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FOR THE

NORTHWEST ATLANTIC FISHERIES

REDBOOK 1972, PART II

RESEARCH REPORTS
BY
MEMBER COUNTRIES

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NOTE

REDBOOK 1972 is in three parts: PART I contains Proceedings of the Standing Committee on Research and Statistics; PART II (this volume) contains Research Reports by Member Countries for the year 1971; and PART III contains Selected Papers from the 1972 Annual Meeting.

This volume was produced in the Secretariat largely through the efforts of Mrs E. R. Cornford who did the typing and to Messrs G. Moulton and R. Myers who did the multigraphing.

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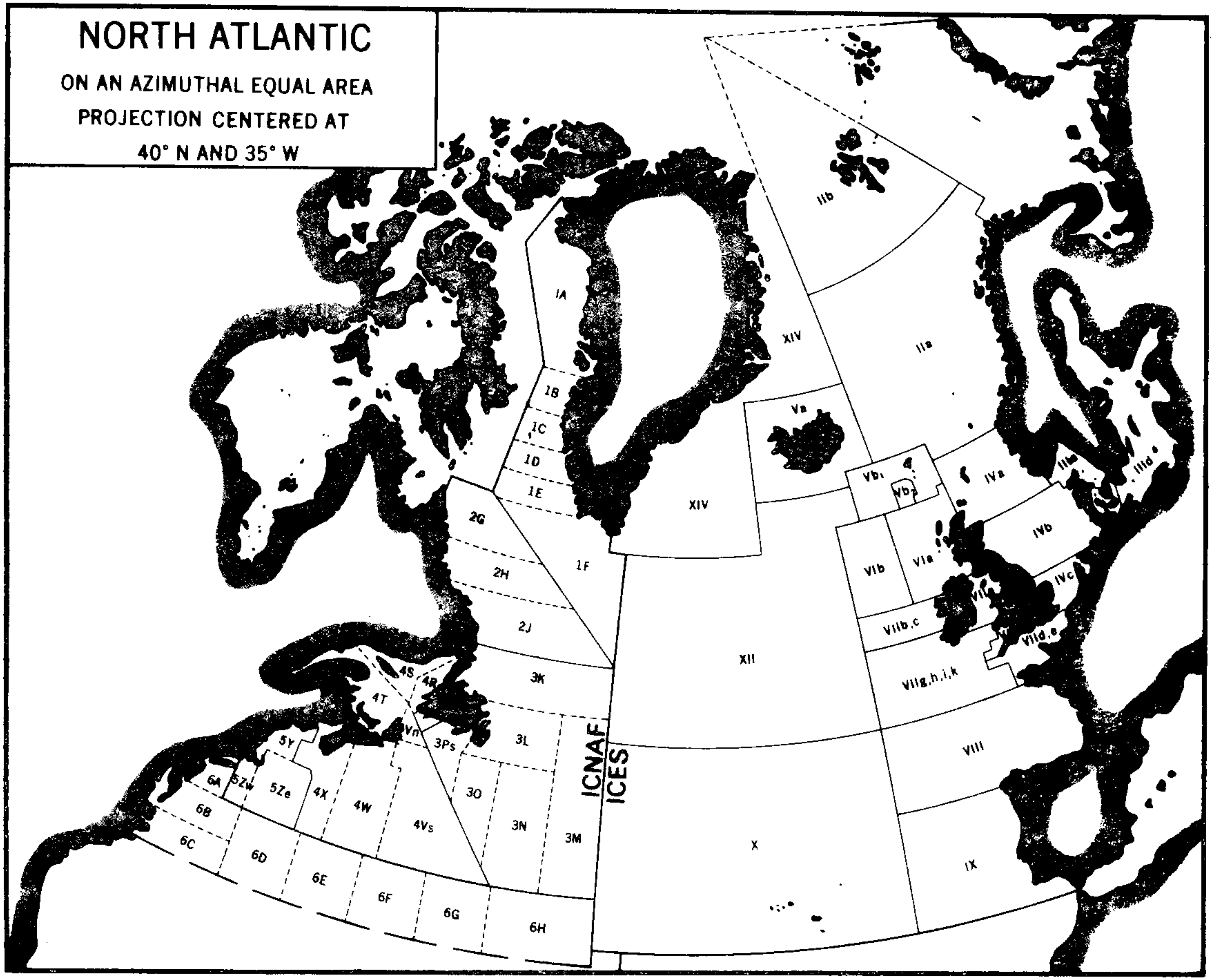
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CANADIAN RESEARCH REPORT, 1971

SECTION I. SUBAREAS 1, 2 and 3

by

W. Templeman and A. M. Fleming

The St. John's Biological Station of the Fisheries Research Board of Canada carried out fisheries and hydrographic researches, the Atlantic Oceanographic Laboratory of the Bedford Institute at Dartmouth engaged in charting in Subareas 1, 2 and 3, and the Arctic Biological Station (Ste. Anne de Bellevue) carried out researches on harp and hooded seals in Subareas 2 and 3 (see Section III).

Data on Canadian landings from the ICNAF Area were not available when this report was prepared and any landings data are preliminary, usually for Newfoundland only and often not available by divisions.

Subarea 1

A. STATUS OF THE FISHERIES

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

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. Offshore bathymetry was done for the general bathymetric chart of the ocean (gebco) program and in support of the geophysical studies.

2. Biological Studies

a) Atlantic Salmon, *Salmo salar* L. Researches were continued off West Greenland during an autumn cruise of the *A. T. Cameron* to this area. One hundred and twenty-one salmon were tagged from driftnets off West Greenland in September. The tagging of 385 salmon from driftnets off West Greenland in September-October 1969 produced 30 returns, of which 17 were from Greenland (2 in the year following tagging), 7 from Canadian waters and 6 from Europe. However, the tagging of 147 salmon in the same manner from gillnets off West Greenland in September-October 1970 produced only 3 local returns in the year of tagging and no returns in 1971.

Analysis of scale patterns of Atlantic salmon smolts indicates that there are significant differences between the widths of annual growth zones and numbers of circuli on scales of smolts from rivers of widely different geographic areas. There were, however, large annual variations in the average widths of the annual zones and numbers of circuli in the second river zone of adult salmon taken in West Greenland during 1969 and 1970 and classified as of North American or European origin by using an electrophoretic technique on serum protein patterns. This may be due to annual variations in temperature or in food in the rivers from which the salmon originated or possibly because the proportions of fish originating from both North America and Europe were derived from different river systems in 1969 than in 1970. The average widths of the first ocean zone for North American salmon taken at West Greenland during 1969 and 1970 were similar as also were those of European origin. However, the first ocean zone was significantly larger in salmon of European origin.

Analysis of the scale patterns of adult salmon and grilse recaptured in the Miramichi River system and in Labrador rivers from tagging experiments indicates that there are significant differences between these two areas in the patterns of growth in the second river year. However, the patterns of growth in the first annual sea zone show no significant differences and indicate the possibility that fish from both these geographic areas share similar feeding areas and live under similar hydrographic conditions during their first year of sea life.

The magnitude of variation in these growth patterns in the scale is such that it may be impossible to take a sample of fish from the high seas or the commercial coastal fishery and determine the proportions originating in different areas on the basis of scale patterns alone. However, it may be possible to do so by using meristic or other characters in addition to scale patterns.

Studies to determine whether parasites might be useful to separate stocks of Atlantic salmon caught on the high seas continued in 1971. Emphasis was placed on continued sampling at nine Canadian stations and in West Greenland. Preliminary observations on the data support earlier conclusions that in Greenland the parasitic nematode *Anisakis* sp. is more abundant in salmon of European origin; also, that the tapeworm

Eubothrium crassum is more abundant in salmon of Canadian origin.

Electrophoretic analysis of *Anisakis* larvae from Canadian salmon have continued and the work has been expanded to genetically controlled esterase and acid phosphatase polymorphisms in *Anisakis* larvae from salmon taken in the British Isles. Results indicate genetic heterogeneity among samples of *Anisakis* larvae from different areas of the North Atlantic.

Subarea 2

A. STATUS OF THE FISHERIES

1. Cod, *Gadus morhua* L.

In the Labrador coastal fishery the cod catch remained very low, only 2,700 tons in Subarea 2.

2. Atlantic salmon

Landings of Atlantic salmon increased due to additional effort because of lack of cod.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. The section off Seal Island was occupied on 3-4 August. Refer to the research document on hydrography of the Newfoundland area for details (Res.Doc. 72/31).

Small harbour surveys and chart revisory surveys were undertaken along the Labrador coast from Belle Isle to Nain.

2. Biological Studies

a) Cod. Sampling of the inshore cod fishery was continued, with 3,865 measured and 1,113 pairs of otoliths collected.

Yield-per-recruit calculations for Div. 2J cod indicate that further increases in F will not give a long-term increase in yield-per-recruit and will further reduce the abundance of the stock. The fishing effort in recent years has been about 95% of that necessary to produce the maximum yield-per-recruit. The reduced number of older (mature) fish in the stock has resulted in a virtual extinction of the inshore Labrador fishery which has been traditionally dependent on older mature post-spawning cod.

In a cruise of the *A. T. Cameron*, 25 April-1 May, no large concentration of cod was located on Hamilton Inlet Bank, but fishing was restricted by ice. Bottom water temperatures were generally within the range in which large catches of cod have previously been taken in these areas. Most of the cod taken were less than 40 cm in length. Cod of the 1967 year-class were most numerous in these catches. This year-class of cod should reach a length of about 40 cm in the spring of 1972 and contribute in fair numbers to the fishery.

In Div. 2J, the average length of cod increased by about 6.7 cm per year from ages 2 to 6 years and by about 4.7 cm per year from ages 7 to 11. The total mortality was estimated to be about 0.9 for Div. 2J over ages 6 to 11. Calculations based on catch and effort data for Div. 2J cod indicate the natural mortality (M) to be in the range of 0.15-0.20. The length at which 50% of the males were mature in Div. 2J was about 42 cm and for the females 49 cm. Cod on Hamilton Inlet Bank were feeding heavily on the deep-water shrimp *Gennadas elegans* and on deep sea fish.

b) Atlantic salmon. In May 24 salmon from surface driftnets and 35 from surface longlines were tagged in the Labrador Sea over oceanic depths beyond the continental shelf. Two were recaptured from the fish tagged from driftnets and 6 from those tagged from longline. All returns were from Newfoundland or the Canadian mainland and in the tagging year. One hundred and forty-five salmon were tagged from driftnets in the coastal region of Labrador in July. Because tagging was in the latter part of the salmon fishing period most of the tagged fish were grilse and returns were almost entirely from the Labrador coast.

Subarea 3

A. STATUS OF THE FISHERIES

1. Cod

Total cod landings in Newfoundland, mainly from the coastal fishery in Subarea 3, were about 8% below the 1970 landings of 153,000 tons which in turn were 15% below the 1969 landings of 179,000 tons. The decrease is principally the result of generally low catches in the coastal fisheries. About 50% of the coastal catch of cod comes from traps in shallow water; in each of 3 monitoring localities the average catch per haul was less than half the 1970 level. There was also a marked decrease in the average catch by bottom gillnet in many areas.

On the northeast coast of Newfoundland the trend continued for larger coastal boats to fish by bottom gillnets in water of 180 m and deeper, further seaward and for a greater variety of fish - cod, plaice, witch, Greenland halibut, wolffish and redfish. Whereas formerly by far the greatest landings for these large meshed gillnets consisted of cod, the scarcity of large cod now makes the total weight of other species from these nets usually far greater than that of cod.

The traps catch the youngest recruits to the commercial cod fishery. In 1971 the 1966 to 1968 year-classes dominated, contributing 70-90% of the numbers caught. The deep water gillnets in the east coast area catch a larger proportion of older fish, over 40% were more than 10 years old in 1971, and the 1955, 1961, and 1966 year-classes were still quite strong. In areas off St. John's and in St. Mary's Bay, where the gillnet fishery is in shallower water, the 1963 to 1965 year-classes made up 65-70% of the numbers caught, and there were relatively few fish over 10 years old.

In research vessel otter-trawl catches with lined codend on the northern part of the Grand Bank (Div. 3L) in June and October 1971, the 1968 year-class formed 45-50% of the numbers. There were relatively few cod older than 6 years.

The inshore cod fishery in Subdiv. 3Ps has been somewhat more productive in the past few years than in the middle 1960's and this is probably becuase of poorer recruitment of the 1956-60 year-classes and better recruitment of the 1961-67 year-classes as indicated by analysis of research vessel survey data. Catch per unit effort by trap in this Subdivision decreased from a high level of 2,300-2,700 kg per haul in 1958-60 to a low level of less than 900 kg in 1964-66 but then increased to 1,400-1,800 kg in 1967-70, except for 1969 when the catch per haul was 900 kg. Similarly the average catch per line for linetrawl decreased from 16 kg in 1957-60 to 7-9 kg in 1962-66 and then increased to 18 kg per line in 1967-70. The multifilament and, more recently, the monofilament bottom gillnet fishery since its inception in 1962 has maintained itself at a level of 50-59 kg per net except for 1964-65 when the catch was 36-41 kg per net.

2. Haddock, *Melanogrammus aeglefinus* L.

Newfoundland haddock landings, probably mainly from Subdiv. 3Ps, were 22% below the 1970 landings of 2,075 tons.

3. Redfish, *Sebastes mentella* Travin and *Sebastes marinus* L.

Newfoundland redfish landings from Subareas 4 and 3, mainly from Div. 4R and almost entirely *Sebastes mentella*, decreased 35% from the 1970 landings of 42,000 tons.

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

Newfoundland landings of flounders, almost all from Subarea 3, fell by 7% from the 1970 landings of 92,000 tons. Newfoundland landings of Greenland halibut decreased 13% from the 1970 landings of 11,000 tons.

5. Herring, *Clupea harengus* L.

Herring landings in Newfoundland, mainly from the southern Gulf of St. Lawrence spawning stock occupying the western part of Div. 3P in winter-spring, fell 13% from the 1970 landings of 158,000 tons.

Prior to the 1970-71 season the herring landings of the mobile fleet were utilized almost entirely for reduction into meal and oil. However, during the 1970-71 season the high prices offered for food herring resulted in 20% of the catch being diverted to the food processing plants. This trend is expected to continue during the 1971-72 season. Population estimates from tag returns indicate that the stock size of the southwest Newfoundland herring population in the 1970-71 season was only 60% of that present in the area during the 1969-70 season. Unless recruitment is more substantial than is indicated by our age and length composition data a further decline in landings can be expected for the 1971-72 season.

6. Atlantic salmon

Newfoundland commercial landings of Atlantic salmon fell slightly from 1,595 tons in 1970 to 1,576 tons in 1971 (The Newfoundland salmon landings of 1,770 tons reported in the preliminary ICNAF statistics for 1970 were in error.)

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

Squid, which had been very scarce in the Newfoundland coastal fishery for several years, showed a modest increase in landings to about 1,600 tons, almost all from Subarea 3.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. The five standard sections across the continental shelf and Labrador Current east of Newfoundland were occupied by the Fisheries Protection vessel, *Cape Freels*, at the usual times in July-August. The year-round monitoring Station 27 off Cape Spear was occupied monthly or oftener during the year. The results of these hydrographic observations are presented in a separate document (Res.Doc. 72/31).

Offshore navigational and natural resource charting continued in the Flemish Cape-Virgin Rocks areas. Coastal charting continued in the Fogo Island area.

2. Biological Studies

a) 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. Virtual population assessments of cod were carried out for Div. 3K and 3L and Subdiv. 3Ps.

For Div. 3K, estimates of average fishing mortality (F) in fully recruited age-groups ranged between 0.24 and 0.40 in 1961-66, except for 1964 for which the estimate was 0.63. Very few 3-year-old fish were caught and fish were fully recruited at 7 years of age, the 50% recruitment age being about 5 years. Yield per recruit calculations incorporating partial recruitment indicated that in the 1961-66 period the fishing mortality was within 95-100% of that necessary to generate the maximum sustainable yield per recruit at about $F = 0.4$. Only in 1964 did the level exceed the maximum. Extrapolation based on the correlation between catch and F indicated that for the years 1967-70 only the 1968 level was beyond the maximum and even at this level the yield per recruit was still within 98% of maximum.

For Div. 3L, estimates of F ranged between 0.19 and 0.39 during 1955-63 but increased to 0.67 and 0.63 in 1964 and 1965 coincident with an increase in landings in these years. F in 1966 was again low (0.36) although landings were still high. Very few 3-year-olds are caught but cod are fully recruited at 7 years of age, the 50% recruitment age being slightly less than 5 years. Yield per recruit calculations indicate that in the period 1959-66 the level of F was at or beyond that necessary to generate the maximum sustainable yield per recruit at about $F = 0.3$. Extrapolation based on the correlation between catch and F indicated that for the years 1967-70, the level of F was beyond that necessary to generate the maximum.

It should be pointed out that in both of these divisions, the growth curve used was for the period 1960-62 and is therefore outdated. Some increase in growth has apparently taken place since then and will undoubtedly affect the yield curve somewhat, but it is felt that the general conclusions will not be altered.

Virtual population analyses on cod in Subdiv. 3Ps indicated that fishing mortality estimates (F) for ages 3-11 fluctuated only moderately between 0.3 and 0.4 during 1959-68 except for 1966 when the estimate of F was unusually high (0.55) especially for cod older than 6 years. There is some reason to doubt the validity of the estimates for this year, however, since neither catch nor effort increased proportionately. The cod in this area are fully recruited at age 7 with very few 3-year-olds being taken, the 50% recruitment age being approximately 4.5 years. The total stock size of cod 3 years old and older decreased from about 200 million fish in 1959 to a low of 100 million fish in 1964 and then increased to 175 million in 1968. This resulted from lower recruitment from the 1956-60 year-classes and higher recruitment from the 1961-65 year-classes. The numbers of age 6+ fish have declined fairly steadily from 34 million in 1959 to 14 million in 1967 and 17 million in 1968. Yield per recruit calculations indicated the point of maximum sustained yield to be at an F-level of 0.3. The level of F for fully recruited age-groups prevailing in the 1960's was between 0.3 and 0.55 and thus was beyond this maximum level, being in the range of 90-100% of it. Further increases in fishing effort on this stock therefore will not result in long-term increases in yield, may result in long-term decreases in catch per unit effort and, depending on the stock-recruitment relationship, in stock size. In fact, some reduction in fishing effort would probably not impair the yield and may result in improved catch per unit effort.

During two *A. T. Cameron* cruises to Div. 3N and 3O during February-March and early June 1971, 65-70% of the cod catches were composed of the 1968 year-class confirming previous estimates of the relative strength of this year-class. Average catch per 30-minute haul in the February-March cruise was 337 kg while in June the average was 27 kg. Five sets during a fall cruise near 44°N in 45-185 m produced only 45 cod. If the 1968 year-class had been fished as heavily in 1971 at 3 years of age as the very abundant 1964 year-class was in 1967, then its major contribution to the catches will be limited to not more than two years.

b) Haddock. *A. T. Cameron* cruises to Div. 3N and 3O in the early spring of 1971 failed to produce any significant quantities of adult or pre-recruit haddock, indicating once again that the adult stock is at an extremely low level and that year-classes up to 1970 have been poor. During the 1971 inshore fishing season, reports were again received of significant quantities of haddock being caught along the south and east coasts of Newfoundland and samples of these were obtained.

c) American plaice. An assessment of American plaice from the Grand Bank (Div. 3L and 3N) was completed using the virtual population method. This method permits the calculation of fishing mortality (F) for each age of the various year-classes independent of effort data. For Div. 3L data from 1955 to 1970 were available, and for Div. 3N the 1956-70 period was used. Natural mortality (M) was estimated at 0.25 for males and 0.20 for females. For fully exploited age-groups, fishing mortality (F) increased in Div. 3L from 0.15 for males and 0.14 for females in 1955 to 0.60 for males and 0.48 for females in 1967, and in Div. 3N from 0.12 for males and 0.10 for females in 1956 to 0.58 for males and 0.60 for females in 1968.

Yield curves, calculated for various values of F of fully recruited plaice, indicated that in 1968 the stock in Div. 3L was being exploited at a level equivalent to 82-86% of the apparent maximum sustainable yield. The effort in 1968 was 63,200 hours producing 570 kg per hour. In 1969 the effort was 92,700 hours giving a projected value of F that would raise the yield level to about 90% of the maximum. The catch per hour was 520 kg. In 1970 at about the same level of exploitation the catch per hour decreased to 450 kg. It is suggested for the type of yield curves produced, which apparently would reach a maximum beyond the 2.0 fishing level, that 80% of the maximum yield, *i.e.* F = 0.50, is perhaps an appropriate level of exploitation. This would apparently produce between 32,000 and 36,000 tons.

For Div. 3N the 1968 estimate of F was about 0.60 which is about 90% of the maximum yield. The effort in 1968 was 37,700 hours and the catch per hour 570 kg. In 1969 and 1970 the effort was 33,600 and 59,000 hours respectively producing catches of 460 and 340 kg per hour. Extrapolating the probable F for the 1970 fishing effort gives an F value between 0.65 and 0.80 or 92-95% of the maximum yield. If 80% of the maximum yield is an acceptable level of exploitation, then a fishing mortality of 0.40, which was close to 1965 level, should be recommended. In 1965 about 23,000 tons were landed from this division. However, Div. 3N is a relatively small area and apparently does not have a large reserve of pre-recruit plaice as in Div. 3L, although they grow faster than in Div. 3L. There is also the strong possibility that Div. 3N is, in part at least, stocked by larval drift from the north and we have no knowledge of how a reduction in stock size in Div. 3L will affect this. It is therefore suggested that landings in Div. 3N probably should not exceed 18,000 tons.

Two groundfish surveys were carried out on the Grand Bank with the *A. T. Cameron* using the stratified random method of fishing station selection, one in June and the second in October 1971. The June cruise, which was a 24-hour fishing operation, surveyed a major portion of the Grand Bank with a total of 86 successful 30-minute tows. Several relatively good catches of plaice were recorded in Div. 3L, ranging from 320 to 640 kg, mostly from the north and northwestern slopes of the bank. Plaice were generally scarce south of 45°N on the east and southeast slopes with catches all less than 230 kg.

The October cruise surveyed some of the deeper strata on the north and northeast parts of the bank that were omitted from the June cruise and in addition repeated some strata sampled earlier in order to compare spring and autumn distribution. Catches of plaice up to 900 kg for a 30-minute set were recorded but average catches of plaice per set were in the 180-270 kg range.

d) Yellowtail flounder. Landings of yellowtail flounder from the Grand Bank increased rapidly from less than 900 tons annually prior to 1965 to a total of about 26,700 tons in 1970.

The age composition of commercial landings and research catches indicate a succession of year-classes of approximately equal strength. The fishery appears to be dependent primarily on 6-, 7- and 8-year-olds; however, the 1970 landings from Div. 3L were dominated by 6- and 7-year-olds.

Total mortality estimates (Z) for Div. 3N from research vessel catch curves for 1951-52 were 0.89 (59%) for males and 0.62 (46%) for females and 0.77 (54%) for males and females combined. These were from samples taken before the large commercial fishery began. Catch curves (research) for 1970 gave estimates of Z as follows: for males 1.82 (83%) and for females 1.27 (72%) or a combined estimate of 1.57 (79%). For commercial catch curves total mortality estimates increased from 0.83 (56%) in 1965 to 1.25 (71%) in 1969. The high total mortality estimates for the pre-exploited period would seem to suggest a high natural mortality rate. However, during this period small yellowtail were probably caught and discarded by the commercial fleet and the larger ones included as American plaice. In addition, if the yellowtail stocks are increasing in abundance, which appears to be the case, total mortality estimates from catch curves are probably too high. With data available from 1971 it might be possible to get estimates of total mortality from catch curves of year-classes and this would eliminate the effects of combining a number of year-classes of unequal strength.

In a groundfish survey cruise of the *A. T. Cameron* to the Grand Bank in June, records of yellowtail catches indicated that this species has spread to most parts of the bank less than 90 m in depth, and 30-minute catches of about 230 kg were obtained at several localities.

e) Greenland halibut. Four hundred and ten Greenland halibut were tagged in Trinity Bay using ½ inch Petersen discs, 28 October-18 November 1971. The fish were caught on longline gear using capelin as bait. A further 7 returns were recovered from the 1969 White Bay tagging bringing the total recoveries to 27 from 249 tagged. Two of the 1971 recoveries were from USSR factory ships fishing on the edge of the continental shelf.

f) Herring. In the 1970-71 season, the southwest Newfoundland fishery was still dependent on pre-1960 year-classes with over 50% by number and much more by weight of the herring sampled being 11 years old or older. Subsequent to the very successful autumn-spawning year-class of 1958 and the successful spring-spawning year-class of 1959, no very successful year-class has entered the fishery. Since the purse-seine fishery began in 1965, the average total length of the herring caught has increased from 31.6 cm in 1965-66 to 33.9 cm in 1970-71.

A total of 708 tags (2.8%) has been recaptured from the 25,000 herring taken by bar seine and tagged with internal metal tags in March 1970 on the southwest Newfoundland coast. The majority of these tags were recovered from the Newfoundland winter fishery but a significant proportion was also recovered from the Magdalen Islands - St. Pauls area and the Chaleur Bay - Gaspé region of the southern Gulf of St. Lawrence. Complementary taggings in the southern Gulf area by the St. Andrews Station have confirmed the return migration to the Newfoundland coast.

In January 1971, 10,000 herring taken by bar seine were tagged with internal metal tags at Bay de Loup on the southwest coast of Newfoundland. Four hundred and five of these were taken in the winter fishery of 1971 on the southwest coast, 6 in 1971 near the Magdalen Islands and 14 in the summer fishery of 1971 in the southern Gulf of St. Lawrence. The results from the Bay de Loup tagging also confirmed the migratory path of herring from the Newfoundland coast to their spawning grounds in the southern Gulf of St. Lawrence.

From 3,400 herring tagged with internal metal tags at Hawke's Bay on the northern part of the west coast of Newfoundland in December 1970, three were taken in the winter-spring fishery of 1971 on the southwest coast of Newfoundland and 2 in the summer of 1971 in the southern Gulf of St. Lawrence. There was apparently a high tagging mortality in these herring, which were obtained from a purse seine and which exhibited a high degree of scale loss.

Tag returns from the March 1970 and January 1971 releases have been adjusted for tagging mortality and recovery efficiencies and stock sizes have been estimated. The stock size of the southwest Newfoundland herring population was estimated at 400,000 tons at the start of the 1969-70 season and about 250,000 tons at the beginning of the 1970-71 season. Over the same period the landings decreased 26% which attests somewhat to the reliability of the population estimates. The monthly exploitation rate was estimated at 4-5%, and, if a similar rate applies for the summer fisheries in the southern Gulf of St. Lawrence, the annual rate for the stock as a whole would be about 40-50%. This is the level at which the Atlanto-Scandian stock began to collapse. Unless recruitment to the exploited stock is considerably more than is evident from present data, herring landings from the southwestern Newfoundland - south Gulf fisheries will continue to decline.

To evaluate further the use of meristic characters as indices for racial separation, the technique of discriminant function analysis was applied to herring meristic data for spring and autumn spawners. From 79 to 91% of individual spring- and autumn-spawning herring were correctly classified to their respective spawning groups by the use of a linear discriminant function based on three meristic characters - pectoral and anal fin rays and gill rakers. The results of the discriminant function analyses confirm that the spring- and autumn-spawning components of the southwest Newfoundland - southern Gulf of St. Lawrence herring stock complex are not members of a homogeneous group but constitute distinct breeding populations which develop at different times of the year under different environmental conditions. This clearly demonstrates that the vast majority of autumn spawners are the progeny of herring which spawned in the autumn and spring spawners of herring which spawned in the spring. The amount of interchange between the two spawning groups is probably slight.

In the Newfoundland area there are geographic trends in the mean numbers of gill rakers and anal fin rays which appear to be correlated with water temperature during early development. Spring-spawning herring from the generally cold waters of eastern Newfoundland have higher gill-raker averages than spring spawners from southeastern Newfoundland where water temperatures are somewhat intermediate. The lowest gill-raker averages occur along southwest Newfoundland and in the southern Gulf of St. Lawrence, with warmer water in the upper layers. The mean number of anal fin rays is also higher for eastern Newfoundland spring spawners than for spring spawners from southern Newfoundland and the Magdalen Islands. Hawke's Bay (on the northern part of the west coast of Newfoundland) spring spawners are somewhat anomalous in that they are similar in mean number of gill rakers to southeastern Newfoundland spring spawners but are similar to eastern Newfoundland spring spawners in the mean number of anal fin rays. No such geographic trends are evident among autumn spawners. It is possible that temperature conditions on the spawning grounds and in the larval nursery areas are more uniform throughout the Newfoundland area during the autumn than during the spring or early summer.

g) Atlantic salmon. The program of sampling salmon from commercial catches to provide quantitative data on the sizes and ages was continued in 1971. A total of 2,962 salmon was sampled for length, weight, scales and, where possible, for sex from the commercial fisheries at Port-aux-Basques, Bonavista, the eastern portion of the Great Northern Peninsula including St. Anthony, various fishing communities along the southern Labrador coast and near St. John's. Samples of viscera and blood were also obtained from representative samples of the fish.

Analysis of the smolt ages of salmon and grilse sampled during 1969-70 shows that most of the fish caught along the Labrador coast had spent 4 to 5 years in the river and indicate that it is highly probable that they were of Labrador or northern Newfoundland origin. Fish sampled from St. Anthony and the eastern part of the Great Northern Peninsula had lower smolt ages (averages 3.56-4.07) than those of Labrador (averages 4.25-4.59) but were in many cases significantly higher than those of Bonavista (averages 2.80-2.99), Port-aux-Basques and Rose Blanche (averages 3.16-3.24), and Miramichi Bay (average 2.88).

Analysis of the salmon length data from fish sampled during June 1971 at Bonavista confirms that the ratio of grilse to older salmon changes significantly as the season progresses. The percentage of fish less than 62 cm (fork length) increased from 17.5% during 8-11 June to 46.4% during 15-19 June and to 54.9% during 21-22 June.

h) Pink salmon, *Oncorhynchus gorbuscha* (Walbaum). Research on the pink salmon transplant at North Harbour River, in St. Mary's Bay on the eastern part of the south coast of Newfoundland, continued in 1971. A Wolf fry trap was operated at the mouth of the egg channel from 6 April to 17 May. A counting fence with the trap set for downstream migrating fish was installed in fishing order on 3 May, approximately 100 feet above the head of tide. The trap was reversed for upstream migration on 10 June and remained in good fishing order until 12 October when the nets were removed.

To determine the time of hatching and survival rate of pink salmon fry from the 1970 spawning, 12 perforated plastic boxes containing 25 eggs each were distributed in the spawning areas on 15 September 1970. A sample was examined weekly until hatching and monthly thereafter. The eggs had all eyed by 15 October and hatching occurred during the period 13-19 November. This was three weeks earlier than for the previous year and the earliest record for North Harbour River.

The fry run at the mouth of the spawning channel, 4.3 km from the river mouth, began 12 April and ended 2 May with the peak on 24 April. The fry run at the mouth of the river (fyke trap sampling), began 14 April and ended 5 May with the peak on 27 April.

To obtain an estimate of the total number of fry migrating to sea, small fyke traps were fished just above the head of tide from 5 April to 17 May. The total number of fry was estimated by the mark and recapture method. The percentage survival of pink fry for 1969, 1970 and 1971 is as follows:

	1969	1970	1971
Egg samples (actual count)	80.4	77.0	78.5
Spawning channel (actual count)	77.8	75.2	76.4
River (mark-recapture estimate)	75.8	71.7	70.0

The estimated total fry run from the spawning channel was 126,795 from an estimated 161,600 eggs deposited by 101 females in 1970. To determine the extent of predation on fry during their migration to sea, a nylon gillnet was fished near the head of tide at various times during the run. Only 8 brook trout, 2 brown trout and 147 smelt were caught. None of these had any fry in their stomachs. The fry run ended before the trout migration began.

The adult pink salmon run to the river began 17 July and ended 28 September. The total was 468 fish (235 male, 233 female), of which 296 were counted at the fence, 141 were seined below the fence and 31 spawned below the fence. All fish seined below the fence and some that passed through the fence were placed in the channel, both ends of which were screened to prevent escape. The total placed in channel was 330 fish (162 male, 168 female).

Water temperature at the fence during the run ranged from 8.5°C to 24.5°C and water heights from 0.3 to 0.9 m. Every tenth salmon of each sex passing through the fence was measured, weighed and a scale sample taken.

Except for a few late running fish, spawning occurred between 10 and 25 September with the greatest concentration 15-18 September. Although only 138 fish (73 male, 65 female) spawned in the main river, spawning was distributed over 5½ km of river. At the completion of spawning 231 redds were counted, 65 in the main river and 166 in the channel.

The total number of adult returns to date is 622 as follows: 468 in North Harbour River, 117 in the commercial fishery, 36 in four other rivers and 1 in the sport fishery in salt water. Of the total reported returns, 95.8% had entered St. Mary's Bay.

i) Short-finned squid. The *E. E. Prince* conducted a squid survey on the shelf off southern Newfoundland and Nova Scotia, 12-22 July 1971. Fifty-eight otter-trawl sets were made at locations fished in the 1970 surveys. Squid were taken in all areas except the southern tip of the Grand Bank. Largest catches were made in the Halibut Channel (860 and 133 specimens in 135 and 275 m respectively), on Banquereau (186 specimens in 180 m) and south of Sable Island (268 specimens in 180 m). Total catch for the cruise was 2,100 specimens, up considerably from the 1970 surveys. Standard biological sampling was conducted and specimens collected for electrophoretic study.

