14). Because of relatively low abundance the characteristics of the fishing fleet have changed considerably in the past few years, and the number of US vessels fishing for this species has declined significantly.

Table 14. United States sea scallop statistics, Subarea 5 (metric tons, weight of adductor muscle only).

Year	Landings	Days Fished	Landings/Day Fished	Research Vessel Index
1965	1,509	2,156	0.7	33.5
1966	901	1,001	0.9	48.0
1967	1,309	1,870	0.7	63.0
1968	1,163	1,938	0.6	44.7
1969	1,465	2,930	0.5	-[1]
1970	1,553	2,588	0.6	-[1]

[1] There were no research vessel cruises for scallop abundance estimate in 1969 and 1970.

IX. Herring

The 1970 catch of herring along the Maine coast was 17,000 tons; down from 25,000 tons in 1969 and the lowest catch since 1938. Most of the fish were larger (ages 4-8) than formerly and, reflecting a wider search, 75% were taken by purse seines. Ten years ago, over 99% of the catch was made by weirs and stop-seines.

The offshore fishery for adult herring in the area around Jeffreys Ledge amounted to 12,200 tons in 1970 as compared to 4,100 tons in 1969.

B. Special Research Studies

I. Environmental Studies

The *Albatross IV* made temperature observations on all cruises conducted in the area. Quantitative plankton samples were taken at all trawl stations on the groundfish surveys (spring and autumn).

The United States Coast Guard conducted two extensive surveys (spring and autumn) covering the area from Nova Scotia to Cape Hatteras. Results of these cruises will be published in US Coast Guard Bulletins.

Recording of a number of environmental factors was continued at the National Marine Fisheries Service laboratory at Boothbay Harbor, Maine. The mean sea surface temperature in 1970 was 8.9°C, the same as 1969 and breaking the upward trend that started in 1967.

The Oceanographic Observation Post Program was continued through the cooperation of the Woods Hole Oceanographic Institution and the United States Coast Guard. Oceanographic observations are made continually at 11 lightships and light stations situated off the East Coast of the United States. Analysis of the data is made by the Oceanographic Institution and published by the Coast Guard.

II. Biological Studies

Groundfish surveys. Research vessel surveys of groundfish stocks were conducted in the spring and autumn between Cape Hatteras and Nova Scotia. The autumn survey was conducted jointly with the USSR. In addition to the survey, cooperative studies were conducted with the USSR to compare the results of using different trawls. These US-USSR studies are reported in other documents of this meeting.

Haddock spawning. The progress of haddock spawning in Subarea 5 was again monitored from samples collected by commercial and research vessels. Spawning was essentially complete by late April, about 2 weeks earlier than 1969.

Yellowtail flounder. Length frequencies collected on research vessel cruises since 1963 were analyzed to determine population change in relation to fishing rate and recruitment. For Georges Bank no consistent change was evident over the period. However, for Southern New England waters (west of 69°W), numbers of larger fish have been significantly reduced in recent years, reflecting the heavy fishing pressure. In addition, poor recruitment in 1968-1970 is indicated by the relatively low numbers of age-group I fish appearing in the length group from 15-20 cm in the autumn (Table 15).

Table 15. Relative abundance index of age-group I+ yellowtail flounder from research vessel surveys.

Year	Southern New England Index	Georges Bank Index
1963	16.3	12.7
1964	18.5	2.2
1965	11.7	1.3
1966	34.4	9.9
1967	19.9	7.7
1968	9.0	9.7
1969	7.9	6.0
1970	8.3	4.5

Generalized production models indicate that the maximum sustainable yeild is about 16,000 tons for Southern New England, and about 12,000 tons for Georges Bank. At the 1968 stock level, a fishing mortality rate of 0.8 yields 18,000 tons from Southern New England and 12,000 tons from Georges Bank. Catch quotas should therefore be about 25-30,000 tons. This is discussed in detail in a document of this meeting.

Herring. Studies on the structure of herring populations in the Gulf of Maine and adjacent areas continued, using meristic and biochemical methods. In addition to esterase and lactic dehydrogenase, another enzyme (phosphohexose isomerase) has shown a significant difference of frequencies between stocks of adult herring. Another enzyme (tetrazolium oxidase) was found to be polymorphic in herring and its variation between stocks is being tested.