Squid were first reported inshore at North Harbour, Placentia Bay on 17 June, the earliest inshore appearance on record. First east coast records were strandings on 24 June at Ferryland and first commercial landings were made there on about 28 June. In spite of the encouraging start, total landings for the year were only 1,600 tons, up considerably from 75 tons in 1970, but still far below average. The jigging ground at Holyrood in Conception Bay accounted for 20% of the Newfoundland landings; catches at Holyrood were greatest in July and August, no squid being landed 12 September-11 October after which low landings continued to 10 November.

The surface temperature at Holyrood was 7.0-7.4°C on 5 July at the time of first landings. The time of absence of squid from the grounds coincided with the highest temperature conditions, about 10-12°C. On 12 October, when the squid returned, surface temperatures were 7.6-9.5°C, and their departure coincided with the first drop of temperature below 5°C.

Size distribution, growth, maturity and parasites were monitored throughout the season at Holyrood, and several samples were obtained from other areas for comparison.

Tagging was accomplished with a small metal clip tag fastened to the tail fin, the technique being similar to that employed in Japanese research on a closely related species. A return of 18.7% was obtained from a tagging of 402 squid at Holyrood. Although the experiment was publicized by radio and through distribution of posters, all returns were from Holyrood. Nearly all recaptures were made within two days of tagging but a few were reported captured up to 86 days after release.

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SECTION II. SUBAREAS 4 and 5

by

J. S. Scott

Canadian researches in Subareas 4 and 5 on oceanography and fish stocks were carried out by the Fisheries Research Board of Canada from the following institutions: St. Andrews Biological Station, Marine Ecology Laboratory (Dartmouth), St. John's Biological Station, Arctic Biological Station (Ste. Anne de Bellevue). The Bedford Institute of Oceanography and Quebec Ministry of Industry and Commerce also contributed. Data for preliminary surveys of 1971 landings were obtained from the Fisheries Service of the Canadian Department of the Environment. This report was prepared from submissions by many scientists engaged in research into problems of ICNAF interest. Harp and hooded seals for Subareas 2, 3 and 4 combined are dealt with in Section III.

Subarea 4

A. STATUS OF THE FISHERIES

1. Groundfish General

Total groundfish landings (Maritimes and Quebec) in Subarea 4 increased by approximately 4% from 1970 to about 296,000 tons. This was mainly due to a 30% increase in redfish landings. However, if the effect of the 1970 fishworkers' strike is taken into account (an estimated loss of 32,000 tons in 1970), there was an effective 4% decrease in production.

2. Cod

Cod landings were down by 5% from 1970 and also formed a smaller proportion of total groundfish landings, from 40% in 1970 to 35% in 1971. Landings from Gulf of St. Lawrence and Cape Breton (Div. 4R, 4S, 4T, 4Vn) dropped almost 10%, a reversal of the trend since 1967. Landings from the remainder of Subarea 4 (Div. 4Vs, 4W, 4X) recovered partly from the 1970 low level, but were still 10% below 1969 landings. This is probably due to a combination of closure of part of Div. 4X in March and April, and low availability of cod.

3. Haddock

Total haddock landings were up by 12% from 1970 but were still more than 30% below 1969 level. The major improvement was a 75% increase from Div. 4W, but Div. 4X and 4Vs also showed slight gains. Landings from the Gulf of St. Lawrence (Div. 4R, 4S, 4T) and Cape Breton (Div. 4Vn) declined to the lowest levels since 1967. reversing the general trend of the past five years, although the decrease is insignificant in relation to total landings from Subarea 4.

4. Flatfish

Total landings (plaice, witch, yellowtail, winter flounder) again showed a decrease from the previous years. The 8% decrease was due mainly to a 25% drop in landings from Gulf of St. Lawrence (Div. 4R, 4S, 4T) which more than offset 50% gains in Div. 4Vs and 4W. The fall in landings from 1970 level is even more serious than overall figures indicate, as it does not take into account the effect of the 1970 fishworkers' strike. Atlantic halibut landings were about the same as in 1970.

5. Redfish

Landings rose by almost 30% over 1970 level, reflecting a general increase in effort for redfish. Gulf of St. Lawrence (Div. 4R, 4S, 4T) and Cape Breton (Div. 4Vn) landings increased almost 13%, while landings from each of Div. 4Vs, 4W and 4X also rose, particularly in Div. 4Vs where there was a fivefold increase.

6. Pollock

Pollock landings increased by 10% over 1970.

7. Other groundfish

Landings increased by 30% from 1970 level to form about 13% of total groundfish. The increase was due mainly to improved hake landings (up 70%) but landings of cusk, wolffish, and unspecified or mixed groundfish also went up.

8. Sea scallop, *Placopecten magellanicus*

Total landings were almost 8,700 tons whole weight (1,050 tons of meat), a decrease of about 40% from 1970. Landings decreased in all divisions. In 1971 Div. 4T, 4V-W and 4X yielded 6,445, 238 and 1,999 tons respectively.

9. Herring

Herring landings from Subarea 4 (excluding Div. 4R) were approximately 280,000 tons, a decrease of about 38,000 tons (12%) from 1970. Div. 4X landings decreased from 132,000 to 94,000 tons and Div. 4T from 169,000 to 134,000 tons. Div. 4W landings increased from 17,000 to 47,000 tons and Div. 4V about 200 tons to over 5,000 tons. Total landings are expected to decline further in 1972.

10. Swordfish

The swordfish fishery ceased abruptly in January, with the discovery of unacceptable levels of mercury, and there is no immediate prospect for its re-activation.

11. Mackerel

Preliminary estimates of mackerel landings in Subarea 4 were 13,200 tons, a decrease of 1,500 tons (10%) from 1970. Landings in Div. 4X, 4V, and 4T were slightly lower but small increases were recorded for Div. 4W. Landings will probably increase in 1972 with some diversion of effort from herring.

12. Tuna

Total landings of tuna were unchanged from 1970 at 3,900 tons. Nearly 2,800 tons were yellowfin, skipjack, and bigeye from eastern Pacific; the remainder, bluefin (900 tons) and skipjack (200 tons) from western Atlantic, about equally divided between Div. 5Z and 6A. Tuna landings are expected to remain at about the same level in 1972.

13. Sharks

Incidental landings of sharks (10 to 100 tons) have been made annually since 1965 but there were none in 1971 due to the closure of the swordfish fishery. No shark landings are expected in 1972.

14. Atlantic salmon

Total catch for Subarea 4, exclusive of Div. 4R which is reported with Subareas 2 and 3, dropped to 342 tons from 651 tons in 1970. Commercial catches in Div. 4S to 4X declined by 49% from 1970, the decrease spread fairly evenly over all divisions. The angling catch (87 tons) was about 56% of the 1970 catch and included 69% grilse as compared to about 60% in 1970.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. Charting was completed for Northumberland Strait and studies continued off coastal Nova Scotia (Div. 4W, 4X). The 1970 wave-climate study of the Canadian Atlantic coast and continental shelf was completed. Results showed wave-energy encountered by month and area in Subareas 4 and 5.

b) Plankton. Data on seasonal distribution and dispersion pattern of larval herring from the Bay of Fundy - Gulf of Maine area (Div. 4X, 5Y, 5Z) for 1967-70 showed no evidence of substantial exchange between the two major spawning areas of Georges Bank and southwest Nova Scotia.

Monitoring of distribution of fish eggs and larvae in southwest Gulf of St. Lawrence (Div. 4T) continued. Studies of larval fish feeding showed good correlation between abundances of small planktonic organisms, particularly cladocerans and copepods, and stomach contents of larval fish.

c) Other environmental studies. A long-term sampling program for petroleum hydrocarbons and other oceanic pollutants, based on quarterly cruises in sea-area Halifax-Bermuda, was started.

Mass mortalities of herring at North Sydney, Nova Scotia, (Div. 4V) in April of 1968 have been attributed to an intermediate oil from coke production. Oil concentrations in tissues (μg/g) were: muscle 5.2, intestines 9.2, skin 17.5, indicating oil absorption through body surface. Labratory determinations of time to 50% mortality were 0.25, 0.87, 3.7, and 93 hours for 100, 10, 8, and 6 ppm of oil, respectively.

A detailed analysis of BT profiles at the Canadian Oceanographic Data Centre has been started to determine temporal and vertical evolutions of the Gulf of St. Lawrence thermocline.

2. Biological Studies

a) Groundfish general. The second annual groundfish survey program was carried out in July-August of 1971, covering Div. 4X northward to Div. 4T. Abundance indices for some major species derived from the results show good agreement with those derived from commercial data and show encouraging agreement with comparable surveys by USA and USSR, and with 1970 results. Abundance estimates of main groundfish species by ICNAF divisions and depth strata in Div. 4V-W-X were derived from historical data for 1958-68.

b) Cod. Commercial landings in the Gulf of St. Lawrence (Div. 4T) comprised mainly 4-, 5-, and 6-year-old fish (peak size 46 cm), as in 1970, but with a stronger representation of 7-year-olds than has been noted since 1965. This was confirmed by research vessel catches which also indicated that in the recruitment area in the southwestern part of the Gulf, 3-year-old fish (peak length 34 cm) predominated. This should assure adequate recruitment to the 1972 fishery.

Research vessel survey data indicate that there are no strong year-classes to improve the fishery in Div. 4X for the next few years.

c) Haddock. Quantitative research vessel surveys in 1969 and 1970 indicate that recruitment from 1967-69 year-classes to the fishery in eastern Scotian Shelf (Div. 4V-W) in 1971-1973 will be poor, probably numbering less than 10 million fish, reflecting a fishing mortality F = 1.12. This is much below previous estimates (22 million for 1972-1973; F = 0.50) and fishing mortality at about the 1970 level of effort (9,000 tons) may well reduce the stock further.

In Div. 4X, imposition of the 18,000 tons catch quota for 1971 failed to reduce the fishing mortality below the high level of previous years (F = 0.60) and stock abundance continued to decline. Poor 1968-70 year-classes indicate that there can be no improvement in recruitment to the fishery before 1975.

The recommended reduced quota for 1972 (9,000 tons) may result in closure of the fishing by May 1972 but even greater reductions, to 6,000 tons, may be advisable. This would close the fishery as the quota would be filled by catches of haddock incidental to other fisheries.

Historical data (1958-71) for Div. 4W haddock indicate that the centre of spawning occurs presistently in a small area between Emerald and Western Banks and to the south of Emerald Bank, unaffected by variations in hydrographic conditions. The spawning period varies and there are differences in maturation cycles between males and females.

d) Yellowtail flounder (*Limanda ferruginea*). Analysis of tagging returns indicated little movement of stocks. Ninety-five percent of the recoveries were within 30 miles of the tagging area. Two separate groups were delineated on the Nova Scotia Banks: (1) Middle Ground - Sable Island (Div. 4W); (2) Banquereau (Subdiv. 4Vs).

Analysis of stomach contents show main items were amphipods and polychaetes. Sand launce, sand dollars, and herring eggs were regionally and seasonally abundant.

e) Sand launce (*Ammodytes*). Biological characteristics of various sand launce groups were examined. They indicate environmental determination of characteristics which results in significant differences in growth rates and meristics between groups. Larval development, feeding habits, and general ecology were also investigated.

f) Flatfish parasites. Assessment of intestinal parasites for use in separating populations of yellowtail flounder, American plaice, and greysole was started. There is considerable variation in parasite incidence and intensity between ICNAF divisions. In particular Div. 4X was characterized by very high incidence of acanthocephalans and comparitively low incidence of certain trematodes.

g) Food resource and digestion rates. Studies of sea raven stomach contents, rates of gastric emptying and estimates of abundance of sea ravens and yearling cod indicate that sea ravens consume 5-10% of yearling cod in Passamaquoddy Bay, New Brunswick (Div. 4X).

Most of the young cod, in turn, feed almost entirely on krill from August to October. From instantaneous rates of grastic emptying determined in laboratory experiments, it was estimated that they consumed 49 kilocalories of krill per kg cod per day. This was verified by an energy budget study.

h) Sea scallop (*Placopecten magellanicus*). Submersible studies of scallop dredging effects showed roughening of sea bottom, dislodging of boulders up to 40 cm diameter and probable lethal damage to about 17% of uncaught scallops left in the dredge track.

i) Herring. Returns from 1970 herring taggings in the Gulf of St. Lawrence continued with the Newfoundland winter fishery yielding 397 returns - 40 from releases off the Magdalen Islands in May and 357 from releases off the Gaspé coast in August. The Gulf of St. Lawrence summer fishery yielded 265 returns

(22 from Magdalen Islands releases and 243 from Gaspé releases). Total returns now number 129 (0.36%) from Magdalen Island taggings and 928 (4.53%) from Gaspé taggings. Results clearly indicate that the same stocks are being exploited in three general areas at different seasons: southwest coast of Newfoundland in winter, southern part of Div. 4T in spring, and western part of Div. 4T in late summer and early autumn. Results also indicate a high fishing mortality.

Comparison of morphological characters and parasitic (larval *Anisakis*) infection levels of Nova Scotia Banks herring with those of southwest Newfoundland - southern Gulf of St. Lawrence, indicates that the two stocks do not intermingle to any great extent. Canso Bank (Div. 4W) and Banquereau (Subdiv. 4Vs) herring appear to be one stock, adults overwintering offshore on Banquereau, younger herring inshore in Canso Bank - Chedabucto Bay area.

Examination of more than 1,000 herring from different Northwest Atlantic fisheries indicates that otoliths can be used as 'natural tags' for identifying herring stocks. Two types are recognized: an S-type characterizing spring-spawners and an A-type characterizing autumn-spawners. These two otolith types provided positive evidence that, in the Gulf of St. Lawrence, spring- and autumn-spawning stocks of herring mix on American Bank (Div. 4T) for feeding. In the Chedabucto Bay (Div. 4W) area, spring and autumn stocks are found mixed during the winter.

j) Swordfish. Commercial records of swordfish longlining show that both catch rate (fish caught per 100 hooks set) and average weight of fish have declined from 2.88 fish averaging 168.1 lb (dressed) in 1963 to 1.03 fish averaging 99.9 lb in 1969.

k) Tuna. Size compositions of small bluefin landed from the 1971 purse seine fishery off the mid-Atlantic coast of the United States again changed considerably as the season progressed. Age-groups 1 and 2 (1970 and 1969 year-classes) dominated early catches, while older fish (ages 3-7) made up the bulk of later catches. The 1966 year-class has been poorly represented since 1969.

l) Atlantic salmon. Over 216,000 hatchery-reared and 30,000 wild smolts were tagged and liberated in stock evaluation and utilization studies. Almost 4,000 adult grilse and salmon were tagged and liberated in fishery areas or as they ascended rivers.

Of 302 adults tagged in a drift-net fishery in Div. 4T in 1970, 35% were recaptured in that year and about 10% in 1971.

Annual numbers of salmon ascending an important salmon stream studied since 1950 have decreased to less than 10% of salmon and 30% of grilse compared with 1950-55 figures. Estimated egg deposition and populations of juvenile salmon were much below normal. Deterioration is attributed to environmental degradation, aggravated by heavy fisheries exploitation both in home waters and in the Greenland - Davis Strait area.

Examination of returns from tagged, wild Northwest Miramichi smolts shows utilization of 2-sea-year salmon in Greenland to be about the same as in intensive commercial fisheries within 50 miles of the home river. This results in an increase in the grilse-salmon ratio for spawners entering the river (22:1) as compared to the grilse/salmon ratio for yield (fisheries + escapement from a given smolt year-class) (3:1). About two thirds of the returning grilse are males, which contributes to low potential egg deposition.

Returns from wild smolts given experimental sublethal treatment with DDT were about 57% of those from a control group. DDT-treated fish showed relatively higher returns as 2-sea-year salmon than as grilse. Returns as grilse from wild and hatchery-reared smolts given 24-hour sublethal treatment with a copper-zinc solution were about 75% of those from a control group.

Identification of genetic polymorphism of blood transferrins was extended to differentiate between native stocks from southwestern and northeastern New Brunswick and between juveniles from headwaters (early-run) and lower reaches (late-run) of the Northwest Miramichi.

3. Gear and Selectivity Studies

Research on fluid mechanics of netting, including experiments with round-wire and textile netting screens, showed that existing theory cannot be applied to trawls, where angles of attack are usually less than 30°. New theory for trawls is being developed in this field and in rational design of bottom and midwater trawls.

A prototype trawl-door instrument package for determination of six variables was tested at sea. Tilt- and heel-angle meters worked very well; tension meters in towing and groundwraps were satisfactory except when overloaded during 'hang-ups'; angle of attack sensor requires minor modification; door spread meter requires further development.

Subarea 5

A. STATUS OF THE FISHERIES

1. Cod

Landings increased from 1970 by 20% to just over 3,000 tons. This is still only 50% of 1969 landings.

2. Haddock

Haddock landings showed a further decrease of 10% from 1970, continuing the decline of the past few years to less than 10% of 1966 landings. Part of the decrease is due to the closed season on Georges Bank (Div. 5Z).

3. Sea scallop

Landings from Div. 5Z, about 32,750 tons whole weight (3,950 tons meat) continued to decline, showing a 2% decrease from 1970 for approximately the same but more widespread fishing effort, and a 34% decrease from the peak year 1964.

4. Herring

Total Canadian catch in Subarea 5 was about 32,000 tons of which about 15,000 tons was sold directly to USA buyers and hence is not included in Canadian landing statistics. Catches were about equally divided between Jeffrey's Ledge (Div. 5Y) and Georges Bank (Div. 5Z). Probable restrictions (quotas) on landings will have a major influence on the 1972 herring fishery in Subarea 5.

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

a) Sea scallop. Underwater photographic studies of an offshore scallop-dredge on Georges Bank (Div. 5Z) indicated that about 15% of all scallops in the path of the dredge were captured. Escapement after entering the dredge was about 50% mainly through inter-ring spaces and belly.

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SECTION III. HARP AND HOODED SEALS

A. STATUS OF THE FISHERIES

The following table gives the Canadian Atlantic seal catch in Subareas 2, 3 and 4 for the years 1970 and 1971:

Year	Area	Harp Seals			Hooded Seals			Grand Total
		Young	Older	Total	Young	Older	Total	
1970	Gulf	72,512	5,463	77,375	405	8	413	78,388
	Front	53,363	10,957	64,320	1,653	803	2,456	66,776
	Total	125,875	16,420	142,295	2,058	811	2,869	145,164
1971	Gulf	70,131	5,577	75,708	13	1	14	75,722
	Front	53,051	6,456	59,507	219	191	410	59,917
	Total	123,182	12,033	135,215	232	192	424	135,639

In 1971, for the first time, a quota of 145,000 harp seals was imposed on the seal fishery: 100,000 for Canadian ships, and 45,000 for Canadian landsmen. This quota was not attained mainly because of shortage of seals available to ships round the Magdalen Islands. Of 70,000 young seals taken in the southern Gulf of St. Lawrence, landsmen and small craft took 31,000 and ships took 39,000.

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

a) From a study of the strength of recent year-classes of harp seals compared with the catch of each year-class as young, production was estimated as lying between 260,000 and 295,000 for median year 1968, with a decrease of about 25,000 annually.

b) From aerial survey in 1970, and the fishery in 1971 (see section A), production in the Gulf was estimated at 70,000 to 75,000 young harp seals. It is believed that, following poor ice conditions in the Gulf in 1969, a part of the Gulf adults transferred to the Front herd. However, age samples from the Gulf area in 1971 show considerable strength of year-classes 1966 and 1968, which were immature age-classes in 1969 and so unaffected by the poor ice conditions for whelping. It is therefore believed that the Gulf herd will show some recovery as these year-classes recruit to the whelping stock beginning at age 5.

c) Age samples from the Front area so far show no strong recent year-classes save that of 1968, a year when catching was voluntarily reduced.

d) Samples collected from a winter net fishery for harp seals in northern Newfoundland show the food of adults at the coast in late March and early April to consist mainly of benthic Crustacea with some fish.

e) Ovaries from females on the Front indicate median age at sexual maturity to be between 4 and 5 years, compared to 4.5 years for Gulf females. Male harp seals now mature sexually between 4 and 6 years, as compared with 6 to 9 years in 1951-54 before the fishery reduced the population.

DANISH RESEARCH REPORT, 1971

by

Sv. Aa. Horsted and E. Smidt

Subarea 1

A. STATUS OF THE FISHERIES

1. General trends

The nominal catches taken by Denmark (Greenland) in 1971 are given in the following table (provisional data):

Species	Nominal Catch (metric tons)	Increase or Decrease from 1970 (%)
Cod	19,890	-1
Redfish	324	+89
Wolffish	2,615	-3
Greenland halibut	1,162	-4
Halibut	4	0
Capelin	2,578	-17
Atlantic salmon	1,375[a]	+9
Arctic char	123	+11
Lumpsucker roe (not converted to round, fresh fish)	244	-41
Industrial fish	181	-35
Other fish	14[b]	0
Deep sea prawns (*Pandalus borealis*)	9,029	+7
Total (excl. lumpsucker roe)	37,295	0

a) Excludes catches by Denmark (M) and (F) of 645 tons and 255 tons respectively.

b) Estimated equal to 1970.

The three most important species (in terms of income) for the Greenland fishermen in 1971 were *Pandalus* (34% of landed value), Atlantic salmon (34%) and cod (26%). Landings (in terms of weight) of these three showed a small increase for the first two and a nearly stable catch of the last as compared to 1970 landings. Landings of species of minor importance fluctuated more widely. Total landings were almost the same as in 1970. Further details on the major fisheries follow.

2. Cod

a) The fisheries. Catches remained stable at the very low level of last year. It must be emphasized, however, that further development in the fleet of trawlers has taken place, and that the catch has been maintained at the 1970 level only by this increase in effort. One 450 GRT otter trawler operated throughout the year, two new trawlers in the 501-900 tonnage class started fishing in April and August respectively. The three trawlers took about 30% of total landings of cod by Denmark (G). In considering this, it is quite clear that the downward trend in the small boat inshore fishery has continued through 1971 by about 7% compared to 1970. The inshore fishery in 1971 (about 14,000 tons) is only 40% of the fishery in the peak year 1962 (35,380 tons). No good measures of effort in the inshore fishery exist, but all evidence points to less abundance and catchability (ice hindrance) of cod as the main causes for the decline.

The trawlers operated mainly in Div. 1C-1E. Inshore fishery was rather evenly distributed between Div. 1B-1F, but compared to 1970 the inshore catches in Div. 1D-1F decreased, mainly in Div. 1F (by 45%), were rather stable in Div. 1C and increased by about 25% in Div. 1B.

b) Forecast for 1972-73. Considering year-class fluctuations and distribution, as described in Section B, below, and that further development in the Greenlandic fleet of big otter trawlers will occur within 1972 and 1973, the fishery by Denmark (G) is expected to increase somewhat in 1972 and 1973 both absolutely as well as in relation to other fleets fishing in Subarea 1. In fact, for the first quarter of 1972 cod landings are 3,619 tons (nominal catch) compared to 1,274 tons at the same time in 1971. The three trawlers took 3,507 tons of the 3,619 tons landed, whereas in 1971 only one trawler operated in the first quarter.

However, the prospect for the total international cod fishery in Subarea 1 is not good. With the exception of the 1968 year-class, the year-classes to recruit to the fishery in the first half of the 1970's seem poor. In the northern divisions (Div. 1B-1D), the 1966 and 1968 year-classes are expected to be the most important probably leading to good fishing in the Banana Bank region in the first half of the year. In Div. 1E-1F and off Southeast Greenland the stock may be less abundant than in the last couple of years. Nevertheless, good fishing for otter trawlers fishing on schooling cod may still occur here in and around the spawning period, especially as such schools will consist of relatively big fish belonging to the 1963, 1964, 1965 and 1966 year-classes, the latter expected to gradually increase its relative importance in the southern divisions partly due to some immigration from Div. 1D and partly due to other (older) year-classes emigrating to East Greenland - Iceland.

3. Atlantic salmon

The total international catch in 1971 of about 2,615 tons is the highest so far recorded, approximately 20% over the 1969/70 level. Catches by Denmark (G) amounted to 1,375 tons (9% more than in 1970). Although no figures for trends in effort and efficiency in the Greenlanders' salmon fishery exist, it was the general impression that abundance of salmon was good in all districts and that fishing conditions were rather favourable. For further details on trends in fishing, see Report of the ICES/ICNAF Joint Working Party on North Atlantic Salmon (Res.Doc. 72/32).

No forecast for salmon fishery in 1972 can be given.

4. Other fish

Catches of redfish have increased due to by-catches by the trawlers. As the trawler fleet continues to increase by-catches of redfish may increase further in the coming years. Also catches of capelin may increase in future if pelagic trawling experiments planned for 1972 are successful.

5. Deep sea prawn

The general increase in this fishery in the last decade continued through 1971. This reflects an increase in effort (number of boats) and efficiency in parallel with an increase in industrial capacity. No signs of overfishing are reported, and unexploited or lightly exploited grounds (stocks) are still found, so that the stocks may be able to support increased fishing, and catches may increase further in the future. However, adverse climatic conditions, *e.g.* ice coverage of the important grounds in Disko Bay, may in some years stop fishing entirely for several months leading to lower catches even if abundance is not affected.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. Again in 1971 the inflow of cold polar water and ice from East Greenland to West Greenland was remarkably high. For further details see paper by F. Herman in ICNAF *Redbook* 1972, Part III.

b) Plankton. In continuing the program of previous years, hauls with 2 m stramin net were taken at the standard hydrographic sections in the Davis Strait in May - October. Oblique hauls were taken from approximately 50 m to surface (wire length 225 m). Displacement volume of plankton was measured and fish eggs and larvae were sorted and counted in all samples. Further, invertebrates (medusae, siphonophora, chaetognatha, polychaeta, crustacea, gastropoda) in most of the samples were also sorted and counted.

Average volume of samples and average numbers of crustaceans from the Fylla Bank section in July during the last decade are presented in the table below (see next page). Plankton catches in the last three years have been relatively poor. This corresponds to the colder surface water conditions and the small quantities of cod eggs and larvae observed in the latest years. It should be noted that an appreciable part of the volume consisted of medusae.

2. Biological Studies

a) Cod eggs and larvae. As mentioned above, eggs and larvae were taken by 2 m stramin net at the standard hydrographic sections in the Davis Strait. The number of eggs taken in May, June and July is shown

Year	Volume ml/30 min.	Crustacean no./30 min.	No. of stations on section
1961	2100	1272	3
1963	820	403	5
1964	463	1575	5
1966	331	855	5
1968	760	-	5
1969	225	-	5
1970	323	118	5
1971	209	102	5

in Fig. 1. In most years concentrations of eggs have been found on the western part of the Sukkertoppen section. In 1969 and 1970, however, few eggs occurred on these stations. In 1971 no eggs at all were observed on stations north of Godthaab, whereas a concentration was found over the western slope of Fylla Bank. Unfortunately the Frederikshaab section was not fished due to ice.

As in 1969 and 1970 the number of cod larvae taken (Fig. 2) was very small. For stations north of Godthaab, the number of cod larvae in 1971 seems to be a new, low record. At these stations larvae were found in July only, and these are thought to originate from more southerly areas, for example, west of Fylla Bank, where the highest numbers were found in May and less in July.

The distribution and numbers of larvae as well as the hydrographic conditions indicate that the 1971 cod year-class of West Greenland origin is very poor.

Occurence of pre-recruit cod (age-groups I, II and III). Age-groups I-III are normally observed by means of fine meshed beach-seine, fine meshed otter trawls (prawn trawl), commercial pound-nets and by visual observations in shallow water. In 1971 visual observation and beach-seine fishing have not been carried out, and samples from commercial pound-nets have generally been taken after small cod have been discarded. No information exist on the magnitude of discarding except that age-group III is known to have occurred to some extent in pound-net catches in the Godthaab Fjord (Div. 1D). The best but still rather limited information on pre-recruits is from fine meshed otter trawl catches on a standard station for groundfish survey in Div. 1D offshore (Fig. 3, Sample No. 13 and 14). Age-group III (year-class 1968) is by far the predominating one accounting for 58% and 83% respectively in the two samples in 1971. Age-group III has also been found in research catches by fine meshed otter trawl in Div. 1E, offshore (No. 15). If the hauls on the standard station in 1971 are compared to hauls in previous years, it is not unlikely that the year-class is comparable to the rather good 1966 year-class in the northern part of Subarea 1. For further details see Res.Doc. 72/19.

Age and size distribution of cod in landings. Samples of commercial landings are shown in Fig. 4. Cod below about 40 cm will normally have been discarded before catches are landed. Relatively highest discarding rate will normally occur for pound-net catches, but no good information for this gear exist for 1971. Discarding by commercial otter trawlers in 1971 is negligible.

The age distribution seems to be markedly different between the area north and the area south of Godthaab. Samples from Banana Bank, in the southern part of Div. 1C (No. 1-3) clearly show the 1966 and 1965 year-classes to account for nearly the whole catch, and inshore samples from Div. 1B-1D (No. 10-12) confirm that the 1966 year-class is highly important in the northern part of West Greenland. The inshore samples contain considerable numbers also of the 1967 year-class, which is less abundant in the offshore samples. But this difference may to some extent be ascribed to difference in selectivity between small meshed pound-nets and large meshed otter trawls.

In areas off Godthaab, northern part of Div. 1D, the 1966 and 1965 year-classes still make up a considerable part of the catch, but the 1963 year-class and, to some extent, the 1964 year-class have also been of great importance for the 1971 fishery (No. 4-6).

In Div. 1E (No. 7) the 1965 and 1963 year-classes predominate, the latter being even more important in Div. 1F (No. 8-9) where the 1963 and 1964 year-classes account for practically the whole catch sampled.

In general it could thus be said that the 1965 and 1966 year-classes dominate in Div. 1C (and probably farther north), and that the 1963 and 1964 year-classes dominate in Div. 1F whereas Div. 1D-1E catches have been a mixture of the four year-classes mentioned.

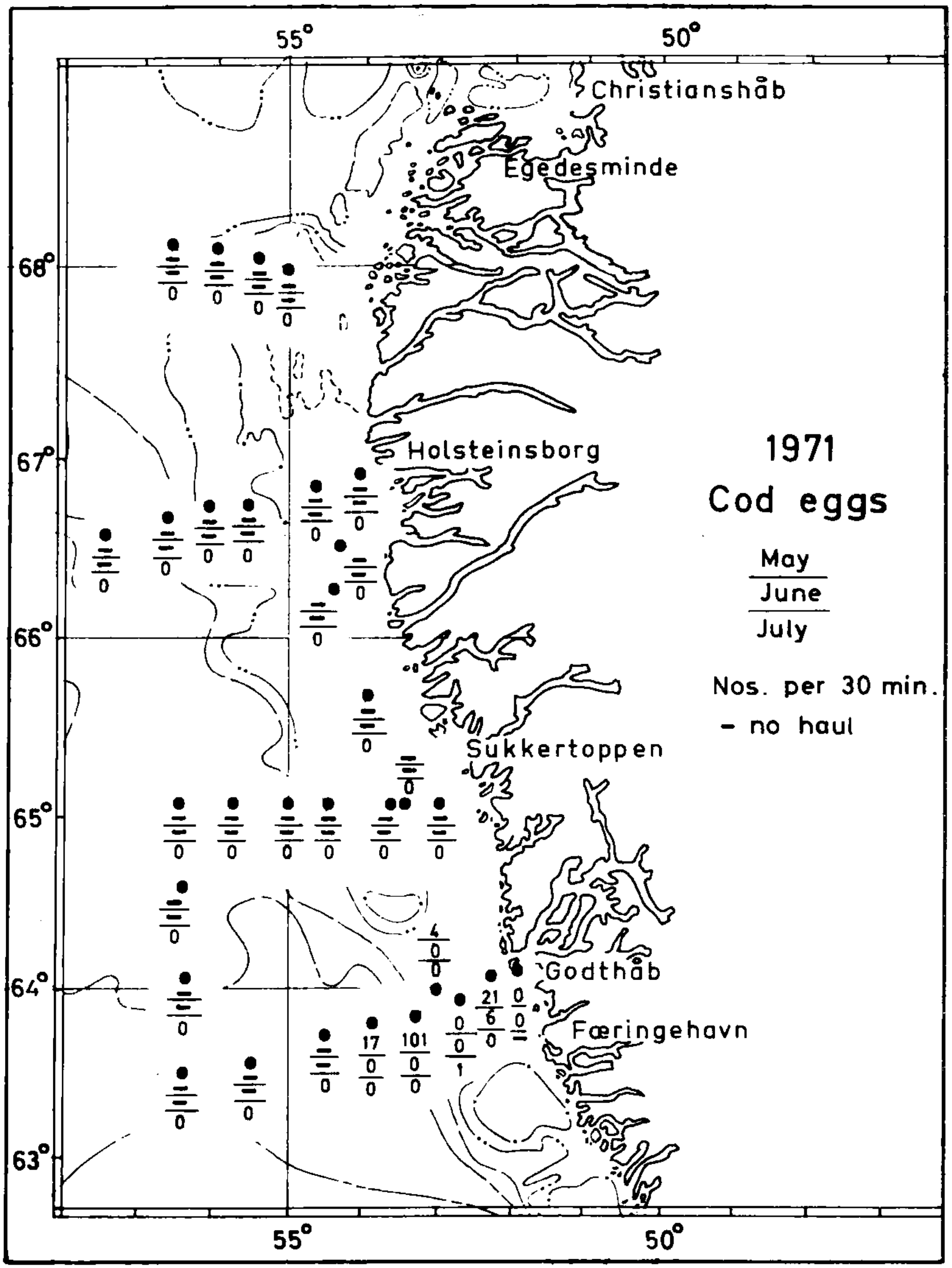

Fig. 1. Cod eggs (number per 30 min.) taken by 2 m stramin net in the upper water layers (maximum depth about 50 m).

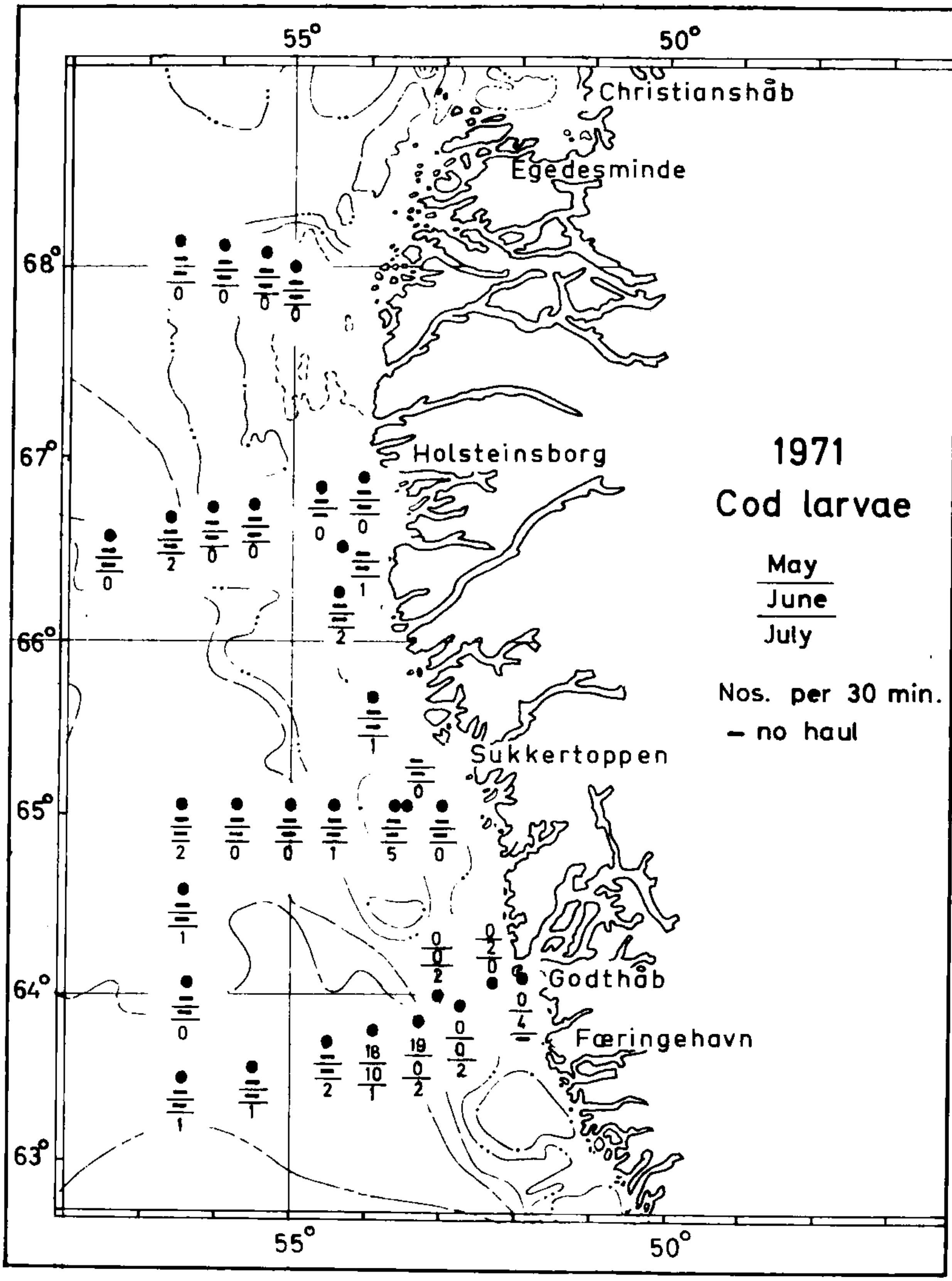

Fig. 2. Cod larvae (number per 30 min.) taken by 2 m stramin net in the upper water layers (maximum depth about 50 m).

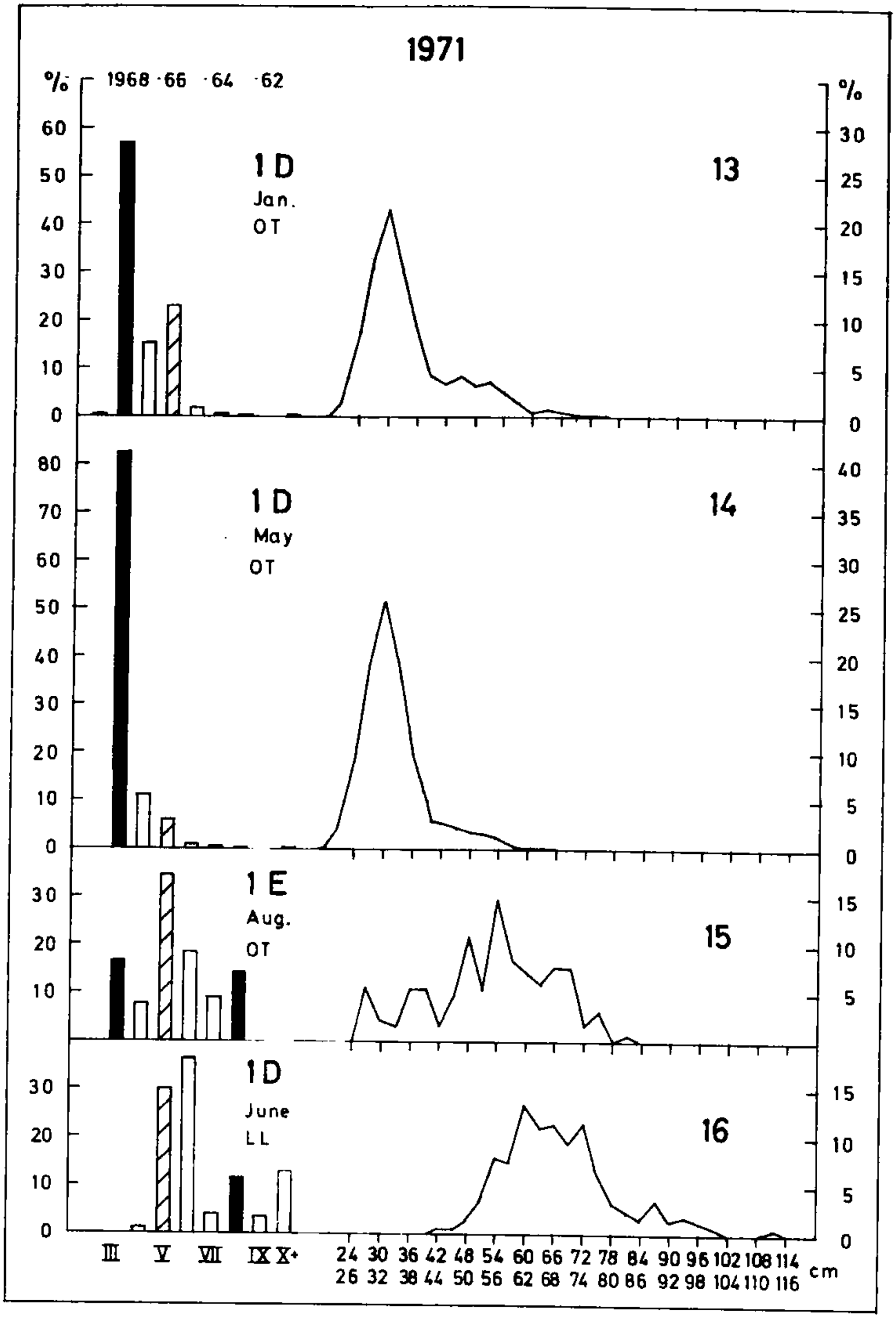

Fig. 3. Age and length composition of cod from some of the research catches. OT = otter trawl with 36 mm codend mesh-size, LL = long-line. Samples Nos. 13 and 14 taken in the Godthåb Deep between Fylla Bank and the coast, No. 15 in the Frederikshåb Deep, No. 16 on the western slope of Fylla Bank.

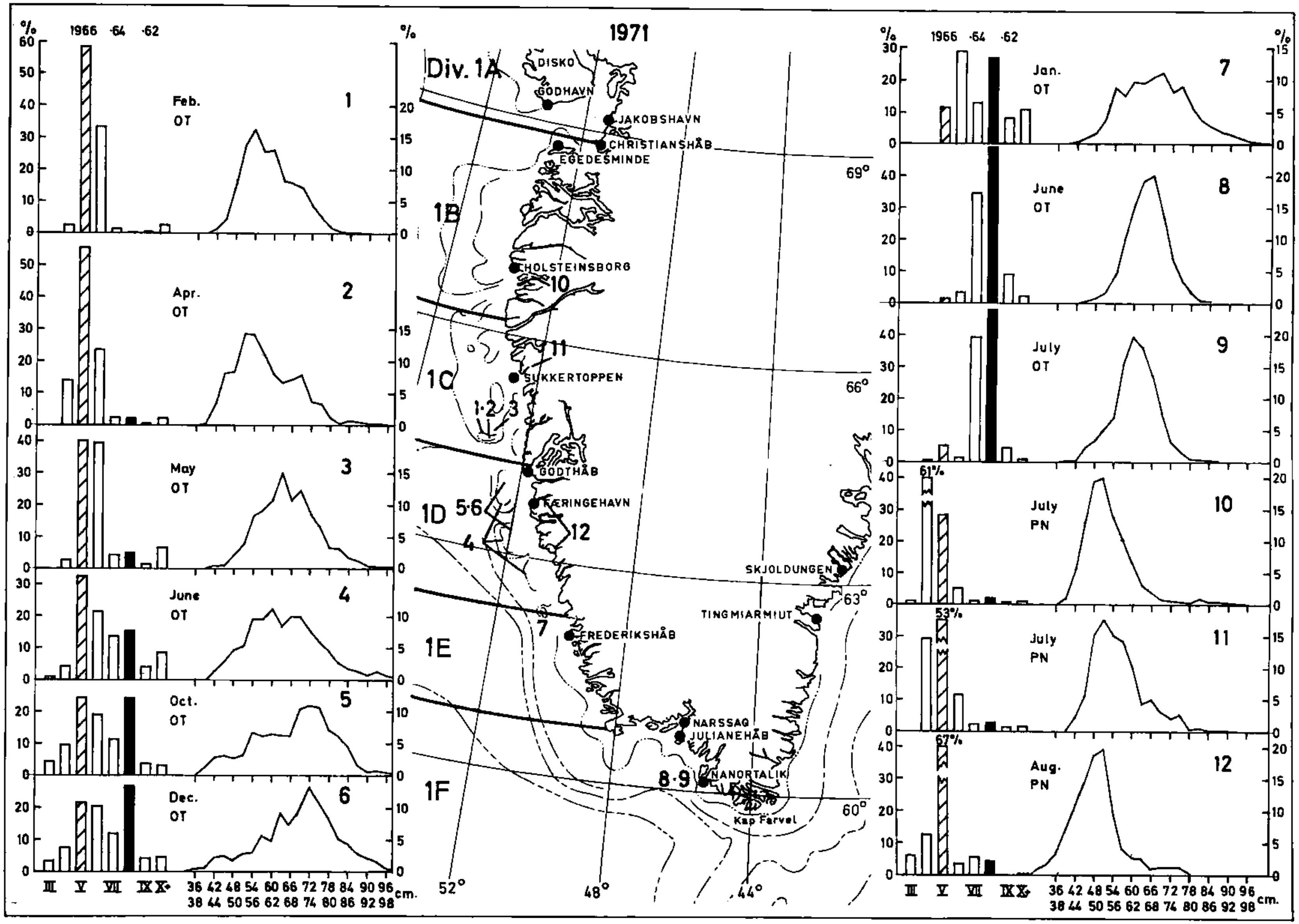

Fig. 4. Age and length composition of cod sampled from commercial landings. Samples Nos. 1-9 all offshore, Nos. 10-12 in fjords.
OT = otter trawl with codend mesh-size at least 130 mm, PN = pound net.

With the differences in age distribution between northern and southern samples, one would expect to find the mean weight of fish in the southern samples considerable higher than for the northern samples. This is, however, not the case. Thus, for Sample No. 1-3 (Fig. 4) the observed mean weight of fish is 2.32, 2.05 and 2.93 kg round fresh respectively, whereas for No. 8-9 the mean weight is 2.39 and 2.05 kg respectively. Highest mean weight is generally found for the samples in Div. 1D-1E with 2.68, 4.15, 3.86 and 3.28 kg for No. 4-7 respectively. This higher mean weight could be due to some occurrence of big cod belonging to that 1961 year-class in these samples. This and older year-classes have also been observed in research catches with long-lines (Fig. 3, No. 16).

Cod in the southern part of the Subarea thus seem to have a slower growth rate in recent years, but the problem needs further investigation.

Cod tagging experiments. A total number of 2,322 cod was tagged as shown in the following table. Here cod below 50 cm total length are called small cod.

Div.	Inshore		Offshore	
	small cod	big cod	small cod	big cod
1B	-	-	63	316
1C	-	-	70	340
1D	1449	-	1	83
Total	1449	0	134	739

b) Atlantic salmon. The international team-work on salmon carried out in Greenland waters since 1965 continued in the 1971 season. The British - Danish team on board the R/V *Adolf Jensen* tagged 108 salmon, and a further 21 salmon were tagged from the research cutter *Tornaq*. The material on salmon was presented to the ICES/ICNAF Joint Working Party on North Atlantic Salmon at its meeting in Dublin, March 1972 (Res. Doc. 72/32).

Fresh water studies aimed at elucidating the possibility of planting salmon in Greenland rivers have been carried out in the area between Sukkertoppen and Frederikshaab (Div. 1C-1E). These studies will be continued through 1972 to cover also southernmost Greenland. In the Kapisigdlit River (Godthaab Fjord) 136 parr were tagged.

c) Pelagic fish. Small catches of capelin were taken by a pelagic trawl in inshore waters near Godthaab (Div. 1D) in August. Samples were taken for length and age measurements and for quality examination.

The distribution of sand eel (*Ammodytes lancea*) larvae taken by stramin net is shown on Fig. 5. By far the biggest numbers were observed in May indicating an early spawning on the offshore banks. Normally sand eel larvae are the most numerous fish larvae in the samples and in 1971 even seemed to be relatively more numerous than in previous years in the decade 1961-1971. The adult fish is a most important food-chain link over the offshore fishing banks in West Greenland, where it plays the same role as the capelin in the inshore area as food for cod, salmon and other fish. The sand eel larvae were not included in the report of the NORWESTLANT survey in 1963.

It is worth noting that in a dredge sample of bottom material taken in July 1971 west of Store Hellefiske Bank (depth 740 m) several partly decomposed sand eels were found. This raises the question whether there is a mass death of spent sand eels as is the case with the capelin in the coastal area

d) Other fish. Lengths, weights and otoliths have been collected from Greenland halibut and American plaice at the standard stations for groundfish and prawn surveys, mainly in Div. 1D. In Div. 1A off Umanak Fjord considerable numbers of small Greenland halibut (age-groups II-III mainly) were found on deep water (580-600 m). Recruitment to the exploited stocks of Greenland halibut in the Umanak region is thought to take place from these nursery grounds. In Div. 1D 51 Greenland halibut and 395 American plaice were tagged.

e) Crustaceans. Continuous research catches of deep sea prawn (*Pandalus borealis*) were taken on offshore grounds in Div. 1C and 1D. New fishing experiments on offshore grounds were conducted in Div. 1A off Umanak Fjord, in Div. 1B west of Store Hellefiske Bank and in Div. 1D-1E in deeps between the fishing banks. Best of these new experiments were those in Div. 1A, but unfortunately ice prevents fishing the stocks on this ground most of the year.

Small scaled trap fishing experiments for the crab, *Chionoecetes opilio*, were conducted in coastal waters near Godthaab. Preliminary results are encouraging and further experiments should be made.

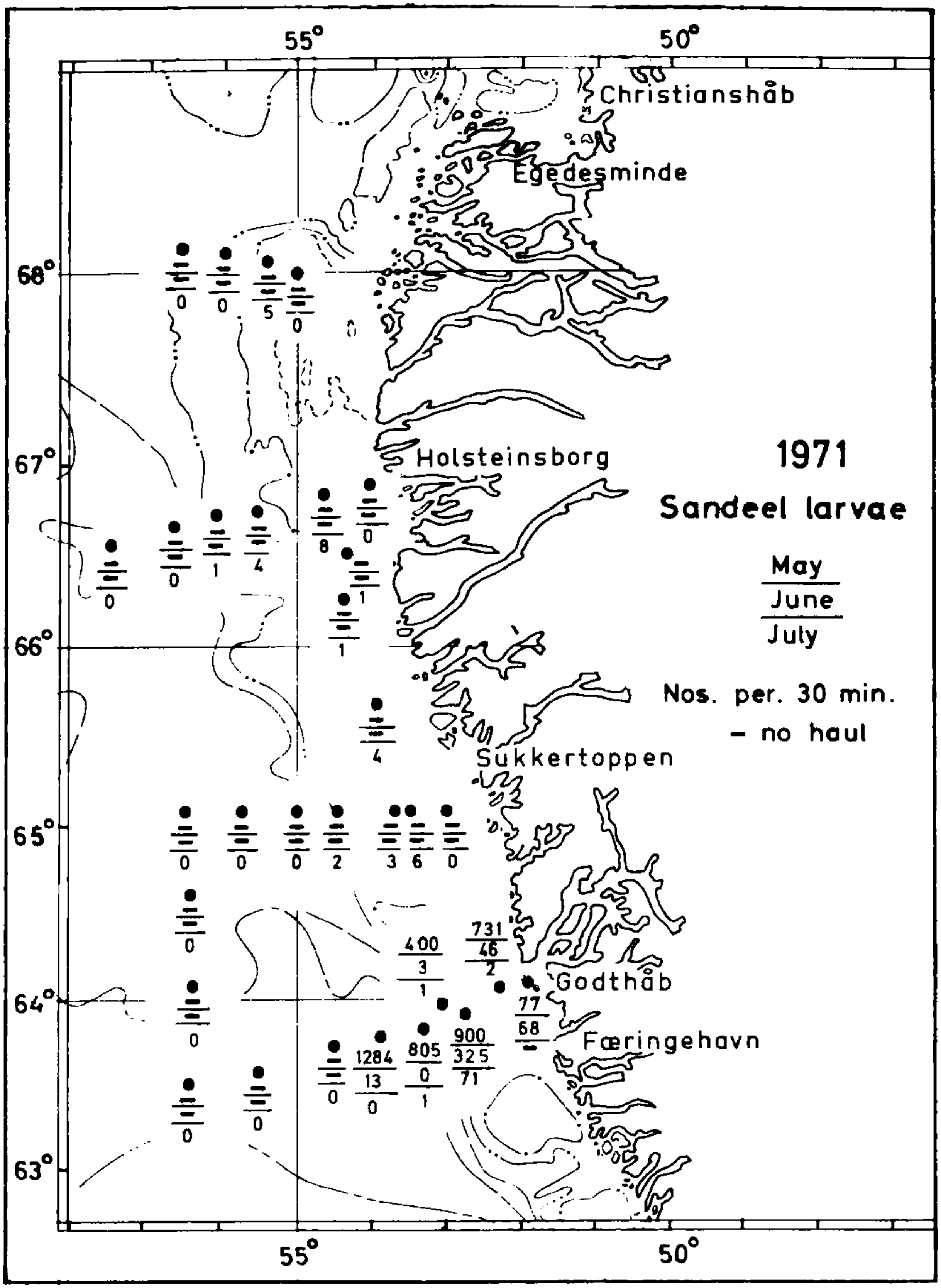

Fig. 5. Sand eel larvae (number per 30 min.) taken by 2 m stramin net in the upper water layers (maximum depth about 50 m).

f) Seals. The hooded seal hunt in southernmost Greenland (Div. 1F) was observed in May. Material for age determination was obtained from 231 animals and for maturity studies from 94 animals. From the Greenland east coast and from northwestern districts, seal hunters supplied jaws of 58 hooded and 46 harp seals. Ringed seal is also included in the seal studies.

3. Gear and Selectivity Studies

Apart from salmon fishing with drift-nets of different mesh-sizes and material, no special selectivity studies were undertaken. As mentioned above fishing experiments with traps for crabs were initiated and will be continued. A fine meshed one-boat pelagic trawl was tried for capelin fishing, but further experiments are necessary.

FRENCH RESEARCH REPORT, 1971

by

M. R. Letaconnoux and J. Morice

A. STATUS OF THE FISHERIES

1. Metropolitan Fishery

In 1971, mostly during the first half of the year, French commercial trawlers took 50,240 tons of cod (*Gadus morhua*) in the Northwest Atlantic. A considerable amount of fishing effort was diverted to the North-east Atlantic where 31,130 tons of cod were taken.

Fishing took place in West Greenland from April to June and off Labrador during January and February, the best catches being made in Div. 1C and 2J. Trawlers did not frequent these fishing grounds as much as in the past. The most important catches were made in February to April in the Gulf of St. Lawrence (Div. 4R) with lesser quantities off southwest Newfoundland (Div. 3P), east of the Grand Bank (Div. 3L) and on Flemish Cap (Div. 3M).

Table 1 summarizes the state of the fishery in 1971. The catches represent only 30.1% of the 1961 peak catch of 166,683 tons by the commercial trawlers and a decrease of 25% from the 1970 catch of 66,131 tons.

Table 1. France (Metropolitan) fishery statistics, 1971.

ICNAF Division	Cod catch (tons)	Subarea Total (tons)
1C	2603	
1D	1007	
1E	498	4108
2H	14	
2J	5895	5909
3K	500	
3L	2984	
3M	9006	
3N	19	
3O	1	
3P	2730	15240
4R	24363	
4T	2	
4Vn	618	24983
ICNAF Area Total		50240

2. Saint Pierre and Miquelon Fisheries

In 1971 a total of 5,528 tons of various species was taken by Saint Pierre trawlers and by 60 dories (Table 2). This figure is 62.8% of the average catch (8,806 tons) in the 10-year period, 1961-70, and only 40.7% of the best catches in 1961 (13,575 tons). The decrease in catch can be explained by the almost complete disappearance of haddock (*Melanogrammus aeglefinus*), 52 tons in 1971 compared with landings of 2,918 tons in 1960, 4,633 tons in 1961 and 2,429 tons in 1962, and a substantial decrease in cod abundance, 1,861 tons in 1971 compared with 2,178 tons in 1970 and peak catches of 4,416 tons in 1960 and 5,595 tons in 1961. The level of fishing effort has remained relatively constant over the period (3-4 trawlers).

The dory fishery takes place near the shore around the islands of Saint Pierre and Miquelon, and, of the 1,861 tons of cod landed, dories took 1,196 tons. Trawlers caught the remainder, mostly on Saint Pierre and Burgeo Banks (Subdiv. 3Ps). The redfish (*Sebastes m. mentella*) catch increased slightly to 1,747 tons compared with 1,627 tons in 1970, and most of the catch was taken on the slopes of Saint Pierre and Burgeo Banks (Subdiv. 3Ps), except for 249 tons in Subdiv. 4Vn and 79 tons in Subdiv. 3Pn. The American plaice (*Hippoglossoides pl. platessoides*) catches increased to 1,166 tons from 812 tons in 1970, and were taken mostly in Div. 3L and Subdiv. 3Ps. Smaller quantities of yellowtail flounder (*Limanda ferruginea*) and skates (*Raja radiata*) were also landed.

Table 2. France (St. Pierre and Miquelon) fishery statistics, 1971.

ICNAF Division	Catch (tons)							
	Cod	A. plaice	Redfish	Skates	Yellowtail	Haddock	Others	Total
3L	43	241	-	56	16	-	38	394
3N	45	68	6	17	32	-	16	184
3O	16	14	2	3	1	-	2	38
3Pn	26	-	79	3	-	-	3	111
3Ps	1651*	820	1325	213	120	45	159	4333
Total	1781	1143	1412	292	169	45	218	5060
4R	68	4	33	-	1	6	3	115
4S	1	1	17	-	-	-	1	20
4Vn	7	13	249	7	2	1	3	282
4Vs	4	5	36	3	-	-	3	51
Total	80	23	335	10	3	7	10	468
Grand Total	1861	1166	1747	302	172	52	228	5528

* Includes 455 tons used for industrial purposes.

B. SPECIAL RESEARCH STUDIES

1. General

The Saint Pierre Research Centre had at its disposal the R/V *Cryos* for the periods 19-29 January and 6 May - 11 December 1971. Investigations carried out included cruises for herring, groundfish (cod, haddock, redfish and American plaice), deep-sea prawn (*Pandalus borealis*) and scallops. Also the R/V *Cryos* participated in a joint Gulf of Maine - Georges Bank survey for larval herring, together with research vessels from USA, USSR and Federal Republic of Germany.

2. Environmental Studies

Hydrography. During July hydrographic studies were made in Subdiv. 3Pn, 3Ps, 4Vn and 4Vs. The near-bottom temperatures along the coast of Cape Breton and on the northern part of the Nova Scotia banks were 1 to 3°C (Fig. 1). In the deeper water of the Laurentian Channel temperatures were higher (5 to 6°C, and even 7°C in the northern part). On the east side of Saint Pierre Bank the near-bottom temperatures indicate two cold water lobes: one on the southern tip of the Bank (0°C) and the other just south of Saint Pierre Island. On the central part of the Bank there is an isolated core of cold water (1°C). On the west side of the Bank strong thermal gradients were observed, 0 to 6°C near the southern tip of the Bank and 2 to 6°C on the northern part. On Burgeo Bank, just to the northwest of St. Pierre Bank, the near-bottom temperature in the shallower water is cold (2 to 3°C), with the water being warmer at greater depths.

The distribution of surface water temperatures (Fig. 2) show a difference in temperature between the eastern and western sides of the Laurentian Channel. Saint Pierre Bank and south coast of Newfoundland waters are influenced by colder water from the east (12 to 13°C), while the surface water of the Cape Breton area is influenced by the warmer water of the Gulf of St. Lawrence (17-18°C).

3. Biological Studies

a) Herring, (*Clupea harengus*). The R/V *Cryos* made a cruise to Georges Bank and the Gulf of Maine (Subarea 5) during 7 September - 7 October. The first part of the cruise (8-24 September) was devoted to studying the abundance and distribution of herring larvae in accordance with the program established by the Herring Working Group at the 1971 ICNAF Annual Meeting. Results are presented in Res.Doc. 72/62.

During 27 September - 7 October the slopes north and south of Georges Bank were surveyed to study the adult herring stock. A large number of trawlers were fishing the important herring concentrations on the northern part of the Bank (Subdiv. 5Ze) near 42°00N and 67°20W. The herring were in spawning condition (Stage VI) and ranged in length from 25 to 37 cm (Fig. 3), the average length being 28.8 cm and average weight 200 g.

In May good catches of herring were made near Cape Smoky, Cape Breton (Subdiv. 4Vn). Length measurements of 1,410 specimens were made, with the range being 18-39 cm (Fig. 3) and the mode at 24 cm. Forty-six percent of the herring had not reached the first stage of sexual maturity (average weight being 94 g).

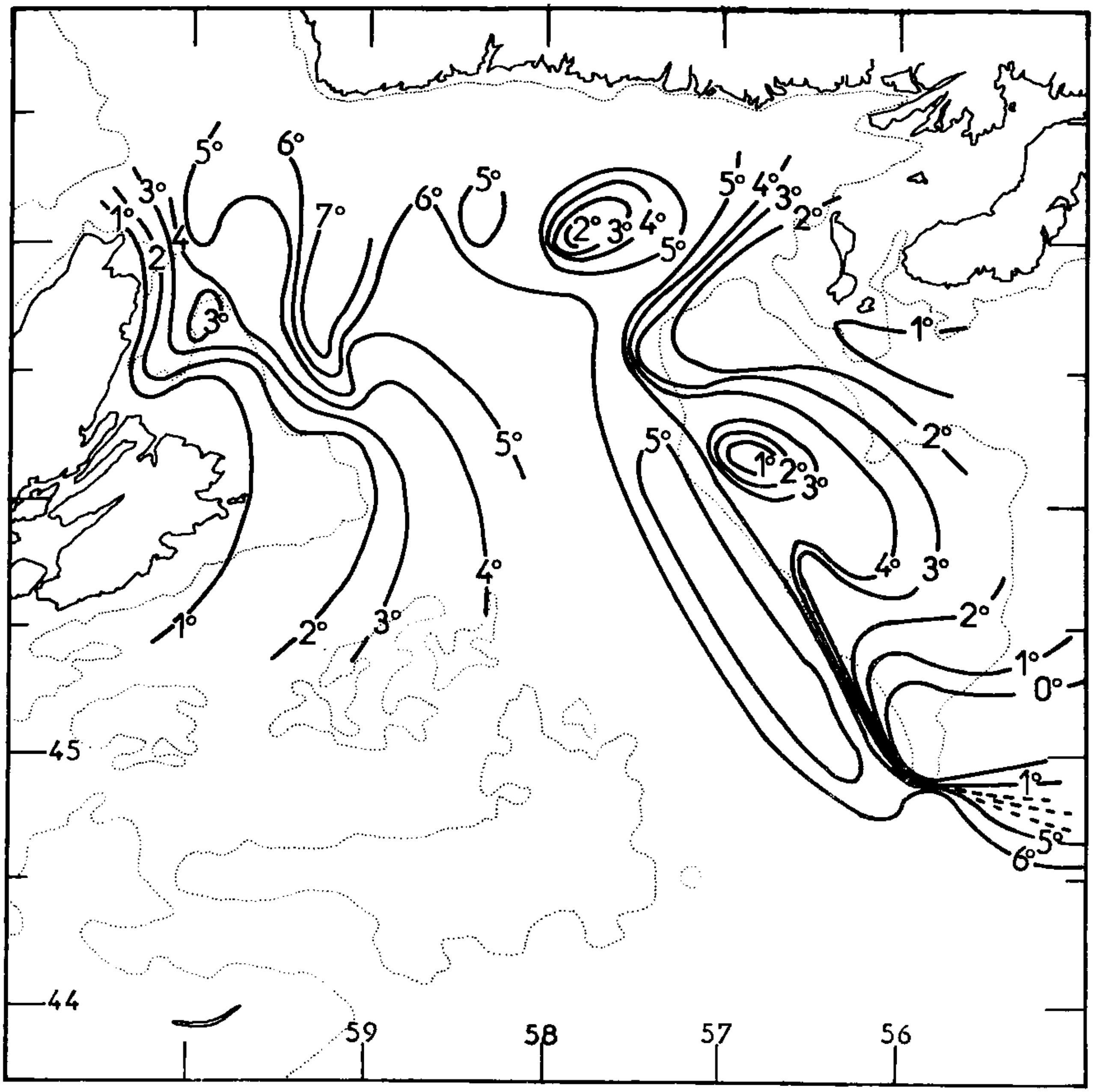

Fig. 1. Bottom temperatures, July 1971.

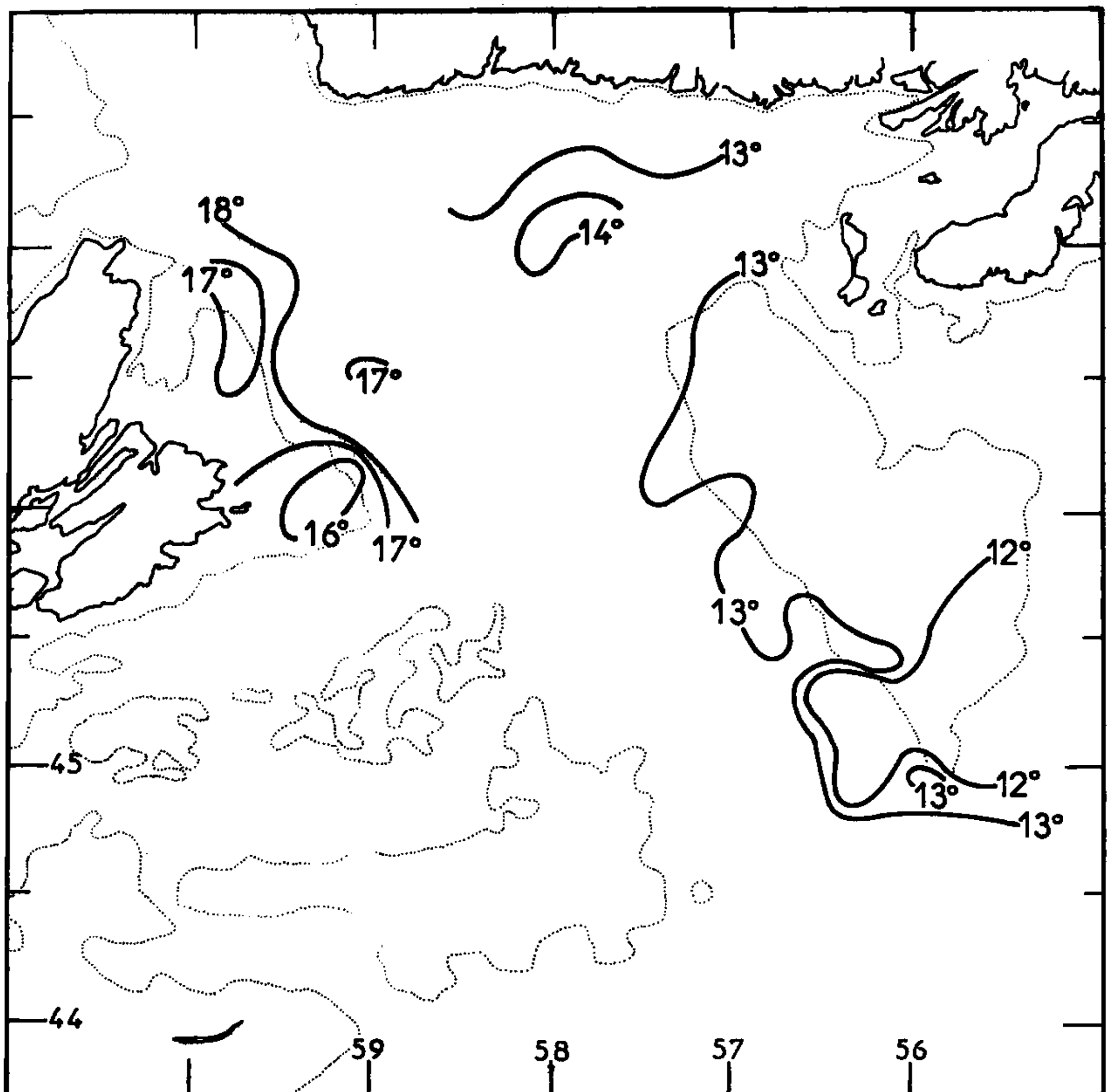

Fig. 2. Surface temperatures, July 1971.