During the year, samples of adult herring were obtained from Subareas 4 and 5 for comparative studies of year-class contribution, length, and gonadal development. Four-year-old fish (year-class 1966) dominated the samples from Georges Bank and coastal Gulf of Maine, while fish older than 8 years (mostly year-classes 1960 and 1961) were dominant in the samples from Nova Scotia and the Jeffreys Ledge area.

Data on gonadal maturity indicated that the onset of spawning occurred in late August on Georges Bank, coastal Gulf of Maine, and Jeffreys Ledge. Peak spawning was reached in October. Limited samples from Nova Scotia indicated some spawning from June through September and suggested a peak in October.

The study of fecundity of herring from the western North Atlantic is continuing and a study of the seasonal distribution and growth of larval herring from the same area, including data taken from November 1962 through April 1970, has been completed.

Lobster. An extensive tagging program on offshore lobsters was continued. By the end of 1970, 641 returns had been made from the 5,710 released. The distribution of tag returns indicates that deep-water lobsters move into shoal

water in the spring and early summer and back into deep water in the autumn and early winter. Of the 499 returns for which locations of recapture are known, 20% had moved distances less than 10 nautical miles, 60% between 10 and 50 miles, and 20% in excess of 50 miles. Lobsters demonstrating the most extensive migrations were predominantly females. The migratory behavior of these "offshore" lobsters contrasts markedly with that of "inshore" lobsters which are essentially non-migratory.

A study of the effects of exploitation on size composition and sex ratio of the offshore lobster stocks was completed. Differences in size-composition and sex ratio among offshore fishing grounds are hypothesized as due to differences in the rate of exploitation.

Parasitological examinations of over 3,000 lobsters have shown qualitative and quantative differences between offshore and coastal lobsters. Consistent differences in rates of occurrence of certain parasites suggest that the two segments of the lobster resource are relatively isolated from each other except in summertime when offshore adults migrate shoalward, presumably for reproductive purposes, and overlap the range of coastal stocks in several areas south of Cape Cod.

Ichthyoplankton. A successful international attempt was made to observe the extent of demersal patches of herring eggs and watch the behaviour of the hatching larvae on Georges Bank. The USSR research vessel *Alferas* searched the area until she found concentrations of newly hatched larvae and set a buoy. The US research vessel *Albatross IV* homed in on a buoy, confirmed the presence of larvae, and then put over the Canadian research submersible *Pisces*. During the next 5 days, 12 dives were made on the spawn beds. Details of these operations are reported in other documents of this meeting.

Progress is being made in compiling a monthly atlas showing the distribution of the various species of fish eggs and larvae in Subareas 5 and 6 in order to delimit spawning areas and times. About 250 ichthyoplankton samples are routinely collected on the *Albatross IV* groundfish surveys twice a year. These collections are being filled in from the literature and unpublished records of other organizations.

Food habits. Studies on the food habits of 14 important species of fish have been expanded in Subareas 4, 5, and 6. Preliminary results show that fish make up 88% of the diet of silver hake while spotted hake ate 52% crustaceans and only 37% fish.

Studies of the benthic invertebrate fauna which is a major source of food for the groundfish continues. The biomass and numbers of 45 major taxa are being related to depth, sediment type, temperature, and area. A study of one of the major components, the mysids, was completed.

Automated age reading. The development of an automated computer based scale reading system was continued. Scales have been successfully scanned by a high resolution optical system with a digitized output. These signals are then processed to count circuli and measure inter-circuli distances.

III. Gear and Selectivity Studies

Standardized fishing effort. Development of an analysis of variance model to obtain estimates of standardized fishing effort proceeded in 1970 to testing vessel size, depth and vessel-depth interaction effects for the New England haddock fleet. The main effects are highly significant and vary from season to season. Interaction was significant in several sets of data and testing of residuals from the fitted model is being done to examine the consistency of interactions and proportions of the variance which is accounted for by the model. Preliminary estimates of landings per standard day fished were found to be comparable to the "study fleet" index which has been used for many years.