Observations on the fat content of herring are given in Table 3 and other biological studies are described in Res.Doc. 72/55.

Table 3. Percentage fat content of autumn and spring herring from various areas.

Spawning type	Area	Date	Number examined	Maturity stage	Percent fat
Autumn	Cape Smoky	11 May	5	I-II	6.01
	Cape Smoky	11 May	9	VIII-III	11.26
	Artimon Bank	20 May	12	III	11.59
	Sydney Bay	25 July	11	IV	14.71
	Sydney Bay	25 July	4	V	16.12
	Cape Gabarous	12 May	12	VIII	6.10
	Georges Bank	28 Sept	13	VI	7.71
	Georges Bank	7 Oct	8	VII-VIII	10.25
Spring	Cape Smoky	11 May	8	IV	13.75
	Cape St. Lawrence	7 May	2	V	10.13

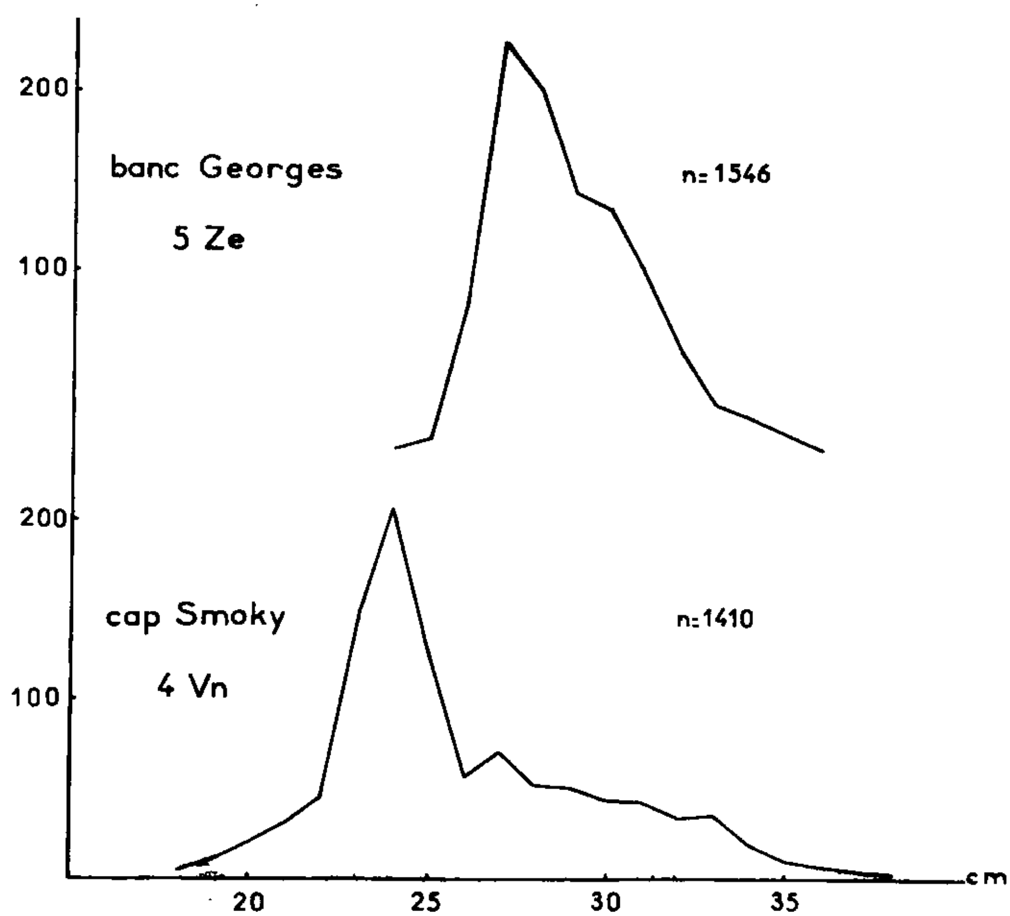

Fig. 3. Length frequency of herring in Subdiv. 4Vn and 5Ze.

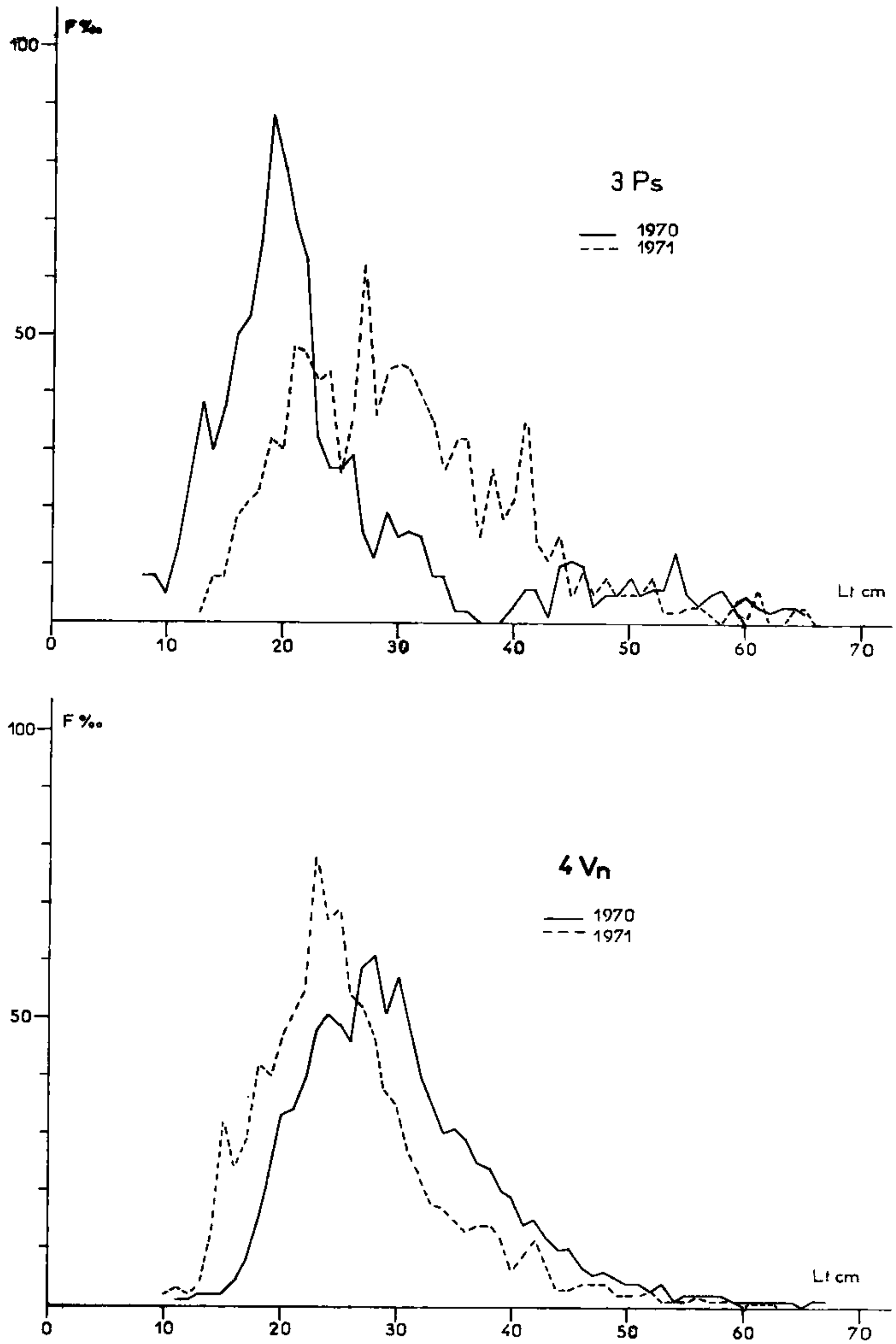

Fig. 4. Length frequency of American plaice in 1970 and 1971 in Subdiv. 3Ps and 4Vn.

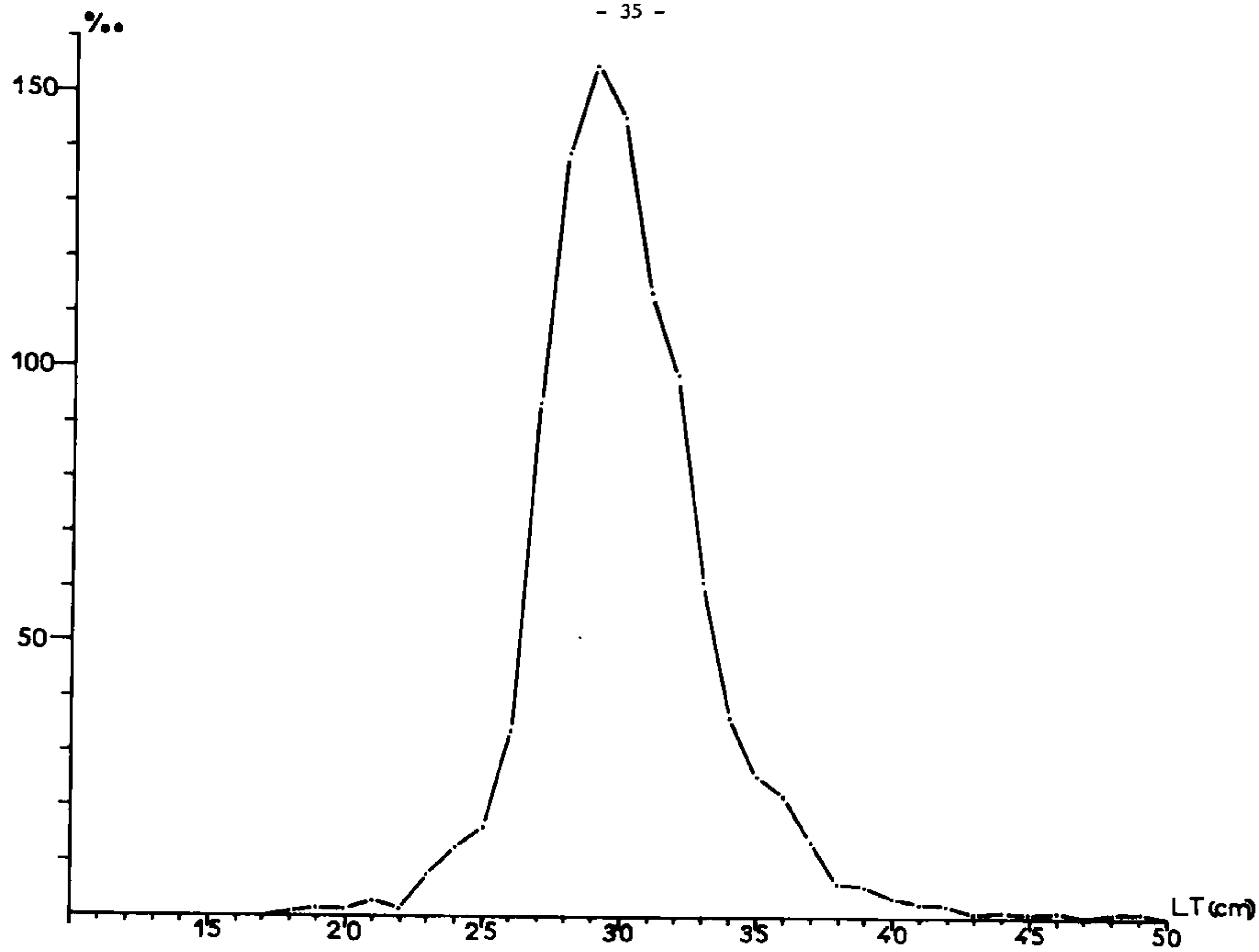

Fig. 5. Length frequency of hake from Georges Bank.

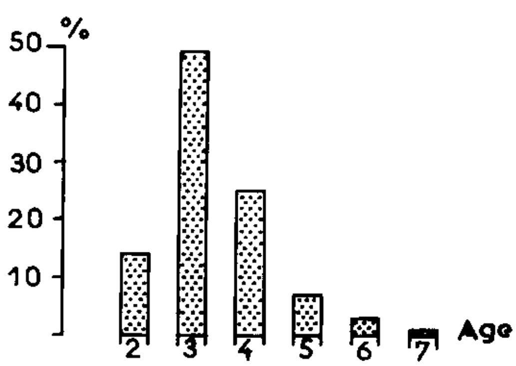

Fig. 6. Age composition of hake.

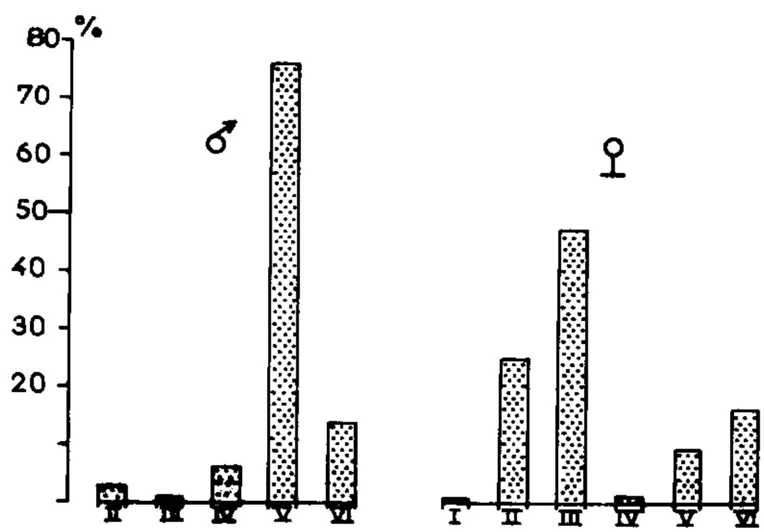

Fig. 7. Stages of maturity of male and female hake.

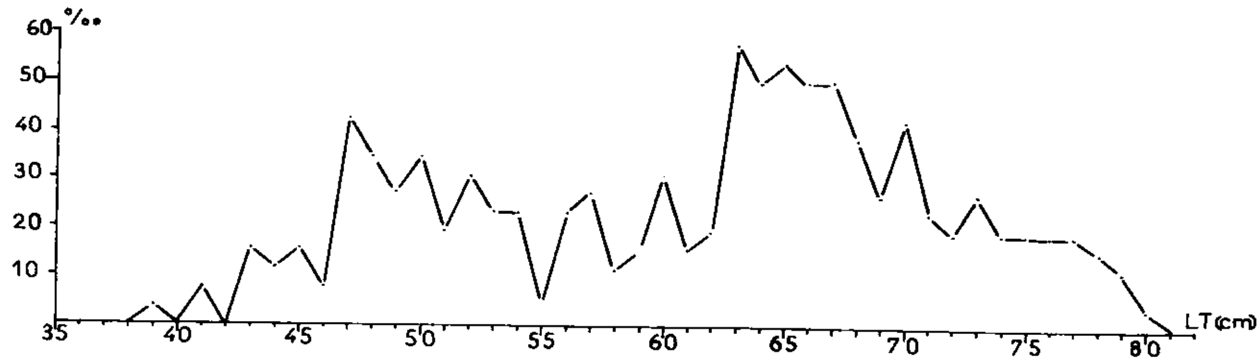

Fig. 8. Length frequency of haddock from Georges Bank

b) American plaice. Observations were made on St. Pierre, Scatari and St. Ann Banks (Fig. 4). The results are given in Res.Doc. 72/53 and 72/56.

c) Silver hake, (*M. bilinearis* and *M. albidus*). Only a few specimens of *M. albidus* were taken on the southern slope of Georges Bank. In 5 hauls in the same area catches of 446-667 kg/hr fishing in depths of 170-245 m were obtained. All other catches were less than 100 kg/hr. Length measurements ranged between 18 and 49 cm with the mode at 29 cm (Fig. 5). The distributions of year-classes and stages of sexual maturity are given in Fig. 6 and 7. More detailed results for both species are given in Res.Doc. 72/61.

d) Other groundfish species. During the Georges Bank survey, cod, red hake (*Urophycis chuss* and *U. tenuis*), and cusk (*Brosme brosme*) were taken in very small quantities, scarcely exceeding 50 kg/hr fishing. One trawl haul yielded 1,920 kg/hr of redfish, south of Georges Bank in a depth of 330 m. The best catches of haddock (136-288 kg/hr) were made on the north of the Bank. Lengths ranged from 39 to 80 cm (Fig. 8). Negligible quantities of flatfish were taken.

e) Lobster. Catches of lobsters on the southern slope of Georges Bank were smaller than those made in the same area in 1969.

f) Deep-sea prawn, (*Pandalus borealis*). Surveys were made in Div. 4Vs, 4W and 4X. During 20 May - 6 June, 46 trawl hauls were made, 29 of which yielded a total catch of 865 kg. The best yields were obtained in Canso Deeps and on Artimon Bank (maximum 88 kg/half hour), and most of the specimens examined had a carapace length less than 25 mm.

During these trawling operations for prawn, a total of 9,700 kg of fish were taken (the total catch of prawn being only 9% of the total weight). The proportion of cod taken per 100 kg of prawn was 60 kg in May - June 1971 compared with 390 kg in March 1970. Results of these surveys are given in Res.Doc. 72/54.

GERMAN (FRG) RESEARCH REPORT, 1971

SECTION I. SUBAREA 1 and EAST GREENLAND

by

A. Meyer and W. Lenz

A. STATUS OF THE FISHERIES

1. General Trends

Table 1 gives the nominal catch off West and East Greenland, taken by the Federal Republic of Germany fleet from 1962 to 1971. Although the total output increased by 14% the 1971 catch of 86,500 tons in only 52% of the average for the 10-year period and only 35% of the maximum catch in 1963. However, in 1971 the average catch per fishing day was the third highest since 1962. This could only be achieved by very heavy fishing during the very short season of highest concentration of the cod (March to June) and very little fishing during the other months when the fish are less concentrated. In contrast to this newly developed fishing pattern the fishery off West and East Greenland during the first half of the sixties was more or less regular fishing throughout the whole year. A comparison of the 1971 situation with the high annual average for the catch per fishing day in 1962 and 1963 achieved by more or less year-round fishing with far smaller and less efficient trawlers (see Table 3) shows that there has been a considerable decrease in the size of the stocks of cod and especially of redfish.

Table 1. Subarea 1 and East Greenland: German nominal catches including industrial fish (tons), 1962-1971.

			COD			REDFISH			TOTAL		
	Year	Days fishing	Catch	Catch per day fish.	% ind.	Catch	Catch per day fish.	% ind.	Catch	Catch per day fish.	% ind.
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
	1971	1,545	37,950	24.6	1.9	3,335	2.2	2.0	42,482	27.5	2.4
E.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
	1971	1,737	28,735	16.5	0.6	14,037	8.1	2.9	44,062	25.4	2.4
Total	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
	1971	3,282	66,685	20.3	1.3	17,372	5.3	2.8	86,544	26.4	2.4

Table 2. Discarded fish in Subarea 1 in tons, 1971.

Division	Cod	Redfish	Species NK	Total
1C	5	∅	4	9
1D	4	1	1	6
1E	12	30	12	54
1F	16	22	16	54
Total	37	53	33	123

Table 3. Average gross registered tonnage of German trawlers fishing in Subarea 1, 1962-1971.

Year	Average G.R.T.	Range of G.R.T.
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)
1971	1504 G.R.T.	(691 - 2684)

2. West Greenland (Subarea 1)

The fishing activity in Subarea 1 decreased by a further 10%. However, due to only seasonal fishing from January to the middle of June and due to a very successful fishery in April on spawning cod in Div. 1C and on post-spawners in May and June in Div. 1E and 1F, 38,000 tons of cod were caught. Thus the highest annual average catch of cod per fishing day (24.6 tons) since 1962 was achieved. This catch per fishing day is, of course, no more a measure for stock abundance and of no use for assessment purposes. It is only an economic figure and shows the great availability of the concentrated cod during the spawning and post-spawning season.

Again, as in 1969 and 1970, ice (also in those parts north of Cape Desolation which up to 1968 were more or less free of ice during the whole year) hampered the fishery to a large extent. Otherwise probably more than 30 tons per fishing day would have been achieved during the time of seasonal fishing.

Only 3,300 tons of redfish were caught in 1971. This is by far the lowest catch and only 5.8% of the maximum of the 10-year period. Redfish is now only a by-catch in fishing for cod or is caught on a few trips of wet-fish trawlers in the Cape Thorvaldsen area.

3. East Greenland

As predicted in last year's report, the cod catches in 1971 exceeded the redfish catches for the first time since the beginning of the German fishery off East Greenland in 1955. The cod catches doubled to 28,000 tons, nearly reaching the maximum catch of cod in 1964. The catch per day increased by 76%, the highest since 1955. This increase in output and catch per day was due to the good state of the East Greenland spawning stock and also to the increased fishing activity of almost the whole fleet of German factory trawlers during the spawning season.

Redfish catches, taken mainly by wet-fish trawlers, decreased further to a new low of 14,000 tons, which is only 37% of the 1964 maximum.

4. Forecast for 1972

a) Subarea 1. Due to the reduced size of the cod stock of West Greenland origin, the catches in 1972 will, as in 1971, depend mainly on the cod of East Greenland origin when these cod in May and June are returning as shoals of post-spawners from East Greenland. Although the stock of East Greenland spawners is in a rather good state, the output of the fishery will be very much conditioned by the ice situation. If this fishery is again, as in the last 3 years, affected by ice the total output in Subarea 1 will be as small as in 1970 and 1971 or probably less. An unsolved question is whether the new quota regulation on herring in Subarea 5 and the announced closure of the Icelandic fishing grounds will compel the factory trawlers to reopen the fishery in Subarea 1 in the second half of the year, although there will be no chance to make this fishery a paying one.

b) East Greenland. The big spawning shoals of the 1961, 1962, 1963, and 1964 year-classes will again be very attractive, especially for the factory trawlers. The total output will depend very much on the ice situation. The fishery will be good when there is a prevailing NE wind during the spawning season and the big ice belt is pressed against the shore, thus making fishing possible on the offshore banks. As in 1971 the catches of cod will exceed those of redfish.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

In late autumn 1971 (4-11 December) hydrographic measurements were made by the R/V *Walther Herwig* off the west coast of Greenland. Five sections (Fig. 2 and 3) have been worked from Little Halibut Bank to Cape Farewell; the positions are indicated in Fig. 1.

The winter of 1972 will probably again bring severe ice situations. This was indicated by the far progression of ice in late 1971: off South East Greenland ice had already appeared in late November, and in the middle of December ice was seen up to Fyllas Bank. In early December ice-bergs were seen up to Danas Bank and ice covered the fishing areas of Nanortalik, Kitsigsut and Cape Farewell. Off Cape Farewell a tremendous conglomeration of ice-bergs was found: 15 miles south of the Cape (Sta. 211) 130 targets were visible on the radar screen within the six-mile range.

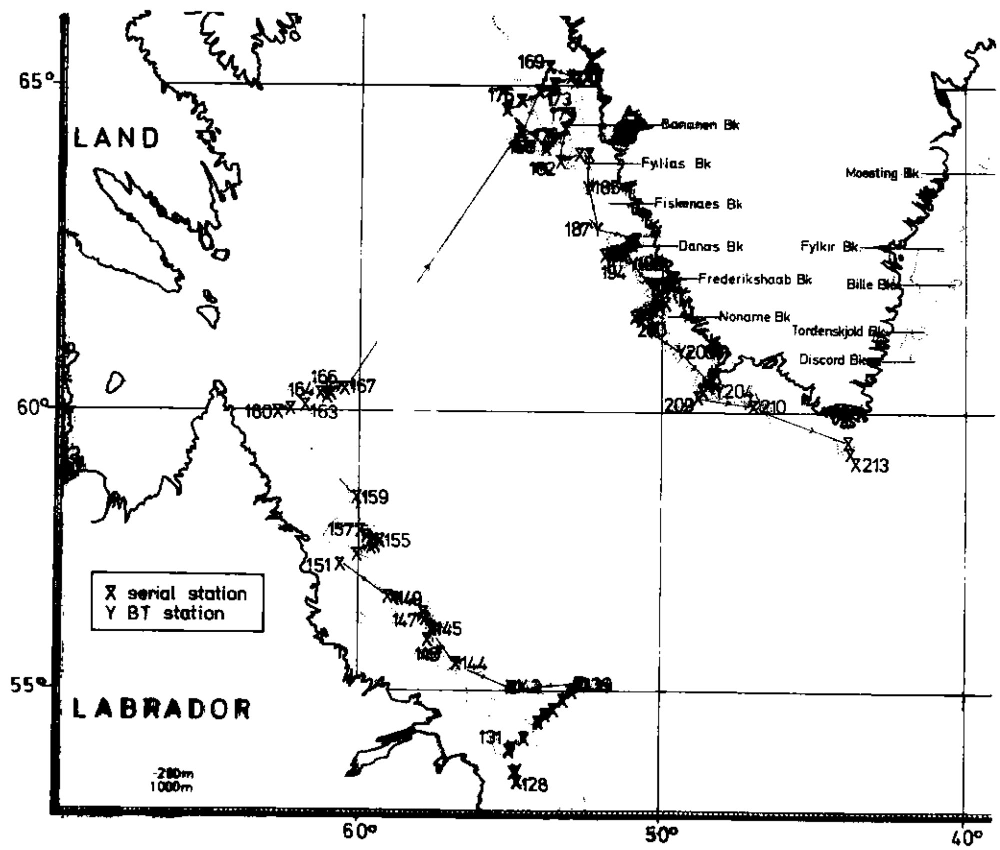

Fig. 1. Cruise track of the R/V *Walther Herwig*, 24 November - 11 December 1971.

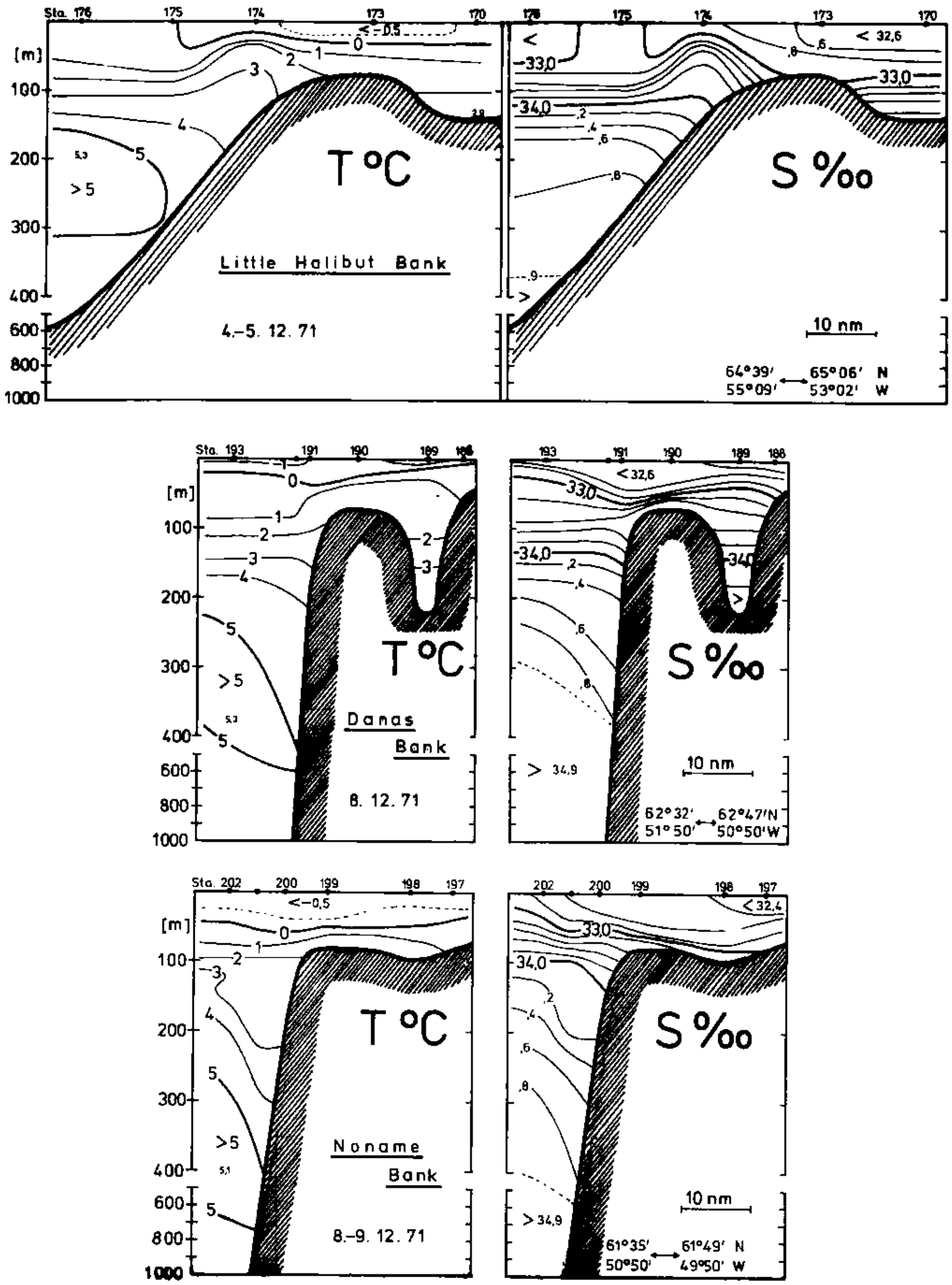

Fig. 2. Temperature and salinity sections across Little Halibut, Danas and Noname Bank for December 1971.

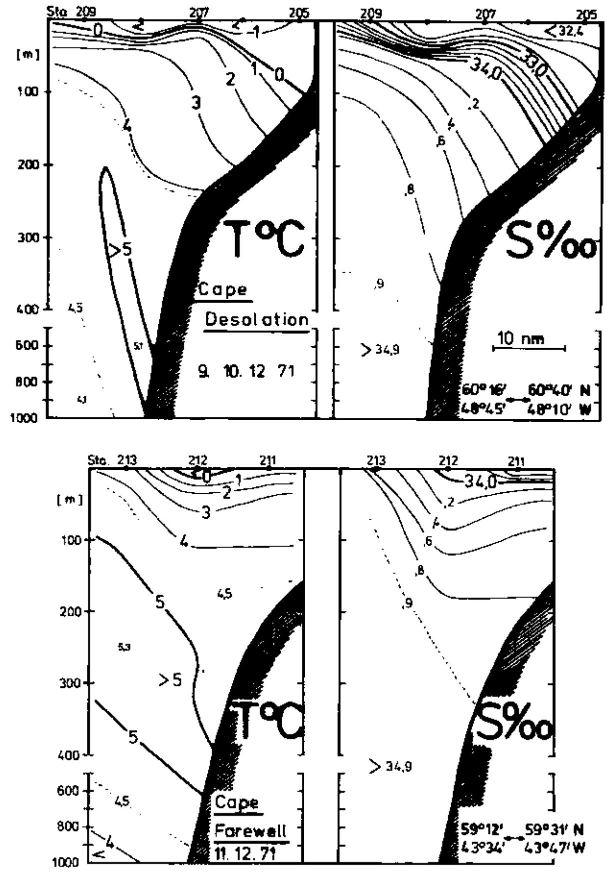

Fig. 3. Temperature and salinity sections off Cape Desolation and Cape Farewell for December 1971

Although only a few comparisons with December 1970 are possible, it might generally be said that in December 1971 the hydrographic situation off West Greenland was at least as bad as in the previous year, which means that the trend to a cooler hydro-climate continues.

Surface waters were below 0°C, sometimes below -1°C even 10 miles off the continental slope. The depth of the 0°-isotherm (corresponding to a salinity of 32.8‰) increased northwards but usually did not exceed 50 m. On top of the banks the temperature was between 1° and 2°C. In the Irminger component of the West Greenland Current the following maximum values were found: 5.36°C at 550 m depth off Fyllas Bank and 34.96‰ salinity at 600 m depth off Cape Farewell.

To give an idea of how much cooler it has become since the warmer period our measurements from early December 1971 may be compared with those from early December 1963 (first cruise of R/V *Walther Herwig*), a year which was presumably representative of a medium warm year. The mean values shown below are calculated from Noname, Fyllas, and Little Halibut Bank:

	1963	1971	Difference
T_{min} at the surface (°C)	0.1	-0.8	-0.9
S_{min} at the surface (‰)	33.01	32.44	-0.57
T_{max} in the Irminger component (°C)	5.6	5.3	-0.3
S_{max} in the Irminger component (‰)	34.99	34.94	-0.05

The negative differences in the third column show that the increasing influence of the East Greenland Current not only affected the waters at the surface but also at greater depths, which is shown by the lower salinities.

2. Biological Studies

In 1971, 32,198 length measurements and 8,406 age determinations of cod were made. They showed that in Div. 1C and 1D the 1965 and 1966 year-classes were dominating. For the third time in the history of the German fishery off West Greenland big concentrations of spawning cod were found on the western slopes of Banana Bank. Most of the fishery took place, as in the years 1961 and 1966, in great depths of 500 to more than 1,000 m. The 1965 year-class (average length 70.6 cm) dominated with 54%, followed by the year-classes 1961 (14%), 1966 (13%), and 1960 (7%). The 1962, 1963, and 1964 year-classes were almost negligible, showing again how poor these year-classes are in the cod stock of West Greenland origin. All cod older than 6 years were mature. Of the 1965 year-class 94% and of the 1966 year-class 51% had reached maturity.

In the Banana Bank fishery during the second part of June the 1963 year-class, missing in the catches of spawners, was predominate (29%), showing that these East Greenland cod, after having spawned off East Greenland, had reached Banana Bank on their northward feeding migration. The 1966 and 1965 year-classes made up 19 and 20% respectively. The average length of the 1965 year-class was 5 cm less than in the spring spawning fishery, showing that only the faster growing fish had reached maturity. Also the 5-year-old cod were smaller than those in the spawning fishery.

In the research catches of R/V *Walther Herwig* in December in Div. 1C the 1966 and 1965 year-classes dominated with 27% and 21% respectively and in Div. 1D for the first time the promising 1968 year-class (average length 39.5 cm) was strongest with 33%.

While the cod stock of West Greenland origin is at present of rather small size due to high fishing effort in the sixties and to poor year-classes after 1961, the 1965 and 1966 seem to be only of average size, the East Greenland stock (off East and Southwest Greenland) is in rather good condition due to less fishing effort, protection by ice and a succession of average to very rich year-classes (1960, <u>1961</u>, 1962, <u>1963</u>, 1964). This explains the shift of German fishery since 1968 (see German Research Report for 1970) from the northern divisions (1B to 1D) to the southern divisions (1E and 1F) and the increased importance of the East Greenland fishing grounds. In 1970 and 1971, 75% and 62% respectively of the German cod catches in Subarea 1 were taken in Div. 1E and 1F, in spite of the increasing obstruction by ice in this area.

In 1971 off southwest Greenland the rich 1963 year-class dominated with 50% (41-65%) followed by the 1964 year-class with 28% (9-46%). The 1962 and 1961 year-classes in the meantime have lost much of their commercial importance (8% and 5% respectively). The 1965 and 1966 year-classes were nearly missing off southwest Greenland; they are pure West Greenland year-classes. However research catches in the Thorvaldsen area in December 1971 revealed that the 1968 year-class is also well represented in the south (average length 3.2 cm less than on the northern banks). This means that, in the last warm year 1968, before the increase in ice flow started, off East Greenland and off West Greenland a possible more promising year-class was born. The gap of 3 years with poor recruitment (1965, 1966, 1967) off East Greenland will in the coming years negatively effect the fishery off southwest and East Greenland and will also reduce the emigration to the spawning places in Iceland waters.

In the catches of migrating and spawning cod off East Greenland during the first half of the year the rich 1963 year-class dominated with 47% off southwest Greenland and with 41% in the more northern Angmagssalik-Dohrn Bank area. The 1964, 1962, and 1961 year-classes off southwest Greenland were of almost equal strength (14-17%). However, in the northern part of East Greenland the older year-classes 1962 and 1961 reached 24 and 21% respectively, while the share of the 1964 year-class, which in 1971 and 1972 recruits to the spawning stock was still small (7%).

GERMAN (FRG) RESEARCH REPORT, 1971

SECTION II. SUBAREAS 2 - 5 (EXCLUDING HERRING)

by

J. Messtorff and W. Lenz

Subarea 2

A. STATUS OF THE FISHERIES

1. General Trends

The upper part of Table 4 gives the nominal catches taken by FRG trawlers off Labrador from 1958 to 1971. During this time three different periods of fishing activity can be distinguished.

The first period from 1958-1960 was characterized by a successful redfish fishery at the slope of the Shelf mainly in Div. 2J. On the average 83% of the total catch consisted of redfish.

During the years 1961-1964 the fishing activity of FRG trawlers was relatively low in Subarea 2 due to the preference given to the extremely good fishing conditions in Greenland waters. Apart from year to year variations the total catch taken from Subarea 2 during this second period consisted of cod (47%) and redfish (46%) in almost equal quantities.

The third period from 1965 onwards is marked by a considerable increase in fishing effort and catches in connection with a shift to a pure offshore cod fishery. To the present the average proportion of cod amounted to 95% of the total FRG catches. The peak of this fishing acitivity was reached in 1969 with a maximum cod catch of over 70,000 tons. In 1970 the FRG cod catch decreased considerably (32%) and continued to decline in 1971 to 60% of the 1970 catch.

Table 4. German nominal catches (tons) in Subarea 2 during 1958-1971, and Subarea 3 during 1962-1971 (including industrial fish = converted to fish meal on board).

			COD			REDFISH			OTHER FISH			TOTAL		
	Year	Days fished	Catch	Catch per day fished	% ind.	Catch	Catch per day fished	% ind.	Catch	Catch per day fished	% ind.	Catch	Catch per day fished	% ind.
Subarea 2	1958	622	618	1.0	-	22,909	37.0	-	516	0.8	-	24,043	38.7	-
	1959	900	3,238	3.6	-	34,604	38.5	-	345	0.4	-	38,187	42.4	-
	1960	1,156	12,145	11.4	-	29,181	25.2	-	1,305	1.1	-	42,631	36.7	-
	1961	732	11,088	15.2	-	8,307	11.4	-	1,599	2.2	-	20,994	28.8	-
	1962	93	882	9.5	4.1	1,939	20.8	15.9	68	0.7	0.0	2,889	31.1	11.9
	1963	76	1,050	13.8	12.3	941	12.4	12.0	59	0.8	67.8	2,050	27.0	13.8
	1964	495	3,559	7.2	14.4	5,079	10.3	10.5	1,029	2.1	91.3	9,667	19.5	20.5
	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
	1971	752	19,256	25.6	4.0	463	0.6	7.1	589	0.8	42.8	20,308	27.0	5.2
Subarea 3	1962	85	779	9.2	37.6	2,124	25.0	15.2	62	0.7	30.6	2,965	34.9	21.4
	1963	113	1,822	16.1	3.5	757	6.7	7.8	146	1.3	76.7	2,725	24.1	8.6
	1964	282	2,344	8.3	[a]	2,495	8.8	[a]	717	2.5	91.1	5,556	19.7	11.8
	1965	724	8,147	11.3	3.1	1,057	1.5	4.2	1,470	2.0	51.6	10,674	14.7	9.9
	1966	572	8,806	15.4	15.6	305	0.5	36.7	268	0.5	80.2	9,379	16.4	18.1
	1967	66	613	9.3	18.3	347	5.3	2.0	39	0.6	43.6	999	15.1	13.5
	1968	-	-	-	-	-	-	-	-	-	-	-	-	-
	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
	1971	434	10,747	24.8	2.3	824	1.9	3.0	299	0.7	18.1	11,870	27.4	2.8
Subareas 2 + 3	1962	178	1,661	9.3	19.8	4,063	22.8	15.5	130	0.7	14.6	5,854	32.9	16.7
	1963	189	2,872	15.2	6.7	1,698	9.0	10.1	205	1.1	74.1	4,775	25.3	10.8
	1964	777	5,903	7.6	8.7[b]	7,574	9.7	7.0[b]	1,746	2.2	91.2	15,223	19.6	17.3
	1965	2,047	49,703	24.3	11.6	3,948	1.9	2.0	2,621	1.3	55.3	56,272	27.5	13.1
	1966	2,704	72,416	26.8	8.7	3,055	1.1	15.5	1,809	0.7	51.4	77,280	28.6	10.0
	1967	1,317	31,202	23.7	8.6	1,963	1.5	14.4	349	0.3	75.9	33,514	25.4	9.6
	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	71,992	34.3	3.4	404	0.2	28.2	1,089	0.5	25.8	73,485	35.0	3.8
	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
	1971	1,186	30,003	25.3	3.4	1,287	1.1	4.5	888	0.7	34.5	32,178	27.1	4.3

[a] Included in "OTHER FISH".

[b] Industrial catch from Subarea 2 only.

The sharp decline of the Subarea 2 cod catch during the last two years was due to a considerable reduction of fishing effort (days fished) by 25% and 53% as compared to 1969 and 1970 respectively. This reduction in effort was primarily due to increasing severe ice conditions off Labrador in spring which forced the fleet to leave the fishing grounds much earlier than in former years. Even a shift of effort to the adjacent Div. 3K where more or less the same cod population was fished could in no way compensate for the losses in Subarea 2 and even there, fishing operations were handicapped by extended drift ice in spring 1971. The combined nominal catches of Subareas 2 + 3 are given at the bottom of Table 4 for comparison. In 1971 the combined catches of cod amounted to only 30,000 tons or 52% of the 1970 catch and only 42% of the record catch in 1969. This proved to be the exact maximum yield forecast for 1971 in the FRG 1970 Report (*Redbook* 1971, Part II, p. 75).

Fishing activity was recorded in Subarea 2 only from beginning of January to 18 February, when ice stopped operations. It started off Cape Mugford (Div. 2G-H), but ice forced the fleet to move southward to Div. 2J in mid-January, where 95% of the Subarea 2 catch was taken during the remaining four weeks of the very short season. Compared to the average of the preceding three years the catch of cod per fishing day had decreased by 23%. Fishing operations were carried out exclusively by factory trawlers of an average size of 1863 GRT (916 - 2684).

As in the three preceding years the redfish by-catch remained unimportant and amounted to only 2% of the total catch in Subarea 2.

The quantities of fish discarded are given in Table 5.

Table 5. Discarded fish in Subareas 2 and 3 in tons, 1971 (1970 in brackets).

	COD		REDFISH		OTHER FISH		ALL SPECIES	
Div. 2G	2	(-)	-	(-)	-	(-)	2	(-)
Div. 2H	4	(42)	-	(1)	2	(2)	6	(45)
Div. 2J	57	(592)	7	(82)	35	(221)	99	(895)
Total	63	(634)	7	(83)	37	(223)	107	(940)
Div. 3K	27	(-)	5	(35)	7	(15)	39	(50)

2. Forecast for 1972

Fishing operations of FRG trawlers in Subarea 2 and Div. 3K were again restricted by very severe ice conditions to the first quarter of 1972. After preliminary estimates their total catch of cod is not expected to exceed that of 1971, but will probably be even smaller (about 25,000 tons).

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Hydrographic observations were carried out by R/V *Walther Herwig* between 25 and 30 November 1971 consisting of three sections across the Shelf off southern (Div. 2J), middle (Div. 2H) and northern Labrador (Div. 2G) as shown in Fig. 4. For the position of these sections see the cruise track in Fig. 1.

Comparisons with earlier investigations by R/V *Walther Herwig* in October 1967 and 1969 (*Redbook* 1968, Part II, p. 56-58), and *Redbook* 1970, Part III, p. 40) show that in general the water temperatures observed in 1971 were slightly lower by some tenths of a degree. Although the measurements in 1971 were taken four weeks later than in the previous years, the advanced winter cooling cannot be the only cause for the lower temperatures, because they were found down to 1,000 m (T_{max} = 4.3°C in the West Greenland component of the Labrador Current). With this lower salinities were also found: at the surface less than 32.6 °/₀₀ and in deep water off the slope never exceeding 35.0°/₀₀. Therefore the lower values are thought to be a consequence of the cold years 1969-70.

The cold water layer with temperatures below 0°C was found to be 100-150 m thick off Cape Chidley, about 100 m thick off middle Labrador and it disappeared somewhere about 56°N latitude. There was obviously no connection with the cold water body of temperatures below 0°C observed on Hamilton Bank, which is supposed to be a residue of the previous winter cooling. This is indicated by considerably higher salinities (>33°/₀₀) than those observed in the cold water of polar origin (<32.2°/₀₀) in the northern sections. Attention is

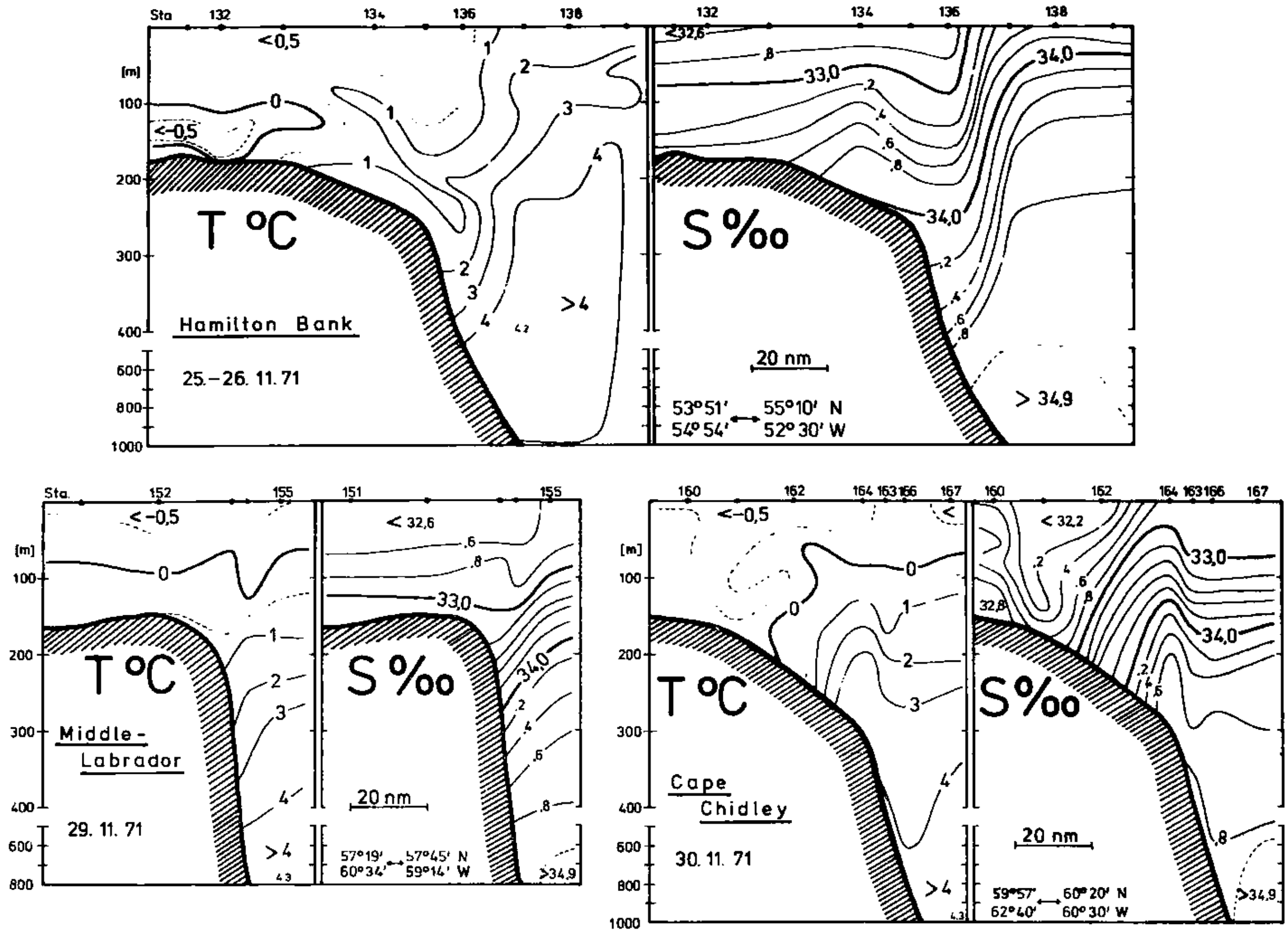

Fig. 4. Temperature and salinity sections in November 1971 off Labrador.

also drawn to some peculiarities in the structure of the isotherms (Fig. 4). Off Cape Chidley there are symptoms of a vertical eddy indicating the core of a strong current. At the outer part of Hamilton Bank a couple of complicated inversions were found in a matter very similar to 1969 (*Redbook* 1970, Part III, p. 40).

2. Biological Studies

R/V *Walther Herwig* carried out a one week groundfish survey off Labrador including Div. 3K in late November 1971. Of 26 hauls in varying depths 8 were completed in Div. 2J and 6 each in Div. 3K, 2H and 2G. The total catch amounted to 17,522 kg fish (947 kg/trawling hour) of which 18% consisted of cod (3,087 kg = 2,468 fish, mean weight 1.25 kg). Length measurements and otoliths were taken from 1,414 cod.

Preliminary results indicate that over 80% of cod were 5-8 years old (1963-66 year-classes). Mean lengths of cod were below 50 cm in all four divisions (3K - 47.8; 2J - 47.5; 2H - 43.8; 2G - 49.4). Maximum length recorded was 80 cm and only 1% of cod measured between 70-80 cm.

Other priority species sampled for length frequency distribution were redfish (16% of total catch weight), Greenland halibut (20%) and roundnose grenadier (37%). The rest (9%) consisted of 37 other species, some of which were also sampled for length distribution.

Subarea 3

A. STATUS OF THE FISHERIES

The nominal catches taken by FRG trawlers during 1962-71 are given in the middle of Table 4. The total catch given for 1971 was taken mostly in Div. 3K but about 15% of the catches were from Flemish Cap (Div. 3M). These latter were taken during the first half of March when fishing operations in Div. 3K were stopped by ice. As in the previous year fishing operations in Div. 3K and 2J overlapped and were more or less directed towards the same cod population. About 78% of the total catch from Div. 3K was taken during a very short period of 2-3 weeks after mid-February. For additional information see above for Subarea 2.

B. SPECIAL RESEARCH STUDIES

See Special Research Studies for Subarea 2.

Subarea 4

A. STATUS OF THE FISHERIES

Except for herring, there was no commercial fishery in this subarea.

B. SPECIAL RESEARCH STUDIES

Selectivity experiments on cod were carried out by R/V *Walther Herwig* in August - September 1971 in Subdiv. 4Vn.

Subarea 5

A. STATUS OF THE FISHERIES

Except for herring, there was no commercial fishery in this subarea.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Hydrographic observations were carried out by R/V *Walther Herwig* during 31 October - 12 November 1971 in connection with the ICNAF Larval Herring Survey in the Gulf of Maine - Georges Bank area. At each ichthyoplankton station BT measurements plus surface and bottom temperatures and also at selected stations forming two N-S sections across the eastern and western part of Georges Bank on 67°W and 69°W respectively complete hydrographic casts were obtained.

The temperature and salinity distribution on Georges Bank as shown in Fig. 5 (eastern section) and Fig. 6 (western section) was found to be almost the same as observed in November 1969 (*Redbook* 1970, Part III, p. 47-48) except that the temperatures on top of the Bank were considerably higher in November 1971. The distribution of surface and bottom temperatures in the surveyed area (Fig. 7) show that the observed maximum temperatures of 13-15°C were found, except west of 70°W, only over Georges Bank, whereby they were restricted to the top of the Bank at the bottom and extended beyond the slopes at the surface

2. Biological Studies

R/V *Walther Herwig* took part in the ICNAF Larval Herring Survey in the Gulf of Maine - Georges Bank area from 31 October to 12 November 1971. At 118 stations oblique plankton tows using paired 60 cm bongo nets were made from a maximum depth of 200 m at a speed of 3.5 knots. At 101 stations additional surface tows with a neuston net were obtained at the same time.

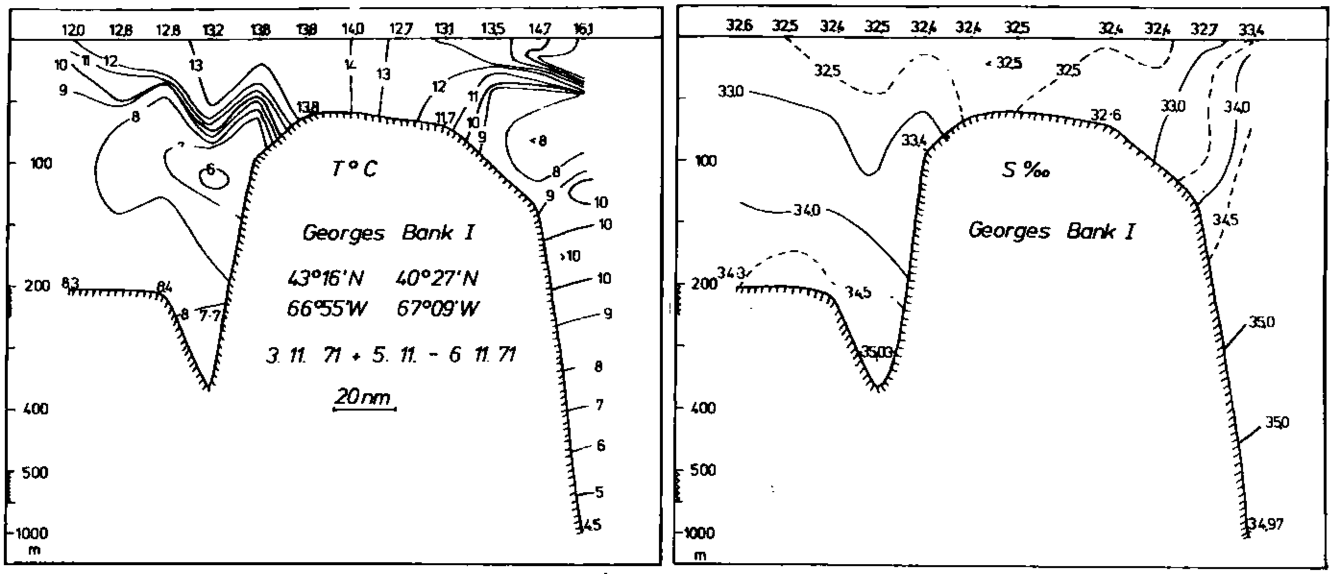

Fig. 5. Temperature and salinity for Georges Bank (eastern section) in November 1971.

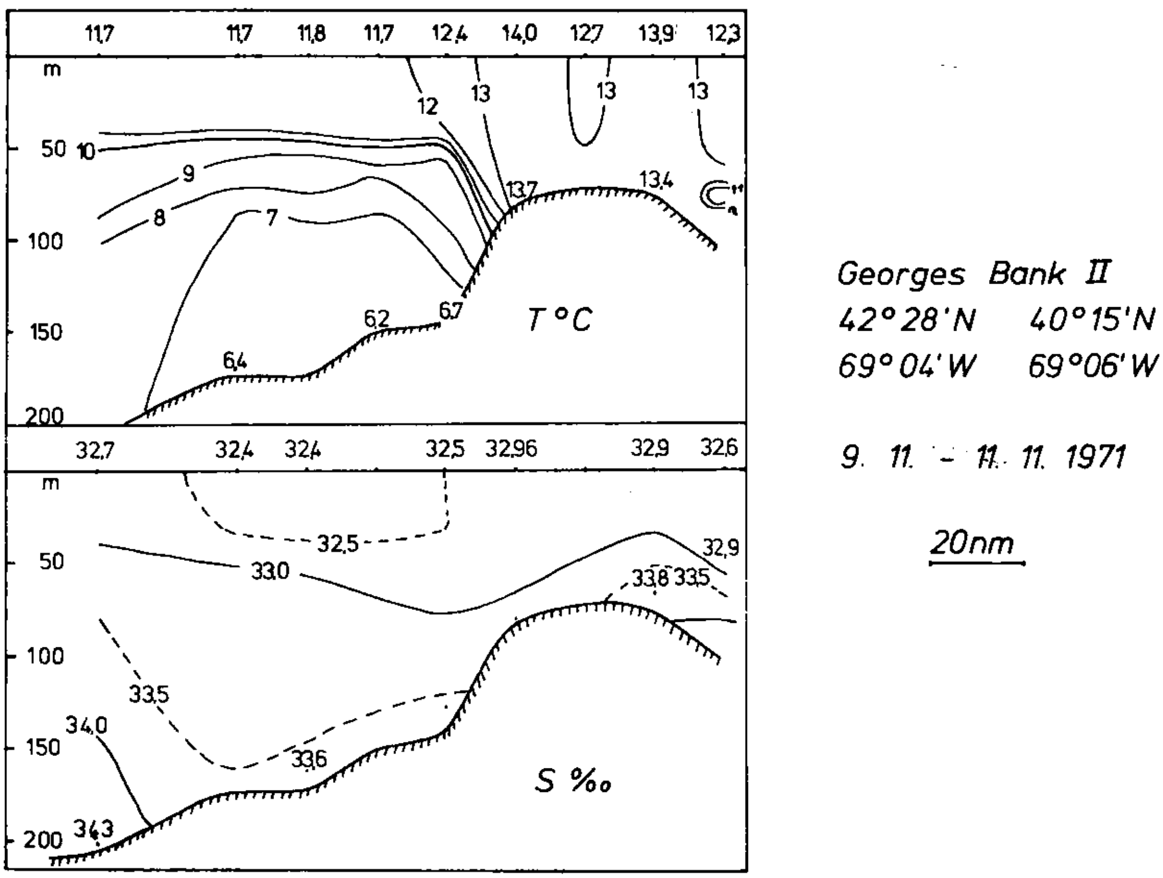

Fig. 6. Temperature and salinity for Georges Bank (western section) in November 1971.

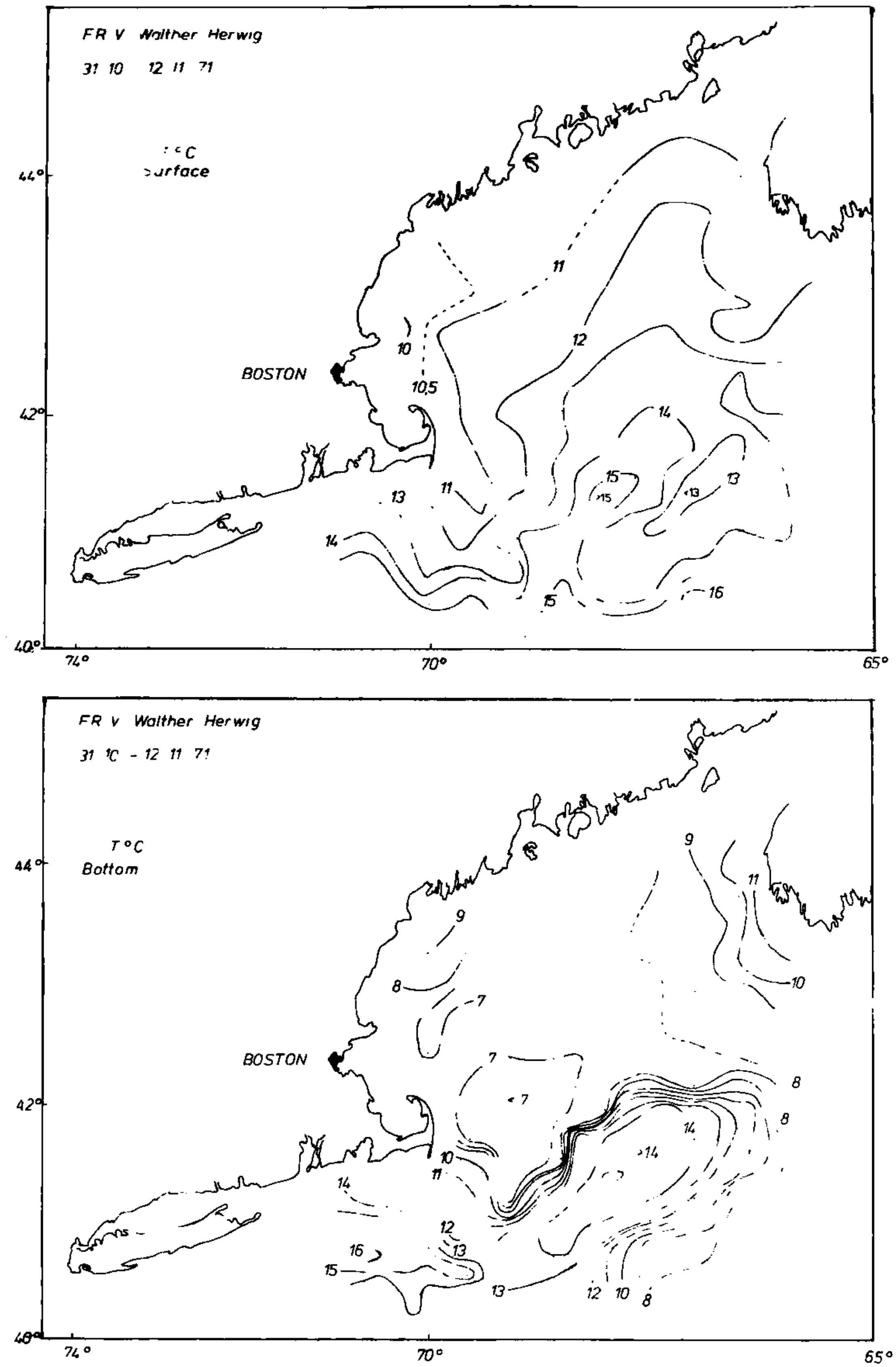

Fig. 7. Surface (upper) and bottom (lower) temperatures in the Georges Bank Area in November 1971.

GERMAN (FRG) RESEARCH REPORT, 1971

SECTION III. SUBAREAS 4, 5 and 6 (HERRING ONLY)

by

K. Schubert

A. STATUS OF THE FISHERIES

A few trawlers (3) from the 1970 season were still fishing in January in Subareas 4, 5 and 6. Fifteen stern freezer trawlers operated with pelagic nets in Subarea 5 from the middle of June to December 1971. The total catch in Subdiv. 4Vn in January amounted to 68 tons, in Div. 5Y - 226 tons, in Subdiv. 5Zw - 291 tons and in Div. 6A - 11 tons. From July to December the fifteen trawlers yielded 52,680 tons in Subarea 5. The main catch of 55,243 tons came from Subdiv. 5Ze and only 963 tons (December) from Div. 5Y and 74 tons (December) from Subdiv. 5Zw.

In Subarea 5 the catch decreased from 88,561 tons in 1970 to 56,860 tons in 1971. This decrease was due to effort which decreased from 2,056 to 1,250 fishing days, whereas the catch per day slightly increased from 42.5 to 45.5 tons.

Monthly catch, total catch, effort, catch-per-unit effort and discarded fish are given in Table 6.

Table 6. Nominal catch (tons), effort (days), catch-per-unit effort (tons) and discards (tons) of German freezer trawlers in Subareas 4, 5 and 6 in 1971.

Division	4Vn	5Y			5Ze								5Zw			5	6A
Month	Jan	Jan	Dec	Total	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Total	Jan	Dec	Total	Total	Jan
Nominal catches (tons)																	
Herring	68	226	963	1189	63	3215	4682	12887	21183	10423	2853	55306	291	74	365	56860	11
Mackerel	-	296	38	334	83	-	-	3	4	5	383	478	26	392	418	1230	1484
Saithe	-	109	395	504	30	-	-	-	-	2	-	32	98	-	98	634	-
Total	68	631	1409	2040	176	3216	4739	13061	21254	10438	3327	56211	420	467	887	59138	1495
Effort																	
Days fishing	10	29	51	80	6	57	147	317	299	234	87	1147	12	11	23	1250	35
Catch per day (tons)																	
Herring	6.8	7.8	18.9	14.9	10.5	56.4	31.9	40.7	70.8	44.5	32.8	48.2	24.3	6.7	15.9	45.5	0.3
Mackerel	-	10.2	0.7	4.2	13.8	-	-	0	0	0	4.4	0.4	2.2	35.6	18.2	1.0	42.4
Saithe	-	3.8	7.8	6.3	5.0	-	-	-	-	0	-	0	8.2	-	4.3	0.5	-
Total	6.8	21.8	27.6	25.5	29.3	56.4	32.2	41.2	71.1	44.6	38.2	49.0	35.0	42.5	38.6	47.3	42.7
Discards (tons)																	
Herring	-	-	-	-	-	210	30	1223	4603	1235	80	7381	-	-	-	7381	-
Total	-	-	-	-	-	210	38	1331	4663	1235	90	7567	-	70	70	7637	-

Average gross registered tonnage of German trawlers fishing for herring in the ICNAF Area were as follows: Subarea 4 - 1842 GRT; Subarea 5 - 2157 GRT (1398-2684); Stat. Area 6 - 1705 GRT (1568-1842).

Fig. 8 shows the catch per day in baskets (50 kg) on an average of about 5 days of 14 German freezer trawlers in 33 trips in Subdiv. 5Ze from the end of June 1971 to the first ten days of November. There was a large increase in catches with the beginning of the spawning time in September.