Fishnet Bathykymograph. Tests of the accuracy and reliability of the FBK, which produces a record of the duration and depth of each otter trawl haul have continued on 23 prototype units. All malfunctions have been minor and easily corrected. We expect that a mass production unit suitable for large scale use will be available soon.

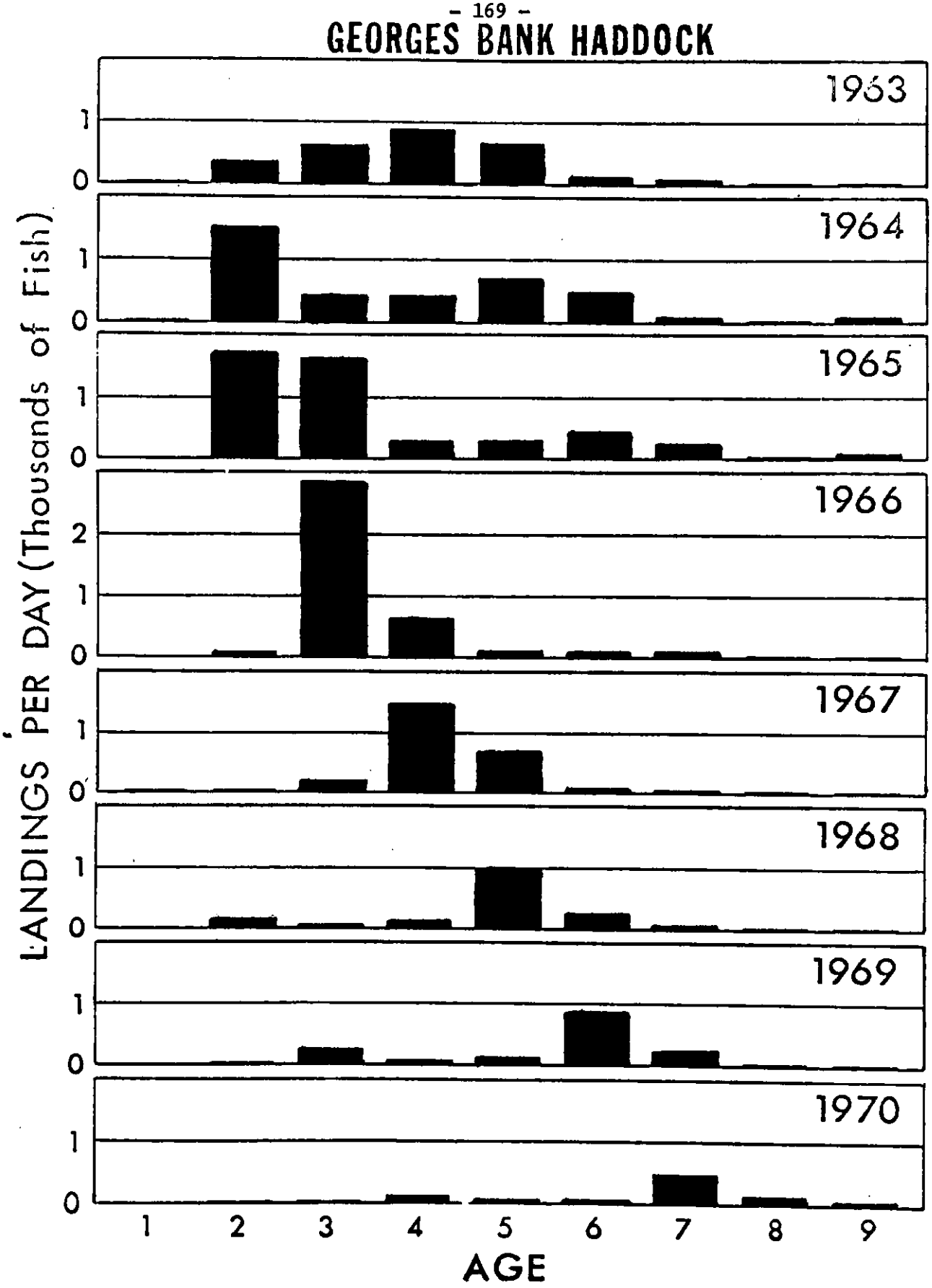

Fig. 1. Age composition of Georges Bank haddock. (Note: 1970 uses first 6 months only.)