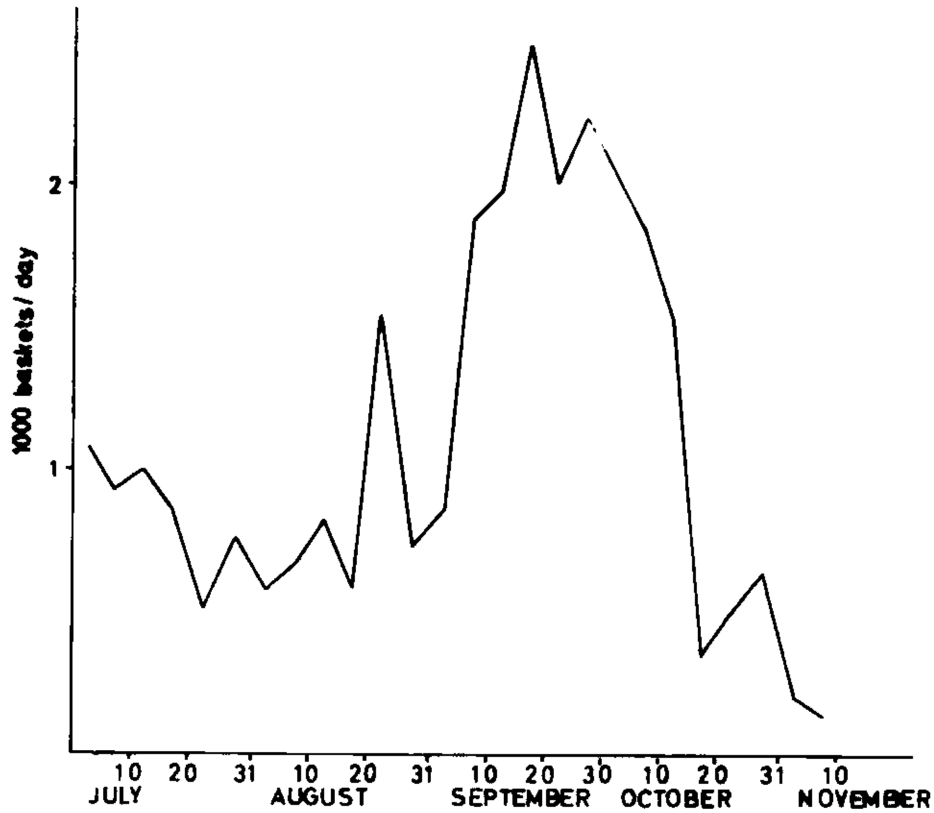

Fig. 8. Herring catch/day (baskets) on an average of about 5 days for 14 German freezer trawlers in 33 trips in Subdiv. 5Ze out of a total of 37 trips in 1971.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

During spawning some hydrographic measurements were made by a member of the staff of our Institute on board of our fishery protection vessel *Poseidon*. The main spawning area was, as observed in 1969 and 1970, situated on the northern edge of Georges Bank in depths from 40 to 80 m. The spawning area extended from 41°30'N - 42°20'N and 66°W - 68°W.

The first spawning was observed on 28 August. However, the main spawning started about 8-10 days later. Spawning occurred first in the western part of the area (67° - 68°W), where larger herring were caught, and shifted at the beginning of October more to the east (66°30' - 67°W) where younger fish occurred.

The spawning areas were situated in a narrow band along the northern edge of the Bank with bottom temperatures of 10° - 13°C. It seems that the herring were coming in from the northern and northwestern area where bottom water temperatures were cooler.

2. Biological Studies

On board of trawlers in Subdiv. 5Ze, 18,466 herring were measured (Table 7). The average length was 26.51 cm (n = 366) in August, 29.93 cm (n = 11,347) in September and 28.53 cm (n = 6,753) in October.

Table 7. Length composition of herring in Subdivision 5Ze in 1971 (based on measurements on board of trawlers).

Length (cm)	Month		
	August	September	October
20	11	-	-
21	16	-	-
22	27	-	-
23	68	-	-
24	140	+	+
25	233	11	18
26	162	74	174
27	79	138	306
28	82	146	185
29	79	169	120
30	52	161	87
31	19	111	48
32	19	81	27
33	8	60	14
34	5	36	11
35	-	12	7
36	-	1	3
Total °/₀₀	1000	1000	1000
No. of samples	4	28	12
No. measured	366	11347	6753
Mean length (cm)	26.51	29.93	28.53
Mean weight (kg)	0.178	0.221	0.200

From these measurements 12 samples were examined for size and age composition (August = 4, September = 5, October = 3). The average length of these sample measurements are in good agreement with the measurements on board of the trawlers. The average length in the different months was 26.51 cm, 29.40 cm and 28.11 cm (Table 8).

The length measurements of spawning herring (Fig. 9) show that early in the spawning season larger fish were in the area (curve A), whereas in the first 10 days of October the proportion of smaller herring increased considerably, and the number of larger herring decreased (curve B). The total curve (A + B) shows that the number of smaller herring were predominant during the spawning period.

Maturity stages 5 (41.8%) and 4 (34.1%) were dominant in August (Table 8). Maturity stage 2 was also of some importance (16.1%). In September only spawning herring (stage 6) were in the catches, and in October the bulk of the catches consisted of herring in maturity stage 6 (99.7%) with some spent herring (stage 7).

The age composition (Table 8) shows the predominance of 3-year-old herring (1968 year-class) with 61.8%. The 4-year-old herring (1967 year-class) had some importance with 15.7%. In September older herring were in the catches: 4-year (1967), 3-year (1968) and 5-year-old specimens (1966) formed with 34.5%, 25.1% and 22.0% respectively. In September the age composition changed to younger herring: 3-year-old (1968 year-class) and 4-year-old herring (1967 year-class) were dominant with 55.5% and 31.8%.

The average number of vertebrae varied between 56.33 and 56.42, the keeled scales between 13.95 and 13.98 and the gillrakers between 48.93 and 49.44 (Table 8 (Continued)).

Table 8 also gives the mean length and mean L_1 (cm) by age.

Table 8. Biological data for herring in Subdivision 5Ze, 1971.

Year-Class	Age	Age composition (°/°°) Aug	Sep	Oct		Length (cm) Aug	Sep	Oct	L_1 (cm) Aug	Sep	Oct
					$\bar{x}$	22.61	-	23.50	14.50	-	-
1969	2	73	-	3	s'	1.796	-	-	16.000	-	-
					n	27	-	1	3	-	-
						25.48	27.02	26.94	14.31	15.72	15.46
1968	3	618	251	553		1.387	0.977	0.720	4.003	2.451	5.959
						226	120	160	26	9	26
						28.43	28.91	28.86	17.06	16.20	16.75
1967	4	157	345	318		0.888	1.036	1.333	10.803	6.910	7.804
						57	165	92	9	10	16
						29.42	30.42	30.37	13.17	14.83	15.10
1966	5	66	220	79		0.776	0.975	0.847	4.389	7.264	12.340
						24	105	23	3	9	5
						30.32	31.73	31.30	13.50	13.40	16.00
1965	6	32	90	17		0.747	1.041	1.210	-	4.768	4.750
						12	43	5	1	10	2
						31.00	32.40	32.50	11.50	12.50	-
1964	7	11	21	3		0.333	0.990	-	-	-	-
						4	10	1	1	1	-
						32.23	32.61	34.50	13.00	-	-
1963	8	30	19	3		1.425	0.863	-	0.500	-	-
						11	9	1	2	-	-
						-	32.50	-	-	15.00	-
1962	9	-	10	-		-	-	-	-	0.500	-
						-	5	-	-	2	-
						33.30	33.45	34.07	11.50	12.25	14.50
<1962	>9	13	44	24		0.710	0.748	1.316	-	8.270	-
						5	21	7	1	4	2
					$\bar{x}$	26.51	29.40	28.11	14.63	14.72	15.81
Total	°/°°	1000	1000	1000	s^2	6.530	4.252	3.624	7.627	6.496	6.861
	n	366	478	290	n	366	478	290	46	45	51

Year-Class	Age		Vertebrae Aug	Sep	Oct	Keeled scales Sep	Oct	Gillrakers Aug	Sep	Oct
1970	1		-	-	-	-	-	-	-	-
		$\bar{x}$	56.19	-	56.00	-	15.00	48.48	-	50.00
1969	2	s^2	0.235	-	-	-	-	2.269	-	-
		n	27	-	1	-	1	27	-	1
			56.49	56.43	56.42	13.98	14.00	48.64	48.82	48.84
1968	3		0.399	0.481	0.372	0.562	0.589	2.196	2.858	2.246
			220	120	159	74	159	225	120	160
			56.40	56.35	56.18	14.11	13.87	49.53	49.51	49.70
1967	4		0.359	0.402	0.413	0.805	0.650	3.186	2.826	3.271
			55	162	91	83	91	57	165	92
			56.29	56.36	56.22	13.87	13.91	50.00	49.72	49.91
1966	5		0.393	0.465	0.453	0.726	0.468	2.267	2.578	2.455
			24	105	23	63	22	24	105	23
			56.08	56.41	56.60	13.94	14.40	49.67	49.58	49.80
1965	6		0.448	0.421	0.300	0.785	0.799	1.162	2.819	2.210
			12	42	5	34	5	12	43	5
			56.25	56.22	56.00	13.80	13.00	49.50	50.60	47.00
1964	7		0.270	0.201	-	0.404	-	6.750	1.840	-
			4	9	1	10	1	4	10	1
			56.36	56.33	57.00	14.50	14.00	49.00	49.67	51.00
1963	8		0.468	0.264	-	0.750	-	1.400	3.514	-
			11	9	1	6	1	11	9	1
			-	56.20	-	13.80	-	-	50.20	-
1962	9		-	0.210	-	0.210	-	-	4.710	-
			-	5	-	5	-	-	5	-
			56.40	56.29	56.57	14.00	13.71	49.80	49.81	49.57
<1962	>9		0.340	0.418	0.310	0.333	0.251	0.210	2.364	0.983
			5	21	7	13	7	5	21	7
		$\bar{x}$	56.42	56.37	56.33	13.98	13.95	48.93	49.44	49.24
Total		s^2	0.384	0.412	0.396	0.678	0.595	2.542	2.893	2.728
		n	358	473	288	288	287	365	478	290

Sexual Maturity °/°° Stages	Aug	Sep	Oct
1	1	-	-
2	161	-	-
3	77	-	-
4	341	-	-
5	418	-	-
6	-	1000	997
7	-	-	3
8	-	-	-
Total	1000	1000	1000
n	366	487	300

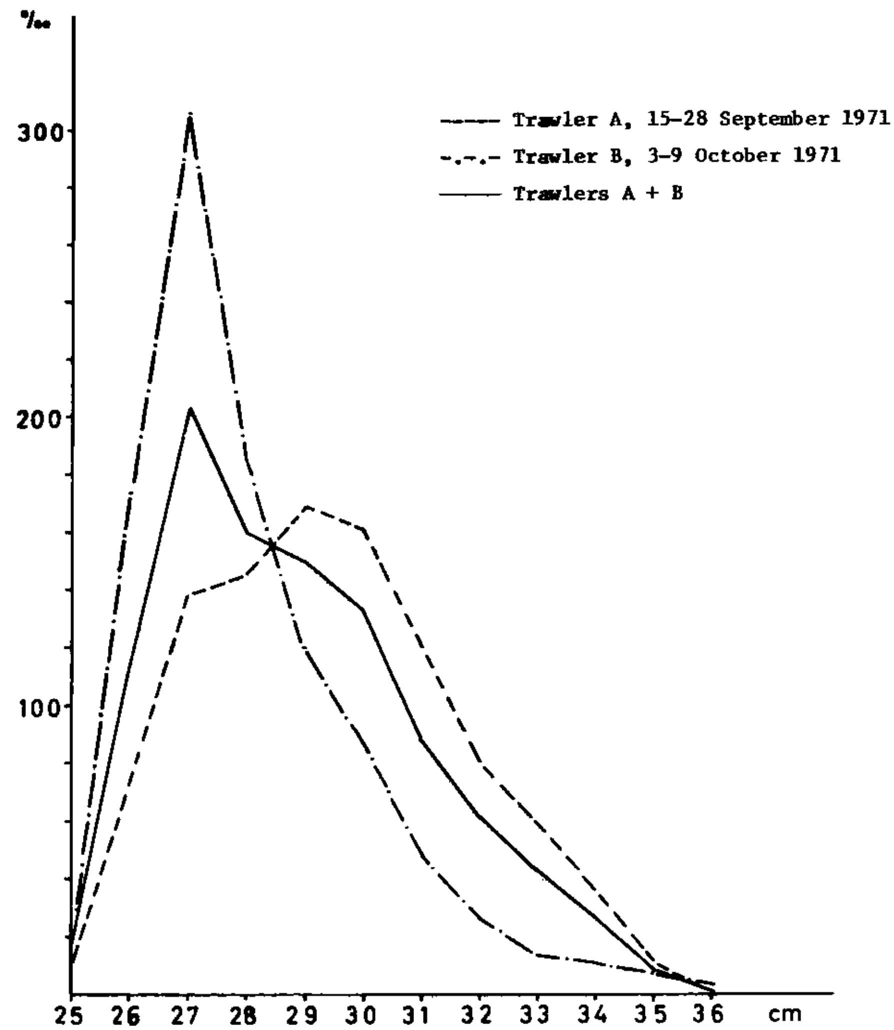

Fig. 9. Length compositions of spawning herring in Subdiv 5Ze in 1971.

JAPANESE RESEARCH REPORT, 1971

by

Ikuo Ikeda

Japanese trawlers fished in Subareas 3, 4 and 5 and in Statistical Area 6 during 1971, taking a total of 41,395 tons. Principal species caught were squids (10,596 tons), argentines (9,003 tons), redfish (8,704 tons), butterfish (5,771 tons), herring (3,234 tons) and mackerel (1,025 tons).

Subarea 3

A. STATUS OF THE FISHERIES

The catch by Japanese trawlers in Subarea 3 increased from 3,500 tons in 1970 to 8,100 tons in 1971 (Table 1). The catch was dominated by redfish followed by argentine. Fishing grounds for redfish were in Subdiv. 3Ps and Div. 3L, 3M and 3O.

Table 1. Japanese catch in Subarea 3, 1968–71.

Year	1968	1969	1970	1971*
Hours fished	1,043	410	1,861	
Total catch (tons)	1,672	810	3,511	8,071
Argentine	145	106	793	445
Redfish	774	533	2,586	7,536
Cod	574	83	49	9
Haddock	6	1	6	-
Flatfishes	38	21	4	-

* Preliminary

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

Length measurements for redfish and argentine were made on board commercial trawlers. In Subdiv. 3Ps and 3O, measurements of redfish were carried out in April and June - October. The size composition shifted toward small size in August with a fork length range of 11-29 cm (Fig. 1). It seems that the trawlers fished shallower grounds in August than in other months.

Subarea 4

A. STATUS OF THE FISHERIES

Japanese trawlers in this subarea caught mainly argentine and redfish. In 1971, the herring catch, mostly in Div. 4X, increased to over 770 tons (Table 2). Fishing grounds for argentine were in Div. 4X as in 1970, and redfish were taken in deep water on the eastern slope (Subdiv. 4Vs).

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

Length measurements of argentine and redfish were made on board commercial trawlers. The size composition of argentine in Div. 4X in May and June ranged from 27 to 42 cm (Fig. 2). In 1971 the mode of the frequency distribution was at 35-36 cm fork length, compared with a mode of 29-30 cm in Div. 4X in June 1970.

Table 2. Japanese catch in Subarea 4, 1968-71.

Year	1968	1969	1970	1971*
Hours fished	1,075	896	2,176	
Total catch (tons)	2,012	1,936	4,779	5,507
Argentine	1,086	1,256	2,940	3,160
Redfish	524	251	967	1,164
Mackerel	19	1	0	-
Herring	9	14	100	768
Silver hake	76	213	128	8
Cod	21	39	154	6
Haddock	18	20	13	1
Flatfishes	28	21	9	-
Squids	94	-	22	-

* Preliminary

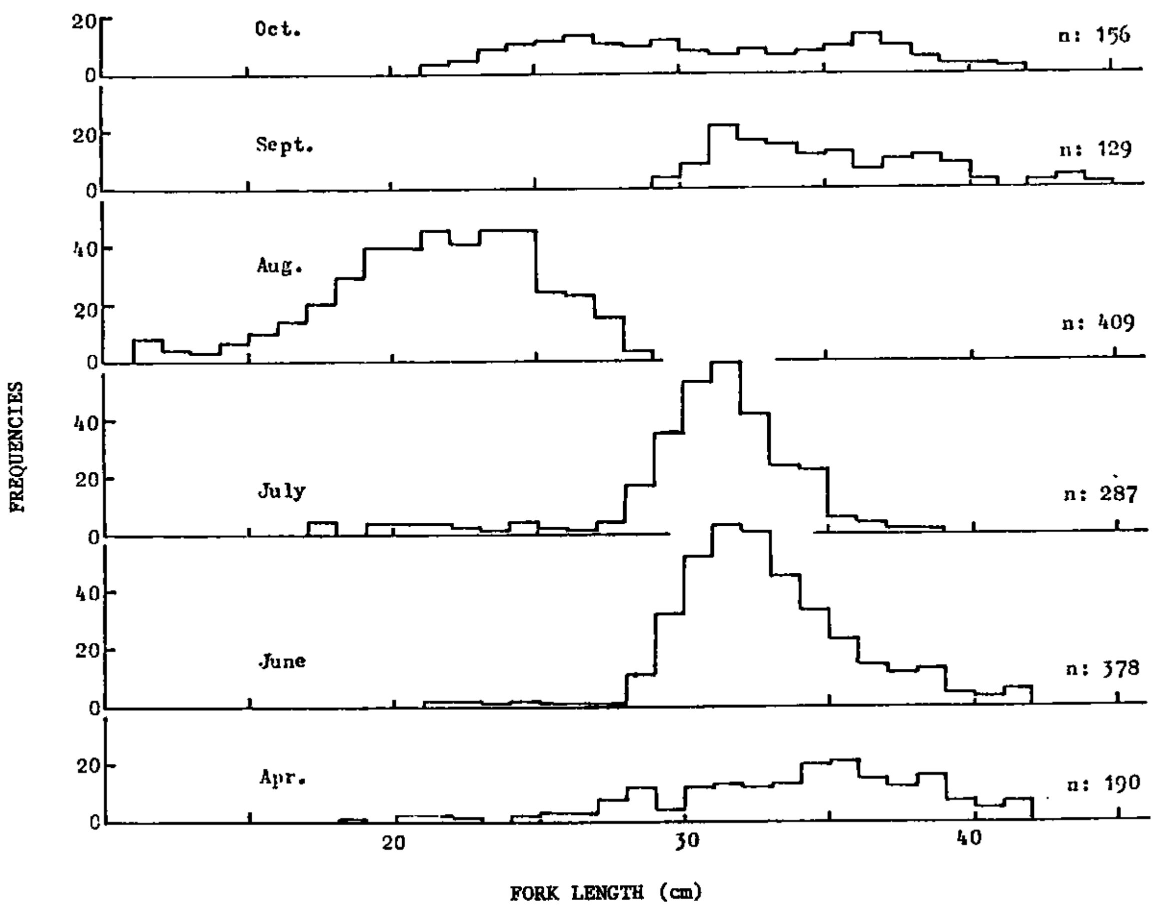

Fig. 1. Size composition of redfish caught by Japanese trawlers in Div. 3Ps and 3O during April and June to October 1971.

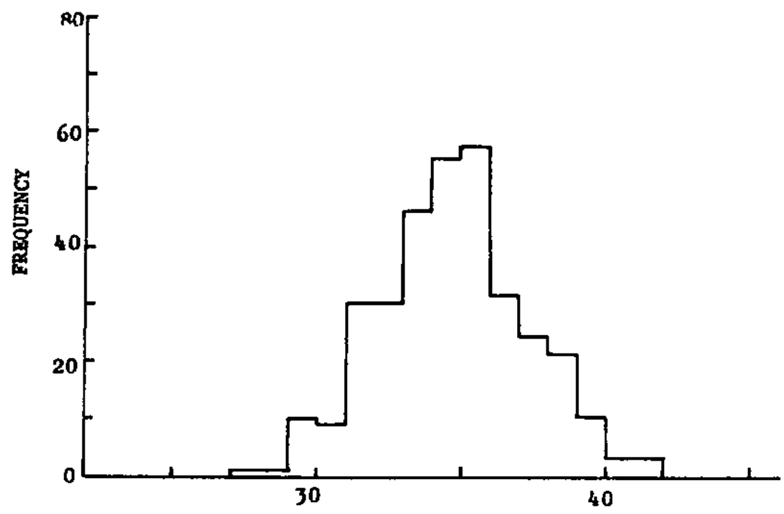

Fig. 2. Size composition of argentine caught in Div. 4X during May and June 1971.

Subarea 5

A. STATUS OF THE FISHERIES

The catches of Japanese trawlers in Subarea 5 increased from 10,700 tons in 1970 to 15,300 tons in 1971. Catches by species show that the catch of argentine increased substantially, the catch of herring was twice as large as in the previous year, while the catches of butterfish and squids decreased (Table 3). Most of the fishes were caught in Subdiv. 5Ze. While the catch in Subarea 5 increased, the catches from Statistical Area 6 including 47% of squids and 38% of butterfish decreased from 18,800 tons in 1970 to 12,500 tons in 1971. This is due to the fact that the activity of the trawlers shifted to the northern fishing grounds because of good catch of argentine in Subdiv. 5Ze.

Table 3. Japanese catch in Subarea 5, 1968-71.

Year	1968	1969	1970	1971*
Hours fished	540	8,216	9,310	
Total catch (tons)	724	8,789	10,722	15,289
Argentine	-	976	368	6,398
Redfish	0	61	19	4
Butterfish	328	1,291	1,724	973
Mackerel	1	197	463	272
Herring	1	527	1,222	2,434
Silver hake	52	229	73	103
Cod	2	45	15	20
Haddock	3	9	1	10
Flatfishes	2	79	138	-
Squids	113	3,902	5,086	4,610

* Preliminary

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

a) Butterfish. Length measurements were made on 1,104 individuals taken in Subarea 5 and Statistical Area 6. The size compositions by divisions and months are shown in Fig. 3.

b) Argentine. In Div. 5Y and 5Ze, 2,034 individuals were measured during February to June. Size compositions (Fig. 4) indicate an increase in size caught from February to March and April and a decrease in May and June.

c) Squids. A breakdown of squids by species, short finned squid (*Illex illecebrosus*) and common American squid (*Loligo pealeii*), was made on board the sample vessel during the summer and winter in 1971. Length measurements of 2,475 specimens were made in Subarea 5 and Statistical Area 6. Size composition by divisions and months are shown in Fig. 5. Generally speaking, the smaller sized squid (less than 10 cm) and the larger squid (more than 20 cm in mantle length) are more abundant in October to December than in January and February.

Catch composition by species of squids observed from the sample vessel is shown in Table 4. Although the length composition by species is not available, it is possible to assume that the length compositions in summer (given in Fig. 5) are mostly for short finned squid and these in winter are mostly for common American squid.

Table 4. Species breakdown of squids (catches in kg) in Subareas 4 and 5 and Statistical Area 6 during July to December 1971. (*Loligo* = common American squid, *Illex* = short finned squid)

Month	July		Aug		Oct		Nov		Dec	
Species	*Loligo*	*Illex*	*Loligo*	*Illex*	*Loligo*	*Illex*	*Loligo*	*Illex*	*Loligo*	*Illex*
Division										
4X	-	-	0	4,450	-	-	-	-	-	-
5Y	-	-	0	1,760	-	-	-	-	-	-
5Ze	-	-	0	3,210	0	0	110	40	-	-
5Zw	-	-	-	-	-	-	880	0	-	-
6A	0	3,950	-	-	180	0	2,930	150	15,100	500
6B	10	8,840	-	-	3,040	30	35,295	1,100	91,440	900
6C	220	18,579	-	-	5,247	0	13,990	370	-	-
Total	230	31,369	0	9,420	8,467	30	53,205	1,660	106,540	1,400

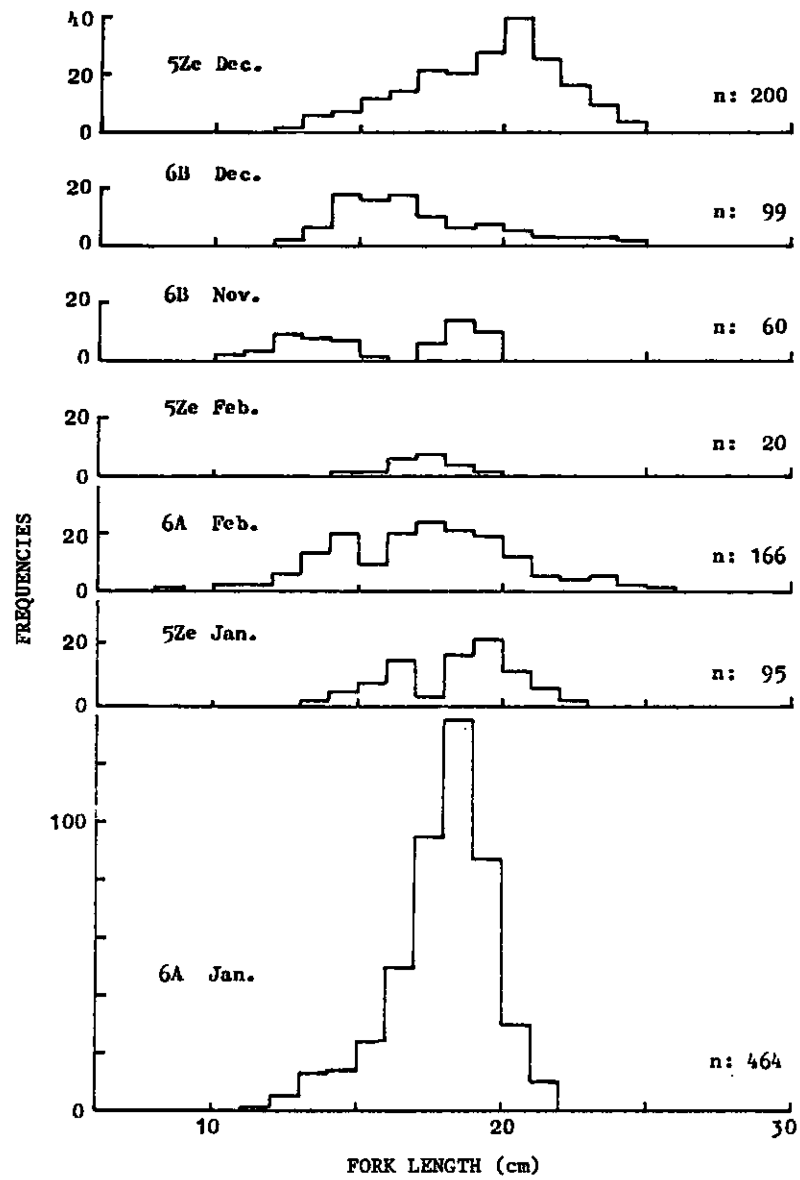

Fig. 3. Size composition of butterfish by division and month in 1971.

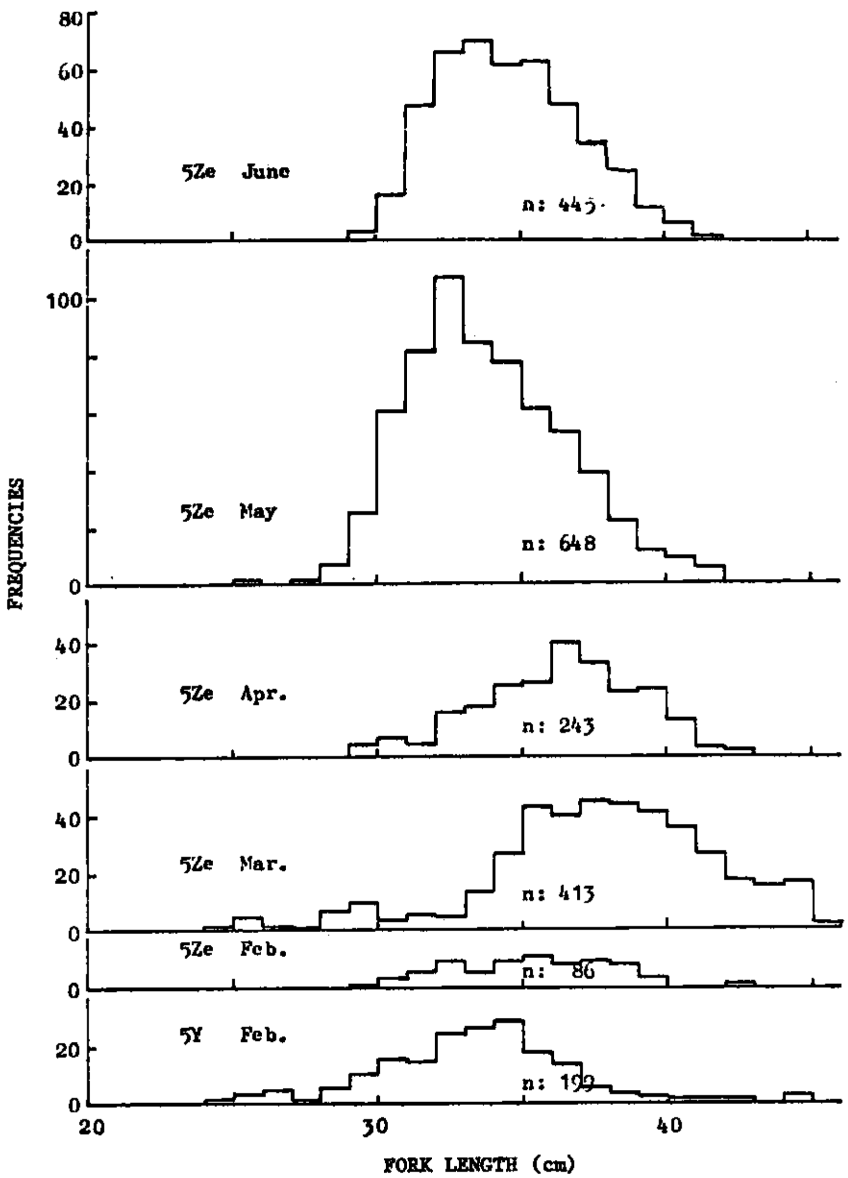

Fig. 4. Size composition of argentine by division and month in 1971.

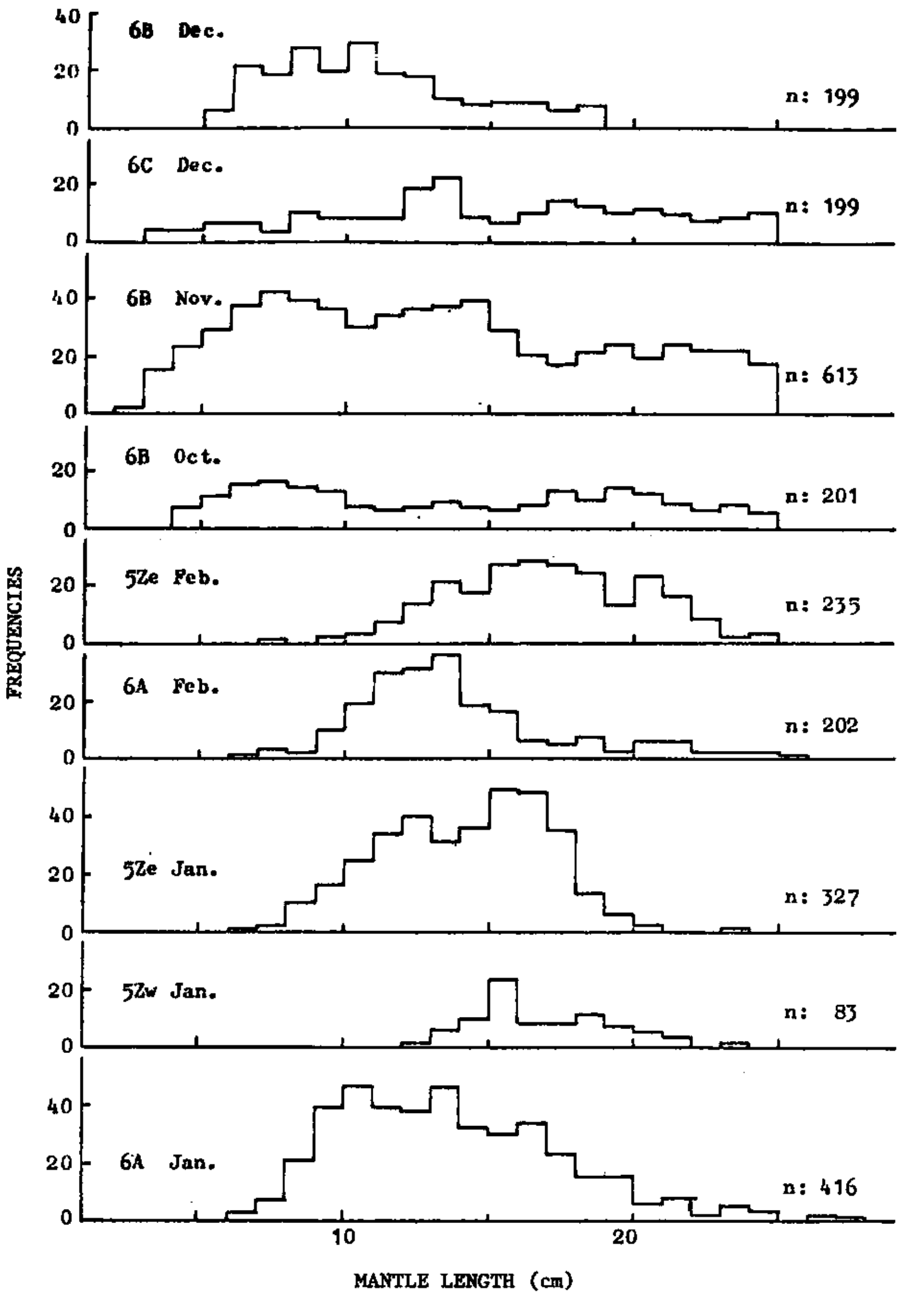

Fig. 5. Size composition of squids in Subarea 5 and Statistical Area 6 by division and month in 1971.

POLISH RESEARCH REPORT, 1971

by

F. Chrzan

Total Polish catches in the ICNAF Area have shown a very small increase from 170,973 tons in 1970 to 171,539 tons in 1971. This was due on the one hand to a substantial decrease in cod catches, and, on the other hand, to an increase in herring catches. The increase in mackerel, flatfish and redfish was rather small. Therefore, the weight differences in Polish catches between the years 1970 and 1971 were insignificant.

In Subareas 2, 3 and 4, 26 factory trawlers operated mainly during the winter and spring seasons. These vessels made 55 trips to the ICNAF Area, while in 1970 the same number of factory trawlers made 41 trips. A large number of factory trawlers operated beyond the ICNAF Area when the winter and spring season was over.

In Subarea 5, in addition to factory trawlers, 11 smaller freezer trawlers of 1,900 gross tons and 12 larger of 3,100 gross tons operated in herring and mackerel fisheries. Moreover, 14 side motor trawlers and 37 side steam trawlers took part in fishing operations. These units made approximately 209 trips compared with 126 trips made by freezer trawlers and side trawlers in 1970.

In order to reduce the loss of time for voyages between fishing grounds and home ports, side trawlers operated with mother ships. The comparative data for the years 1970 and 1971, with respect to major species and their percent relation in the catches are given in Table 1.

Table 1. Polish catches in the ICNAF Area, 1970 and 1971.

	1971		1970	
Species	metric tons	%	metric tons	%
Redfish	8,444	4.9	5,846	3.4
Cod	29,365	17.1	49,587	29.0
Flatfish	6,740	3.9	4,502	2.7
Greenland halibut	5,238	3.1	8,270	4.8
Mackerel	43,684	25.4	41,036	24.0
Herring	69,086	40.3	56,050	32.8
Other species	8,982	5.3	5,682	3.3
Total	171,539	100.0	170,972	100.0

The above data show that Polish fisheries were still mainly for herring, cod and mackerel. An increase in landings of mackerel and herring was noted in 1971 compared with 1970, whereas there was a substantial decrease in the cod catch.

Subarea 2

A. STATUS OF THE FISHERIES

Fifteen factory trawlers operated in Div. 2H and 2J of Subarea 2, mainly in January and February. In March most ships shifted toward southern fishing grounds. During the other months of the year Polish catches in Subarea 2 were irregular. The catch and fishing effort in Subarea 2 are given in Table 2.

Table 2. Polish catch and fishing effort in Subarea 2 in 1971.

ICNAF Div.	CATCH (metric tons) Redfish	Cod	Greenland halibut	Flatfish	Other species	Hours fishing	Days fished
2G	-	-	3	-	-	34	4
2H	67	1,660	1,511	10	100	1,997	168
2J	683	15,344	894	1,194	5	9,179	704
Total	750	17,004	2,408	1,204	105	11,210	876

In January the yield from the fishing grounds in Div. 2H reached 25.2 tons per day. In Div. 2J the daily yields in successive months were as follows: January - 27.9 tons, February - 24.9 tons, March - 23.7 tons, April - 31.1 tons, May - 21.0 tons and June - 17.0 tons per day fished. As early as March, however, drift ice hampered fishing operations so much that, in spite of good yields, fishing vessels had to withdraw from these fishing grounds. During the summer months the fishing yields were lower than in the same period of the previous year. In general, the decrease in fishing yield led to less fishing effort (number of hours fished), 23% below that of 1970.

B. SPECIAL RESEARCH STUDIES

1. Cod

The observations on cod were carried out on commercial vessels. In January and February, 16,049 cod specimens were measured. The length of cod in the catches ranged from 21 to 87 cm. The average length fluctuated between 41.2 cm and 49.1 cm. The fish caught were 3 to 15 years old. The most numerous, however, were those in the 5 to 7 age-groups. In February, 1,445 cod specimens were caught in an hour in Div. 2J. In this sample 7-year-olds (1964 year-class) were represented by 352 specimens. Next was the 1966 year-class (5 years of age) represented by 350 specimens. The 1965 year-class (6 years of age) was third with 304 specimens. The remaining 439 specimens were from all the other year-classes. According to Stanek, the number of cod caught per hour in previous years, during the peak period of the fishing season, was as follows: 1963 - 3,734, 1969 - 2,299 and 1970 - 1,626.

2. Redfish

In Div. 2J, in commercial catches, 1,295 redfish (type *mentella*) were measured and 300 otoliths read for age. The length of these fish ranged from 20 to 47 cm. Fish with a length of about 30 cm were predominant. The otoliths of redfish which had been examined showed a range of age from 6 to 16 years. The most numerous were fish of ages 8, 9 and 10 years.

Subarea 3

A. STATUS OF THE FISHERIES

In this Subarea only factory trawlers fished mainly during the period from January to October. The best fishing results were obtained during February to May. Catch and fishing effort are presented in Table 3. The data show that Polish trawlers operated mainly in Div. 3K. In consecutive months of fishing the daily yields were as follows: January - 6.7 tons, February - 28.4 tons, March - 22.3 tons, April - 23.7 tons, May - 19.6 tons, June - 13.7 tons, July - 24.5 tons, August - 1.3 tons, September - 11.0 tons, October - 7.2 tons, November - 14.1 tons, December - 9.3 tons. In the last four years the mean yield per hour fishing was as follows: 1968 - 1.33 tons, 1969 - 1.58 tons, 1970 - 1.35 tons and in 1971 - 1.61 tons, the 1971 yield being higher than in the previous 3 years.

B. SPECIAL RESEARCH STUDIES

1. Biological

a) Cod. In Div. 3K 3,182 fish were measured. Their length ranged from 21 to 86 cm and their age from 2 to 13 years. Fish in the length range of 39-59 cm constituted 62.9% of the samples, and in the age range of 5 to 7 years (1966, 1965 and 1964 year-classes) made up 69.7%. Cod born in 1965 made up 26.8% of the catch. The mean number of fish caught per hour scarcely reached 226 fish. The most numerous were cod of

Table 3. Polish catch and fishing effort in Subarea 3 in 1971.

ICNAF Div.	CATCH (metric tons) Redfish	Cod	Greenland halibut	Flatfish	Other species	Hours fishing	Days fished
3K	5,438	10,302	2,778	4,998	22	13,702	1,019
3L	599	1,868	48	505	35	2,386	182
3M	22	19	-	-	-	50	7
3N	8	-	-	2	-	11	1
30	225	1	4	16	-	197	17
3Ps	58	1	-	-	-	89	8
Total	6,350	12,191	2,830	5,521	57	16,435	1,234

the 1965 year-class (age 6) - 60 fish/hour. The 1966 year-class (age 5) was next - 52 fish/hour and third was the 1964 year-class - 45 fish/hour. The yield of all other year-classes amounted to 69 fish/hour. According to Stanek, the numbers of cod caught per hour in certain previous years were as follows: 1963 - 1,548, 1970 - 1,264 and 1971 - 226. This shows a considerable decrease in the number of cod in 1971.

b) Redfish. In May in the northern part of Div. 3K commercial vessels caught redfish in the length range of 20-45 cm. The mean length of these fish was 30.6 cm and their mean age 9.2 years. In September in Div. 30 (Green Bank) an appreciable quantity of small redfish was found. A total of 393 fish were measured; their length ranged from 6 to 23 cm, their mean length was 12.2 cm and their mean age 2.4 years. Green Bank is understood to be a good feeding ground for the young redfish.

c) American plaice. In June, in Div. 3K 653 fish were measured and their otoliths read for age. Fish in the length range of 21-62 cm occurred in the catches; their mean length was 44.9 cm. The age-groups represented were ages 7 to 25+ but groups 12 to 17 were the most numerous. In September, in Div. 3L 816 fish were measured and read for age. Their length ranged from 6 to 52 cm and their mean length was 22.1 cm. Fish from 1 to 11 years of age occurred in the catches, the predominant ones, however, were ages 2-6.

2. Hydrography

Hydrographic observations were rather fragmentary and were performed only from 12 to 20 September 1971 on the southwestern slope of the Great Newfoundland Bank. Here, by the end of summer, the temperature of the surface waters was 17 to 18°C. The temperature dropped markedly with depth and there were even areas with a temperature of 0.50°C. At greater depths there occurred Atlantic water with a temperature of 6°C.

Subarea 4

A. STATUS OF THE FISHERIES

In Subarea 4 only a few factory trawlers operated. On Banquereau Bank these ships caught mainly redfish. The catch results and fishing effort are given in Table 4.

Table 4. Polish catch and fishing effort in Subarea 4 in 1971.

ICNAF Div.	CATCH (metric tons) Redfish	Cod	Halibut	Other species	Hours fishing	Days fished
4Vs	1,257	15	13	-	894	68
4W	3	-	-	7	11	3
Total	1,260	15	13	7	905	71

The redfish yields in the period August - October were 1,180-1,520 kg per hour. The mean daily yield of all species in 1971 was 18.0 tons whereas in 1970 factory trawlers, on the same fishing grounds, caught 12.3 tons per day. In 1971, however, the redfish caught were slightly smaller than those in 1970.

B. SPECIAL RESEARCH STUDIES

1. Biological

No research work was carried out in 1971 in Subarea 4. Only 228 redfish were measured. They had a length of 21-39 cm with the mean length being 30.2 cm.

2. Hydrography

In Subarea 4 hydrographic observations were carried out from 20 to 24 October only on Browns Bank, LaHave Bank and Emerald Bank. On Browns Bank, surface temperatures increased from 11 to 13°C from the coastal region to the open ocean. At a depth of 50 m the mean temperature was about 10°C and at a depth of 150 m it ranged from 7 to 8°C. On LaHave Bank from the surface to 30 m the water temperature was 13°C. Then deeper to 60 m there occurred a marked drop of temperature to 5°C (thermocline). Only at a depth of about 130 m to 200 m was an increase of temperature again observed. On Emerald Bank, too, at 30-50 m a drop of temperature from 13 to 5°C was observed. The temperature rose again at greater depths. On the Atlantic slope, at a depth of 150 m the bottom temperature was 10°C.

Subarea 5

A. STATUS OF THE FISHERIES

During herring and mackerel fishing season 26 factory trawlers, 12 large freezer trawlers (3,100 gross tons each), 11 smaller freezer trawlers (1,900 gross tons each), 14 motor side trawlers (800 gross tons each) and 37 steam side trawlers operated in Subarea 5. The side trawlers and smaller freezer trawlers operated with mother ships. Data concerning catch and fishing efforts for these ships are given in Table 5.

Table 5. Polish catch and fishing effort in Subarea 5 in 1971.

ICNAF Div.	CATCH (metric tons)				Hours fishing	Days fished
	Cod	Herring	Mackerel	Other species		
		Factory trawlers				
5Ze	4	19,117	2,699	216	7,827	718
5Zw	16	164	10,081	33	1,545	184
		Freezer trawlers (3,100 G.T.)				
5Ze	29	17,661	10,076	3,374	6,972	888
5Zw	-	44	2,375	29	362	60
		Freezer trawlers (1,900 G.T.)				
5Ze	-	13,221	11,174	3,532	6,432	799
5Zw	-	2,228	3,048	769	1,681	242
		Motor side trawlers				
5Ze	92	3,412	2,269	879	4,044	628
5Zw	-	802	601	138	715	112
		Steam side trawlers				
5Ze	12	11,071	793	1,337	16,941	2,107
5Zw	2	1,363	566	462	3,027	415
Total	155	69,083	43,682	10,769	49,546	6,153

Fishing operations took place from April to December, mainly on Georges Bank. The greatest fishing activity occurred from July to November. It may be of interest to compare the yield per unit of fishing effort of particular types of ships in the consecutive months of the year. These data are given in Table 6.

Table 6. Catch per unit effort by month and trawler type in Subarea 5, 1971.

Months	Yield per hour (in kg)				
	Type B-15-22 Factory trawlers	Type B-18-418 Freezer trawlers 3,100 tons	Type B-29-29s Freezer trawlers 1,900 tons	Type B-20 Motor side trawlers	Type B-10-14 Steam side trawlers
April	3,398	-	2,986	-	964
May	2,095	6,762	3,002	1,215	621
June	-	4,708	2,440	2,246	717
July	2,512	4,274	2,492	1,980	850
August	1,738	3,226	1,846	896	391
September	3,101	4,910	11,106	1,513	1,071
October	3,844	4,814	4,344	1,077	668
November	3,520	4,977	4,929	1,557	763
December	8,067	-	4,830	-	849
Mean	3,450	4,580	4,187	1,721	781

Stern trawlers, factory trawlers and freezer trawlers had relatively high yields. These ships, however, often used mid-water trawls. Side trawlers using bottom trawls had rather low yields.

B. SPECIAL RESEARCH STUDIES

1. Biological

a) Herring. In Subarea 5, 9,499 fish caught during commercial fishing were measured and 1,487 otoliths were read for age. In Statistical Area 6, 4,924 fish were measured and 1,134 otoliths read for age. The mean length of herring on feeding grounds was 28.4 cm and on spawning grounds 29.86 cm. The age composition of herring varied depending on the position of the fishing ground and on the fishing season (Table 7).

Table 7. Percent year-class composition of herring 1971.

Fishing grounds and seasons	Year-class									
	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960
Subarea 6 January - May	-	4.6	13.6	25.8	17.8	10.9	12.9	3.2	6.6	4.6
Georges Bank June - August	0.3	31.8	21.0	27.0	12.5	3.5	2.1	0.8	0.6	0.4
Georges Bank September - December	-	15.7	18.0	26.6	18.8	9.3	6.4	2.4	1.6	1.2
Mean	0.1	17.8	17.9	26.5	16.7	8.0	6.6	2.1	2.5	1.8

Taking into account the fishing effort, the index of total mortality of fish of four years of age and older has been determined. According to observations of Dr Draganik, the index of total mortality (Z) during recent years was as follows: 1967/1968 - 0.69, 1968/1969 - 0.78, 1969/1970 - 1.08, 1970/1971 - 1.11. This shows a significant increase of fishing intensity. As the abundance of larvae may be evidence of the intensity of spawning of herring, observations on the quantity of larvae were carried out. From among 127 stations, herring larvae were found with a Hensen net only at 23 stations scattered mainly in Georges Bank.

Most of the larvae were found in the western and central part of Georges Bank. At these stations, the number of larvae per 1 square meter of surface reached 500. Observations on the feeding of herring were also carried out. They showed that herring fed most intensely from May to August. Copepods occupy the first place as a food item then euphausiacea, decapods and amphipods.

b) Mackerel. Observations on the fishing yields show that with bottom trawls the mean daily yield of motor side trawlers was 8.6 tons, whereas freezer trawlers using mid-water trawls caught 41.6 tons per day. A total of 17,150 mackerel were measured and 2,880 otoliths read for age. The year-class composition (from otolith readings) of mackerel in Polish catches during the last two years, are given in Table 8.

Table 8. Percent year-class composition of mackerel, 1970 and 1971.

Year	Year-class										
	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960
1970	-	125	17	501	214	86	19	13	14	13	4
1971	8	86	32	544	224	52	14	14	17	9	-

The figures cited show that fish from 1 to 10 years of age occurred in the catch. In both years an important part of the catches consisted of the 1967 year-class. The length of mackerel ranged from 20 to 48 cm and the mean length was 35 cm. In examining the abundance of age-classes during the last two years, the size of the fish caught and the daily yield in the 1971 catches, it may be supposed that previous catches have not caused apparent changes in the exploited stock. Observations were also carried out on the feeding of mackerel. In the region of Georges Bank, in May and June, the basic food of mackerel consisted of copepods and then of thaliacea. In the stomachs of the fish examined there were also amphipods, euphausiacea, *Sagitta* and decapod larvae. The mean degree of stomach repletion - according to the 5-degree scale, depending on the depth of the fishing ground, oscillated between 0.49 (at a depth of 140 m) and 2.88 (at a depth of 90 m).

c) Yellowtail flounder. Polish fisheries did not fish intentionally for yellowtail flounder in Subarea 5. However, fish caught occasionally were measured and otoliths read for age. A total of 212 fish were measured and 165 otoliths were read for age. The length of fish ranged from 22 to 44 cm, their mean length being 34.5 cm. The age composition consisted of fish of ages 2 to 7, the most numerous being age 4 (about 40% of the number examined).

2. Hydrography

Hydrographic observations were carried out in the region of Georges Bank from 4 to 24 October 1971. Mr A. Furtak carried out observations on the temperature and the salinity according to a designed graticule of hydrographic sections. On the basis of these investigations he distinguished 5 types of water masses which are shown in Fig. 1. The names of the masses of water show their origin. It should be said, however, that bottom water is a complex of Labrador and Gulf Stream waters. Atlantic water which reaches the southern slope of Georges Bank is in fact Gulf Stream water. Observations on O_2 content were also carried out. On Georges Bank, in the surface layers the O_2 content as a rule, amounted to more than 5.5 ml/l. In the bottom layers, at a depth of 100 m and even 150 m a drop of O_2 content to 4 ml/l was noted.

Observations on plankton, besides definition of the quantity of herring larvae, were aimed at determining the species and biomass composition. From 24 September to 4 November 1971, the most frequent component of plankton in the region of Georges Bank and partly of the Bay of Maine were copepods (*Calanus finmarchicus, Pseudocalamus elongatus, Oithoma similis*). The next important component was euphausiacea (*Meganictiphanes norvegica, Thyssanoessa inermis*). *Sagitta* also occurred very often in the plankton.

According to data from 116 stations, the biomass of plankton oscillated between 0.1 to 83.0 cm^3 and amounted to a mean value of 17.2 cm^3.

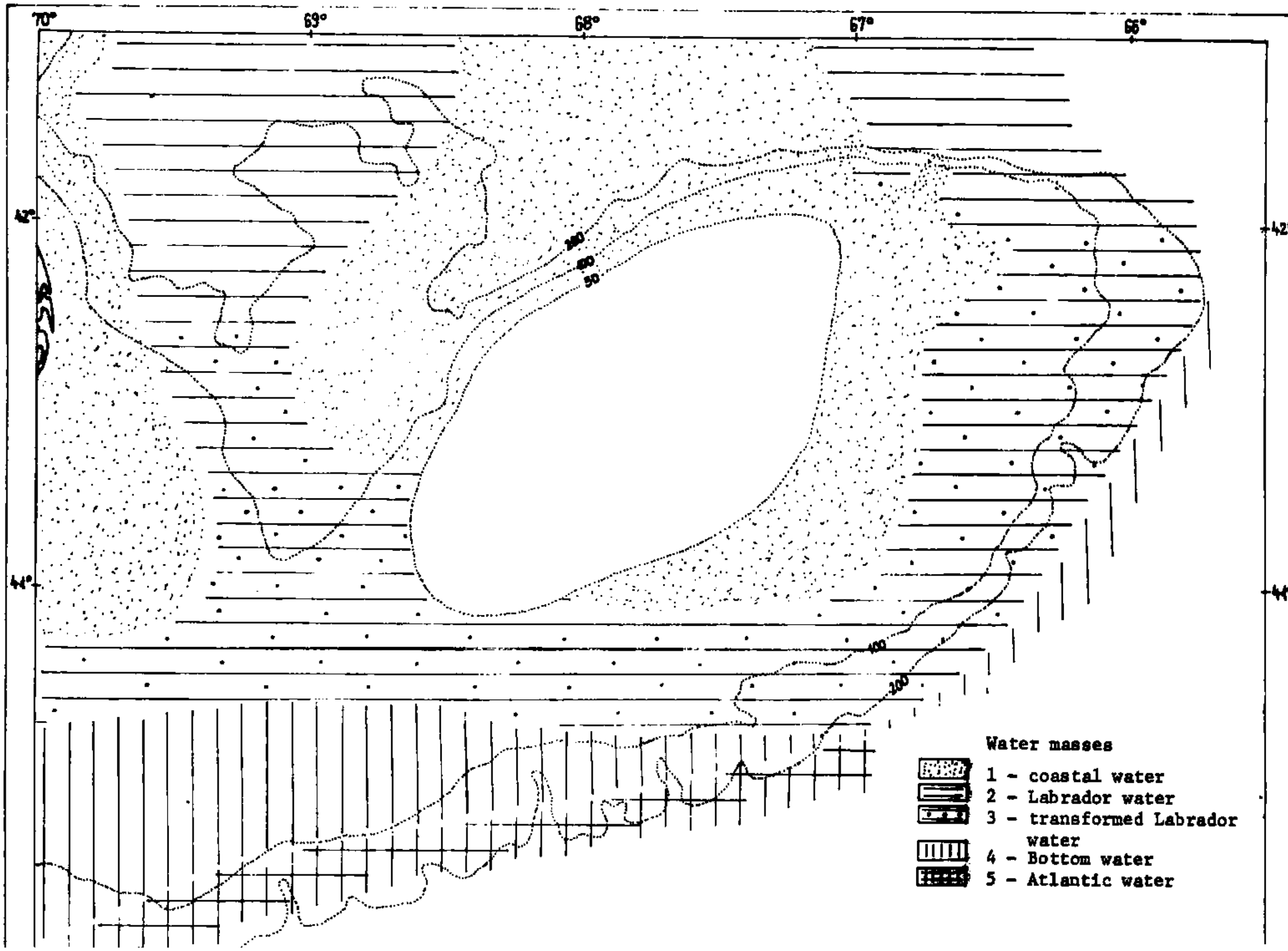

Figure 1. Distribution of water masses at 50 m depth on the Georges Bank in autumn 1971.

PORTUGUESE RESEARCH REPORT, 1971

by

Manuel Lima Dias

The Portuguese cod catch in the ICNAF Area in 1971 was 152,557 tons (Table 1 and Fig. 1) which was 10,000 tons less than in 1970.

Table 1. Portuguese cod catch (metric tons) in the ICNAF Area, 1971.

	Trawl			Line		
Subarea	Side	Stern	Total	Dory vessel	Gill nets	Total
1	577	728	1,305	2,169	2,821	6,295
2	18,788	15,506	34,294	-	-	34,294
3	52,632	17,797	70,429	14,882	9,369	94,680
4	12,506	4,782	17,288	-	-	17,288
Total	84,503	38,813	123,136	17,051	12,190	152,557

In 1971 some of the dory vessels changed to gillnets which gave more benefits than the dory line gear. The dory vessel line catch was slightly bigger than the gillnet catch (17,051 tons from dory lines, against 12,190 from gillnetters). The total otter trawl catch of cod decreased from 131,884 tons in 1970 to 123,316 tons in 1971 (Table 1, Fig. 1). The otter trawl fishery was carried out in Subareas 1-4 and took more than four times the tonnage landed from the dory line and the gillnet fisheries. The greatest decline was in the dory fishery: 30,771 tons in 1970 to 17,051 tons in 1971. As in 1970, the Portuguese side-trawler landings in 1971 were greater than by the stern trawlers. Except in Subarea 1, side-trawler landings were also greater than that by the stern trawlers.

Side and stern otter trawl, dory vessel, gillnet and total catches are shown by Subareas in Fig. 2 and by months in Fig. 3. The trawlers operated in Subareas 1-4 but fished mainly in Subareas 3 and 2, over all quarters of the year. Dory and gillnet vessels visited Subareas 1 and 3. The greatest trawler catch was 20,108 tons taken in February (13,848 tons by side trawl and 6,260 tons by stern trawlers). The dory vessels worked over the second and third quarters in Subareas 1 and 3, with the best fishery occurring in August (4,549 tons) and July (4,398 tons) in Subarea 3. The Subarea 1 catch was lower, only 2,169 tons in both quarters of the year, than the catch from Subarea 3, where, for the same period, 14,882 tons were landed.

The gillnet fishery also took place in Subareas 1 and 3, but over all quarters of the year; mainly in the second and third in Subarea 3, with 4,284 tons and 3,224 tons respectively. The gillnet landings were only 2,821 tons from Subarea 1, and 9,369 tons from Subarea 3. The best gillnet fishery took 2,440 tons in June in Subarea 3.

The present report, in addition to reviewing the status of fisheries, presents also data on length, age, maturity and probable age at first maturity, obtained from random sampling on board commercial trawlers before discarding the under-sized fish. Detailed information on length and age samples are included in the ICNAF Sampling Yearbook.

Subarea 1

A. STATUS OF THE FISHERIES

The otter trawlers took 1,305 tons in Div. 1B, 1C, 1D, and 1F during April and May; the best catch was made by the stern trawlers, 728 tons against 577 tons by the side trawlers. The catch in April was very low - only 4 tons. The dory and gillnet fisheries were not very important in this Subarea. Dory vessels fishing in June and July only landed 2,169 tons; catches from gillnets amounted to 2,821 tons taken in August (1,452 tons) and September (1,369 tons).

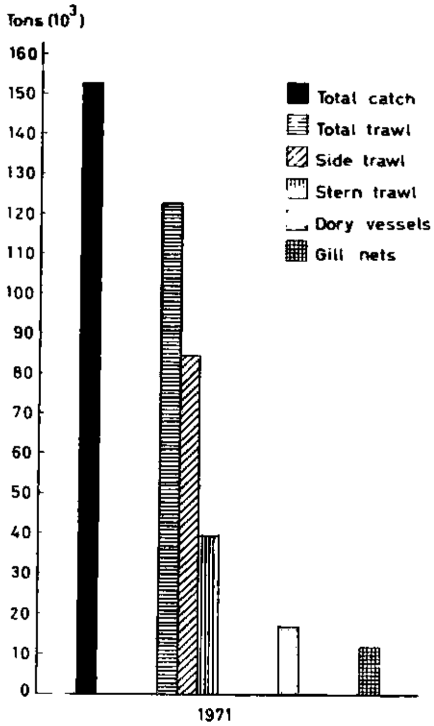

Fig. 1. Cod catch (tons) by Portuguese fleet in ICNAF Area.

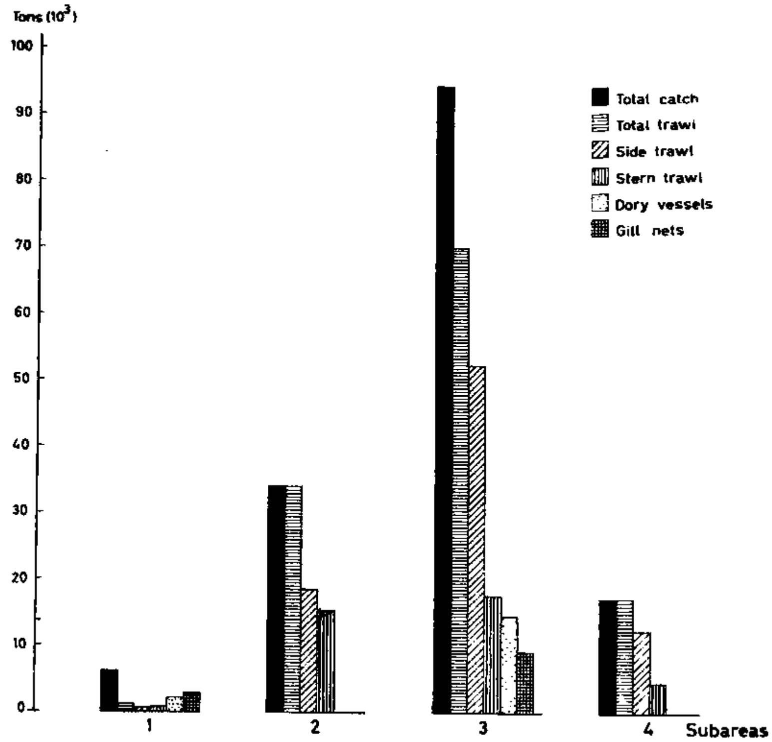

Fig. 2. Cod catch (tons) by Portuguese fleet by subareas - 1971.

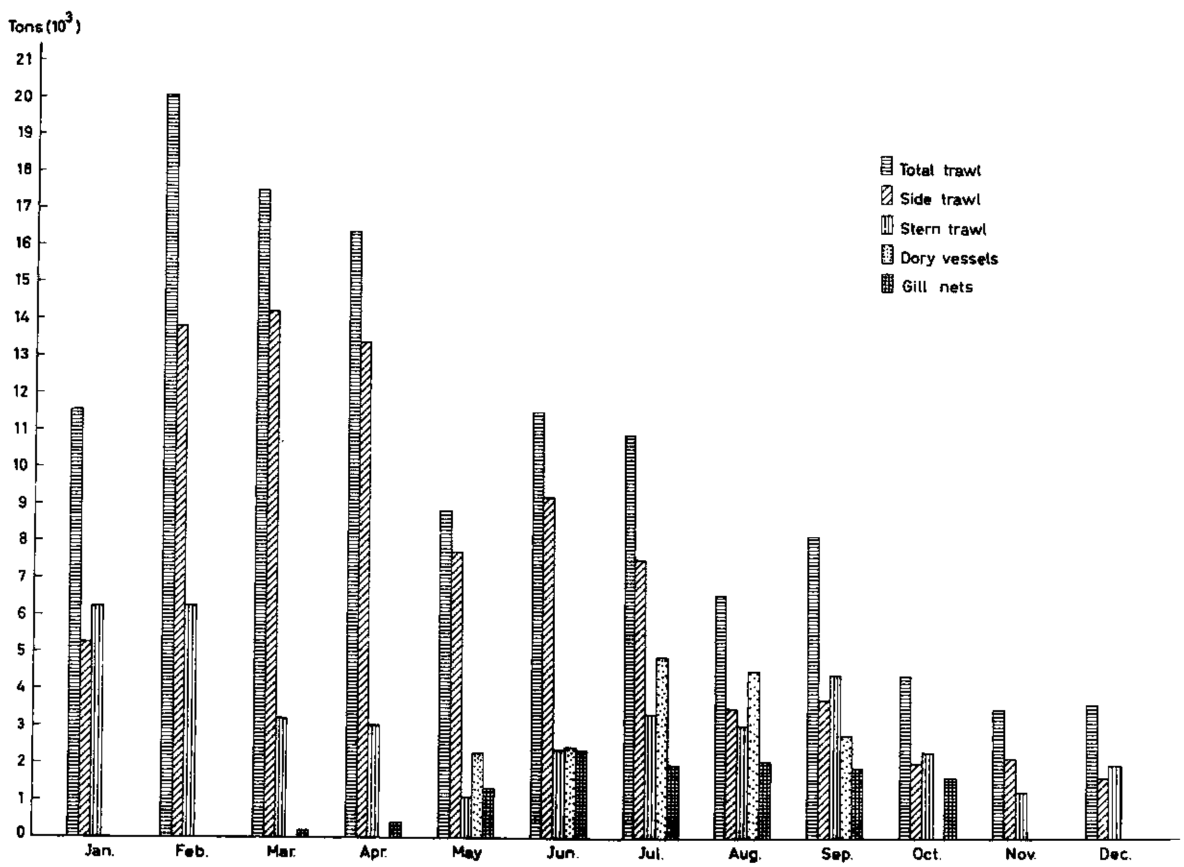

Fig. 3. Total catch of cod (tons) by Portutugese fleet (trawlers, dory vessels and gillnets) by months - 1971.

B. SPECIAL RESEARCH STUDIES

Samples for biological study were collected from Div. 1C, 1D, 1E, between 4 and 23 May 1971 as follows:

Div.	Samples	Date	Depth (m)	Length[1] No.	Length[1] Average in cm
1C	A	5-23 May	180-290	525	64.6
1D	B	6-17 May	200-250	325	62.6
1E	C	5-11 May	300-600	150	67.6

[1] Lengths ranged from 43 cm to 103 cm (3-cm classes) (Fig. 4).

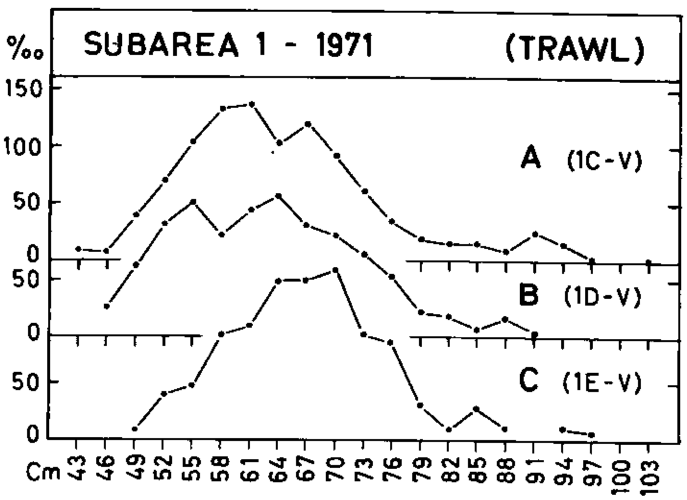

Fig. 4. Length frequencies - cod - otter trawl - Subarea 1, 1971.

Subarea 2

A. STATUS OF THE FISHERIES

Only the otter trawlers fished in this Subarea. A total of 34,294 tons was taken in Div. 2H and 2J. The stern trawlers took 4,336 tons in Div. 2H and 11,170 tons in Div. 2J, while the side trawlers took 18,788 tons in Div. 2J only.

The greatest catch was made in the first quarter, with 15,474 tons landed (8,023 tons by side trawlers and 7,451 by stern trawlers). The highest trawler catch was made in January, 11,117 tons (5,973 by stern trawlers and 5,114 by side trawlers).

B. SPECIAL RESEARCH STUDIES

1. Cod

Samples for biological study were collected from a commercial trawler, in Div. 2J, in the second quarter of the year as follows:

Div.	Samples	Date	Depth (m)	Number of fish lengths	Number of fish otoliths
2J	A	17-23 April	280-400	975	400
2J	B	29-31 May	260-290	599	100
2J	C	1-13 June	250-320	1,325	200

Lengths ranged from 34 to 121 cm (Fig. 5); mean lengths were 56.9 cm in sample A (April), 49.6 cm in B (May), and 52.3 cm in C (June). Ages ranged from 4 to 19 years with 5, 6, and 7-year-olds dominant, while in April 8-year-olds were also quite well represented; mean ages were 7.2 in sample A, 6.3 in B, and 6.5 in C. Average length (cm) at age of cod caught by trawl, sampled during the second quarter, are shown for Div. 2J below.

Year-class	Age-group	April	May	June	No. of fish
1967	IV	43.0	37.4	32.2	2
1966	V	45.1	45.2	44.3	86
1965	VI	51.4	48.6	49.6	235
1964	VII	57.4	54.4	55.0	201
1963	VIII	61.8	59.0	60.2	99
1962	IX	65.4	64.8	65.0	38
1961	X	71.4	68.9	72.3	13
1960	XI	71.9	69.5	71.3	6
1959	XII	70.2	69.6	70.8	7
1958	XIII	72.3	65.2	72.6	4
1957	XIV	80.6	74.6	75.8	6
1956	XV	68.7	64.0	71.2	2
1955	XVI	-	-	-	-
1954	XVII	-	-	-	-
1953	XVIII	-	-	-	-
1952	XIX	76.0	-	76.0	1

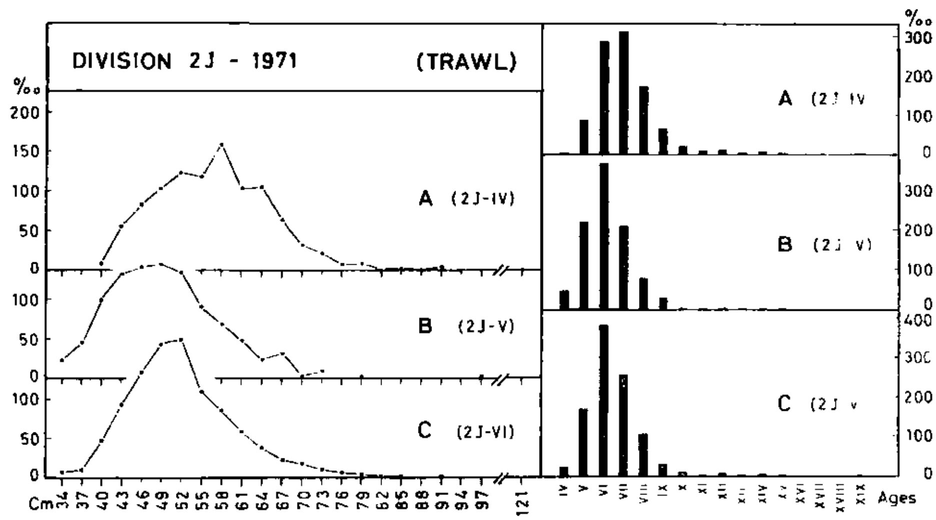

Fig. 5. Length and age frequencies - cod - otter trawl - Div. 2J, 1971.

Fig. 6 shows the distribution of several stages of maturity in the males and in the females. The resting or recovering stage represented a higher percentage in April and May than in June. The other stages were observed in the males with a predominance of the spawning and post-spawning stages; the latter being quite well represented in June. In the females in May the spawning stage was not observed but the developing stage was recorded in about 20%, and the resting or recovering stage varied from 40 to 60% in the three months.

Only a very low percentage of the otoliths showed a well-defined first maturity ring. However, some of them showed the age at first maturity as 5, 6, and 7, but mainly 6. A very high percentage of the cod sampled were in the immature stage.

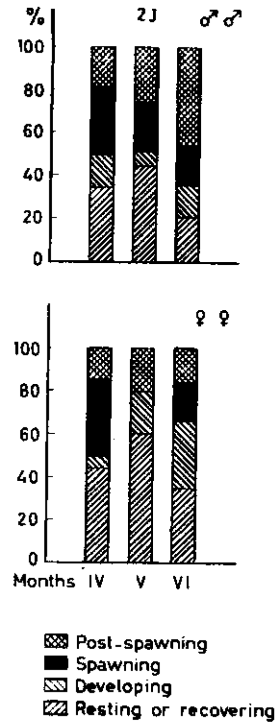

Fig. 6. Maturity - cod - Div. 2J, 1971.

Subarea 3

A. STATUS OF THE FISHERIES

The Portuguese cod fishery was most intensive in this Subarea. The trawlers operated in all Divisions of this Subarea. Landings in metric tons are shown below:

Div.	Side	Stern	Total
3K	3,758	1,734	5,492
3L	44,195	12,272	56,467
3M	3,673	3,599	7,272
3N	16	-	16
30	111	-	111
3Pn	798	192	990
3Ps	81	-	81
	52,632	17,797	70,429

The dory vessels visited only Div. 3L and 3N and took 13,265 tons and 1,617 tons respectively; the gillnet fishery took 4,524 tons in Div. 3L, 4,442 tons in Div. 3N, and only 403 tons in Div. 30.

The best trawl catches were in March with 15,206 tons fished (12,241 tons by side trawlers, and 2,965 tons by stern trawlers). The total trawl catch was 70,429 tons, (52,632 tons by side trawlers and 17,797 tons by stern trawlers). The best dory vessel catch occurred in August, 4,549 tons. The total dory vessel catches amounted, in this area, to 14,882 tons. The gillnet fishery had reasonable catches in the second and third quarters of the year, mainly in June (2,440 tons) and July (2,012 tons). The gillnet catch was 9,369 tons from Subarea 3. The best monthly catch occurred in June (2,440 tons), July (2,012 tons) and Octoler (1,649 tons).

B. SPECIAL RESEARCH STUDIES

1. Cod

Samples for biological studies were collected from a trawler in Div. 3K and 3L as follows:

Div.	Samples	Date	Depth (m)	Number of fish lengths	Number of fish otoliths
3K	A	4-31 July	200-270	525	150
3K	B	1-6 August	230-310	440	65
Total 3K				965	215
3L	C	2-14 April	200-265	1,450	300
3L	D	1-2 May	250	150	150
3L	E	15-28 June	190-240	1,650	250
3L	F	6-29 July	170-285	2,180	200
Total 3L				5,430	900
Total Subarea 3				6,395	1,115

Lengths ranged from 25 to 133 cm (Fig. 7); mean lengths in the samples were 55.1 cm for A, 56.2 cm for B, 49.1 cm for C, 52.4 cm for D, 54.7 cm for E and 55.3 cm for F. Ages ranged from 4 to 12 years and were mainly 5, 6, 7 and 8 years. In Div. 3K the dominant ages were 5, 6 and 7 in July, and 6, 7 and 5 in August. Div. 3L, in the second quarter of the year, showed mainly ages 5 and 6. In July, however, the age distribution was not so different from other second quarter distributions. There was also a very good percentage of 4 and 7-year-olds. Mean ages for each of the samples were 6.4 years for A and B, 5.4 for C, 5.7 for D, 5.8 for E and 5.5 years for F. Average length (cm) of cod fished by trawl and sampled in Div. 3K and 3L are as follows:

Div. 3K				
		Third Quarter		
Year-class	Age-group	July	August	No. of fish
1967	IV	43.9	42.3	3
1966	V	46.0	48.3	35
1965	VI	54.0	54.2	58
1964	VII	59.6	59.5	62
1963	VIII	66.0	65.2	34
1962	IX	70.4	70.0	16
1961	X	70.1	66.7	3
1960	XI	72.8	71.2	3
1959	XII	94.0	-	1

Div. 3L							
		Second Quarter				Third Quarter	
Year-class	Age-group	April	May	June	No. of fish	July	No. of fish
1968	III	35.6	40.0	40.0	2	41.0	10
1967	IV	40.9	43.3	42.3	43	44.8	40
1966	V	46.4	48.4	47.8	224	51.3	60
1965	VI	51.7	52.9	53.1	244	56.2	53
1964	VII	61.6	60.9	62.3	132	65.9	25
1963	VIII	69.6	68.2	69.7	41	70.9	9
1962	IX	77.5	79.0	78.2	8	76.0	2
1961	X	79.2	80.9	84.3	3	-	-
1960	XI	85.0	-	91.0	2	91.0	1
1959	XII	76.0	76.0	76.0	1	-	-

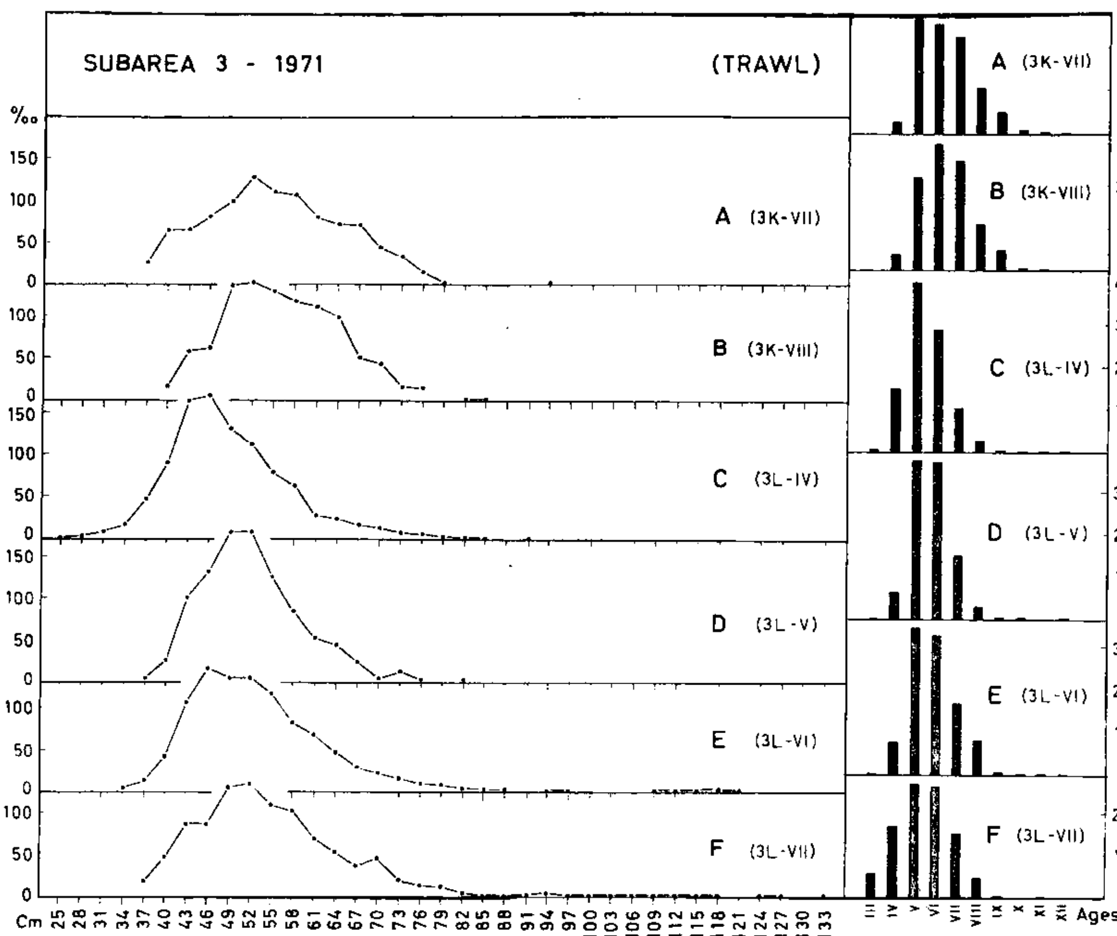

Fig. 7. Length and age frequencies - cod - otter trawl - Subarea 3, 1971.

Fig. 8 shows the different stages of maturity (in percents) observed in males and females during the third quarter of the year. In June and July in Div. 3K, the greater percentage of the fish observed were in the resting or recovering and spawning stages, with the females showing a reasonable percentage in the spawning stage. The males in June also showed a significant proportion in the post-spawning stage. In Div. 3L the fish were mainly in the resting or recovering stages and largely females; also there was an important percentage in the spawning, and resting or recovering stages, the post-spawning stages being better represented in the males, mainly in the third quarter of the year.

As in other Subareas the otoliths aged in Div. 3K and 3L did not show the age at maturity with any certainty. However, it was possible to estimate age at first maturity from some otoliths at age 6 and 7. The larger percentage of the otoliths were of such condition that the determination of this parameter was not possible.

Subarea 4

A. STATUS OF THE FISHERIES

Only the trawlers fished in this Subarea. They caught 17,288 tons, of which 12,506 tons were by side trawlers and 4,782 by stern trawlers. The vessels fished in Div. 4R, 4Vn and 4Vs, but most of the catch (17,144 tons) was taken in Div. 4R. The catches were made only during the first quarter of the year, mainly in February with 14,969 tons landed.

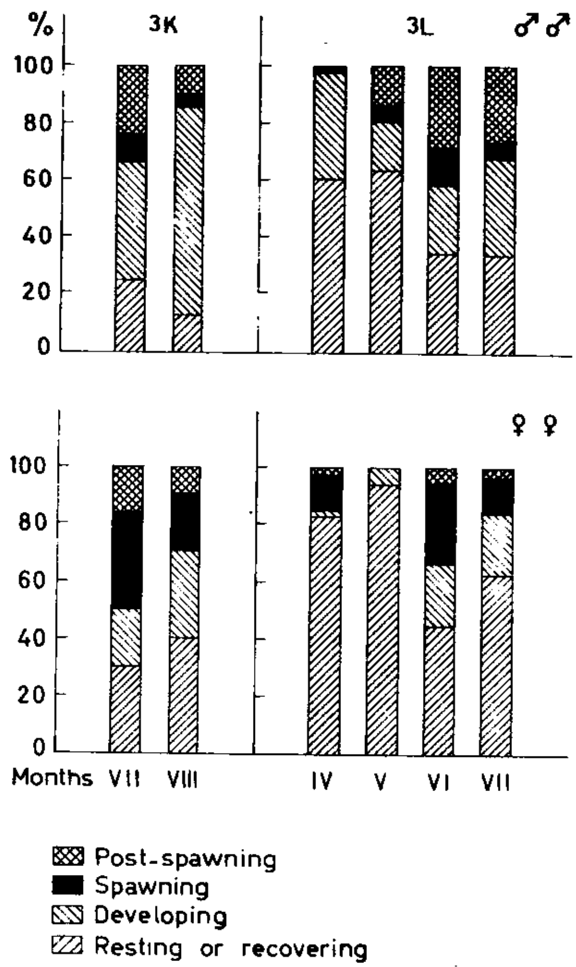

Fig. 8. Maturity - cod - Subarea 3, 1971.

The higher catch was made by the side trawler fleet with 10,499 tons in February, against 4,470 tons in the same period by the stern trawler fleet. The total catch by side trawlers was 12,506 tons and by stern trawlers only 4,782 tons.

B. SPECIAL RESEARCH STUDIES

No sampling or other studies was carried out in this Subarea.

SPANISH RESEARCH REPORT, 1971

by

M. G. Larrañeta and J. Rucabado

Sixteen trawlers and 135 pair trawlers operated in the ICNAF Area during 1971. Total catch was 269,172 tons (254,733 tons of cod and 7,821 tons of haddock). Total tonnage of the fleet was 91,669 gross tons and the crews consisted of 4,319 fishermen. The evolution of these figures in the last four years is shown in Table 1.

Table 1. Total catch, cod and haddock catches, total tonnage and number of fishermen of the Spanish fleet, 1968-71.

	1968	1969	1970	1971
Total catch (tons)	341,311	293,972	276,007	269,172
Cod (tons)	329,180	286,844	267,888	254,733
Haddock (tons)	10,185	5,138	6,564	7,821
Fleet tonnage	93,705	89,205	83,605	91,669
No. of fishermen	4,847	4,414	4,053	4,319

Cod and total catches have decreased since 1968, but the haddock catch has increased since 1969. The greatest decrease in cod catch is observed in Subarea 2 (Table 2).

Table 2. Cod catches by Subareas, 1968-71.

Subarea	1968	1969	1970	1971
1	21,688	23,781	18,799	22,085
2	32,853	33,152	10,683	5,611
3	201,008	171,231	164,530	171,541
4	59,010	44,930	66,629	47,878
5	14,621	13,750	7,247	7,618
Total	329,180	286,844	267,888	254,733

Subarea 1

A. STATUS OF THE FISHERIES

Main fishing activity took place in Div. 1C (8,416 tons of cod) and Div. 1D (11,387 tons of cod). In 1970 the main fishing activity was in Div. 1D, 1B and 1A.

Subarea 2

A. STATUS OF THE FISHERIES

Small catches were made in this Subarea, the greatest being 5,333 tons of cod in Div. 2J.

Subarea 3

A. STATUS OF THE FISHERIES

Total cod catches in Subarea 3 increased (7,011 tons) 4.3%. In 1970 Div. 3L and 30 provided 58%, and in 1971 provided 61.1% of the whole catch from this Subarea. Total haddock catch in 1971 was 3,156 tons, 63% in Div. 3N and 30.

B. SPECIAL RESEARCH STUDIES

Cod catch by trawler was sampled in February and March from Div. 3Ps and 3L, for length, age and sex. The following numbers of cod were measured and had otoliths read: 2,459 and 94 in Subdiv. 3Ps; and 2,145 and 93 in Div. 3L. A significant deviation from 50% in the proportion of sexes was observed in March for cod less than 53.5 cm. Females were more numerous than males.

Subarea 4

A. STATUS OF THE FISHERIES

Cod catch was 18,751 tons less (28%) than last year. Div. 4Vs and 4W provided in 1970 and also in 1971, 82% of the whole cod catch from this Subarea. Haddock catch was 3,175 tons, 571 tons more than in 1970. Div. 4Vs and 4W provided 81.5% of the total haddock catch in this Subarea. In 1970 these divisions gave 83% of the haddock catch in Subarea 4. Pollock catch (739 tons) was up about 40% over 1970 (526 tons). Pollock is caught in Div. 4R, 4Vn, 4Vs, 4W and 4X. In 1970 nearly 80% of the whole catch in Subarea 4 was in Div. 4W, but in 1971 was only 44%, owing to a great increase in Subdiv. 4Vn and 4Vs.

B. SPECIAL RESEARCH STUDIES

Cod catch by a trawler was sampled in March and April from Subdiv. 4Vs for length, age and sex. The following numbers of cod were measured and had otoliths read: 2,587 and 151 in March, 2,242 and 116 in April. Significant deviations from 50% in proportion of sexes were observed in April in cod less than 53.5 cm as well as in other larger than this size. In both cases, females were more numerous than males.

Subarea 5

A. STATUS OF THE FISHERIES

Total catch was 9,402 tons, an increase of 15.2% over the 1970 catch. Cod catch has remained at the 1970 level, but haddock catch (1,336 tons) increased over 1970 catch (845 tons) by 58%, mainly in Subdiv. 5Ze.

USSR RESEARCH REPORT, 1971

by

K. G. Konstantinov and A. S. Noskov

The total USSR catch in the Convention Area in 1971 was 902,211 tons (Table 1), 193,013 tons higher than in 1970. The total USSR catch in the Northwest Atlantic in 1971 was 1,017,006 tons, 204,701 tons higher than in 1970.

Subarea 1

A. STATUS OF THE FISHERIES

In 1971 the total fish catch in this Subarea was 4,962 tons, consisting of 4,118 tons of grenadiers (Table 1).

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Hydrographic observations made from R/V *Perseus III* and *Procyon* showed the water temperature on the West Greenland central banks to be lower than the average long-term normal. The water temperature remained low in the northern part of the Davis Strait, *e.g.* along standard hydrographic section 9-A (Fig. 1).

2. Biological Studies

a) Grenadier. In August and October series of hauls were made with a bottom trawl at a depth of 600-800 m along the Greenland - Canada ridge, mainly in the western part of Div. 1C. Roundnose grenadier (*Macrurus rupestris*) measuring 35-95 cm prevailed in the catches, with the highest number of fish within the length range of 55-65 cm. Males were somewhat smaller but more abundant than females and comprised 59.5% of the total number of fish taken. All the fish taken were immature. The stomachs contained shrimps, *Themisto*, *Calanus*, jellyfish, luminous anchovy, (bathypelagic species). Commercial concentrations of grenadier usually occurred at a temperature of 3-4°. No grenadiers were recorded north of the Greenland - Canada ridge where the near bottom temperature was below 1°C.

b) Greenland halibut. Greenland halibut (*Reinhardtius hippoglossoides*) occurred in commercial quantities in the bottom trawl catches of research and exploratory vessels both south and north of the Greenland - Canada ridge. At a depth of about 800 m in Div. 1C in June males were much more abundant than females, with about 20% of the fish of either sex showing the evidence of comparatively recent spawning. The predominant length range was 50-70 cm for males and 55-80 cm for females.

In August, 424 Greenland halibut measuring 35-85 cm were tagged west of Store Hellefiske Bank.

Subarea 2

A. STATUS OF THE FISHERIES

In 1971 the total catch in Subarea 2 was 136,126 tons (Table 1), consisting of 61,562 tons of cod, 55,761 tons of grenadier, 7,420 tons of Greenland halibut, 5,519 tons of redfish, and small quantities of flounders and other groundfish.

In 1971 the cod catch declined against 1970 mainly due to severe ice conditions which made the commercial fleet leave Subarea 2 as early as the middle of February, 1971. In subsequent months the vessels operated in this Subarea only from time to time and did not obtain good catches.

According to the cod fishery forecast (see USSR Research Report, *Redbook* 1971, Part II) for 1972 an increase in the effectiveness of fleet operations and an increase in the catch per hour trawling were expected. The actual fishery in the early months of 1972 showed an increase in the density of cod concentrations in Div. 2J and 3K as compared with the same period of several preceding years.

In 1973 a further improvement in the cod trawl fishery is likely to occur in Subarea 2 mainly due to the recruitment to the Labrador stock of the strong 1968 year-class (Table 5) and the expected decrease in the water temperature over the Labrador shelf.

Table 1. Species composition of the USSR catches (metric tons) in the Northwest Atlantic, 1971.

Species	1971 Catches by Subarea					Total ICNAF Area		Area 6		Baffin Island		Total Northwest Atlantic	
	1	2	3	4	5	1970	1971	1970	1971	1970	1971	1970	1971
TOTAL	4962	136126	198310	270059	292754	709198	902211	102308	113960	799	835	812305	1017006
Argentine	-	-	87	3555	1893	2614	5535	-	-	-	-	2614	5535
Capelin	-	-	750	-	-	-	750	-	-	-	-	-	750
Halibut	-	-	199	42	-	-	241	-	-	-	-	-	241
Greenland halibut	545	7420	1848	-	-	8136	9813	-	-	215	240	8351	10053
American plaice	192	1680	19578	6700	340	21763	28490	-	-	-	-	21763	28490
Winter flounder	-	-	-	1647	1946	504	3593	8	114	-	-	512	3707
Summer flounder	-	-	-	-	843	25	843	11	61	-	-	36	904
Yellowtail	-	-	13102	728	925	9039	14755	111	829	-	-	9150	15584
Witch	-	926	15874	10964	2713	17140	30477	2	124	-	-	17142	30601
Cod	59	61562	44262	4843	1270	113570	111996	-	-	29	-	113599	111996
Haddock	-	-	479	572	374	932	1425	-	-	-	-	932	1425
Pollock	-	-	106	1053	1163	550	2322	-	-	-	-	550	2322
White hake	-	-	4588	-	-	-	4588	-	-	-	-	-	4588
Red hake	-	-	-	1799	25353	7680	27152	834	8285	-	-	8514	35437
Silver hake	-	-	-	128633	81515	197913	210148	3044	7061	-	-	200957	217209
Grenadier	4118	55761	18408	-	-	28844	78287	-	-	545	595	29389	78882
Redfish	13	5519	71246	20591	3394	76023	100763	-	-	-	-	76023	100763
Wolffish	-	206	2390	-	-	798	2596	-	-	-	-	798	2596
Sculpins	-	-	-	-	1095	2333	1095	320	443	-	-	2653	1538
Ocean pout	-	-	-	172	3553	915	3725	-	186	-	-	915	3911
Scup	-	-	-	5	193	93	198	72	372	-	-	165	570
Sea robin	-	-	-	-	46	-	46	258	792	-	-	258	838
Angler fish	-	-	31	13507	3644	3439	17182	-	-	-	-	3439	17182
Butterfish	-	-	-	-	400	399	400	8	86	-	-	407	486
Bluefish	-	-	-	-	-	-	-	-	16	-	-	-	16
Atlantic saury	-	-	-	-	2144	1054	2144	-	-	-	-	1054	2144
Herring	-	-	-	29048	63903	111136	92951	22406	17355	-	-	133592	110306
Alewife	-	-	-	-	9014	13145	9014	5954	2275	-	-	19099	11289
Scomber	-	-	-	9492	59074	60449	68566	68026	68754	-	-	128475	137320
Menhaden	-	-	-	-	-	6	-	-	-	-	-	6	-
Sharks	-	-	-	-	9045	4336	9045	588	2997	-	-	4924	12042
Skates	-	-	35	17638	3750	7352	21423	-	-	-	-	7352	21423
Other fish	35	3052	5327	11844	8691	16653	28949	665	3731	10	-	17329	32680
Squids	-	-	-	7226	5659	1489	12885	-	479	-	-	1489	13364
Other mollusks	-	-	-	-	814	818	814	-	-	-	-	818	814

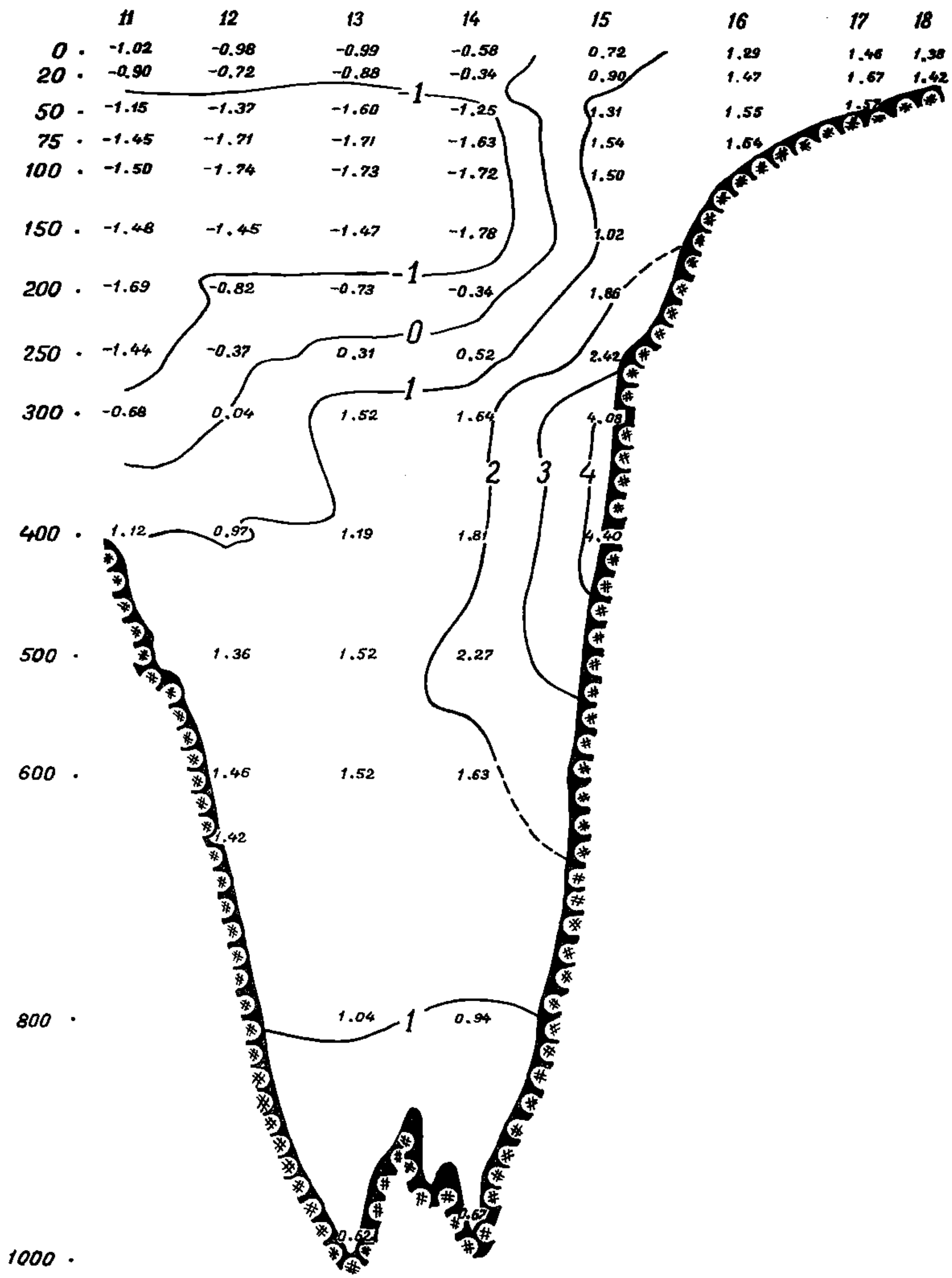

Fig. 1. Water temperature along Section 9A, October 25-26, 1971.

During the last months of 1971 the commercial fleet operated successfully on grenadier and Greenland halibut concentrations in Subarea 2. The length composition of these species in trawl catches is shown in Figs. 2 and 3.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

In early November standard hydrographic section 3-A was made by R/V *Perseus III*. 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) water temperature was lower than the average long-term normal (Table 2).

Table 2. Average water temperature (°C) along the AB portion of section 8-A across Hamilton Bank (1 November).

Depth (m)	1964	1965	1966	1967	1968	1969	1970	1971
0-50	0.98	1.30	2.41	2.00	2.29	0.82	1.34	0.88
50-200	-0.18	1.06	1.44	0.89	-0.18	0.36	0.31	0.43
0-200	0.17	1.13	1.72	1.19	0.50	0.50	0.60	0.57
200-500	0.98	-	2.47	0.95	0.31	1.64	-	1.58

2. Biological Studies

a) Cod. The length compositions of cod in the trawl catches in Div. 2J are presented in Table 3.

Table 3. Length composition of cod in trawl catches in Div. 2J by month, 1971.

Length (cm)	Jan	Feb	Mar	Apr	May
18-20	-	-	-	-	1
21-23	-	1	2	-	2
24-26	4	6	15	-	11
27-29	18	29	67	3	30
30-32	66	86	180	10	57
33-35	101	121	202	39	88
36-38	107	96	105	64	119
39-41	102	80	60	70	88
42-44	129	86	53	100	81
45-47	142	106	57	150	130
48-50	125	107	58	127	84
51-53	66	66	48	138	101
54-56	39	58	35	97	73
57-59	42	56	39	82	52
60-62	25	42	31	53	34
63-65	15	26	21	28	18
66-68	11	16	11	21	15
69-71	5	9	7	6	8
72-74	2	5	4	5	4
75-77	1	2	3	2	3
78-80	-	2	1	4	1
81-83	-	-	1	1	-
Total (°/₀₀)	1,000	1,000	1,000	1,000	1,000
No. of fish	12,186	7,771	4,748	2,198	3,668
Mean length (cm)	44.11	44.86	40.56	49.45	45.10

In 1971 the mean length of cod was found to be lower than in 1970 (USSR Research Report, *Redbook* 1971, Part II) and the peak of the size range shifted to the left. This change was caused by the recruitment to the commercial stock of the abundant 1967, 1966 and 1965 year-classes which were of minor importance in the 1970 catches but reached commercial sizes a year later while the abundance of the 1961, 1962 and 1963 year-classes decreased due to natural mortality and fisheries, and these fish lost their dominating importance in trawl catches.

Variations in the length composition of cod in different months are caused by seasonal migrations. In January - February both immature and pre-spawning cod concentrate on the continental slope of South Labrador. In March mature cod move northward to the main spawning grounds while small immature cod remain in the South Labrador area. In April - May the big spent cod migrate back to South Labrador after spawning.

An indication of the age composition is provided by a sample taken on Sundahl Bank in April when both mature and immature cod remain near South Labrador (Table 4).

Table 4. Age composition and mean length of cod in Div. 2J in April 1971.

Year-class	Age	Number (°/₀₀)	Mean length (cm)
1967	4	80	36.00
1966	5	140	39.58
1965	6	371	45.67
1964	7	220	50.18
1963	8	83	57.28
1962	9	53	59.88
1961	10	30	65.67
1960	11	13	64.75
1958	13	7	70.00
1948	23	3	88.00

The sample consisted of 300 fish (162 males and 138 females). Typically, males were numerically predominant in younger age groups from 4 to 8 years. (More males than females are hatched from the eggs of the North Atlantic cod and the sex ratio does not level off until the fish attain maturity.)

b) Other species. The length compositions of roundnose grenadier and Greenland halibut in the trawl catches are shown in Fig. 2 and 3. For grenadiers there is no significant difference in size composition of males and females, but for Greenland halibut most of the males ranged between 50 and 70 cm whereas the lengths of females were spread over a much wider range of 45-100 cm.

c) Recapture of tagged fish. Among the recaptured tagged fish of some interest is the cod marked with N 229196 tag. This fish was released from R/V *Perseus III* on 8 February 1970 at 53°24'N, 52°50'W with the overall length at the moment of release of 55 cm. One year and five months later, on 5 July 1971 this cod was recaptured at 46°27'N, 50°48'W by the Portuguese vessel *Neptuno*, which suggests that cod belonging to the Labrador stock may migrate in summer up to the very boundary of Div. 3N and 3O.

Subarea 3

A. STATUS OF THE FISHERIES

In 1971 the total catch in Subarea 3 was 198,310 tons, consisting of redfish (71,246 tons), cod (44,262 tons), flounders (50,402 tons), grenadier (18,408 tons), and other species (13,992 tons).

In 1973 an improvement in the cod fishery in the southern part of Subarea 3 (Div. 3N, 3O and 3P) may be expected due to the high abundance of the 1968 year-class (Table 5). This year-class is likely to be strong also in Div. 3M. Therefore in 1973 the productivity of cod trawl fisheries on Flemish Cap Bank may increase provided that the total fishing effort is restricted (see USSR Research Report, *Redbook* 1971, Part II).

In 1973 the abundance of the Newfoundland haddock will remain at a very low level due to the absence of good year-classes for a number of preceding years (Table 6).

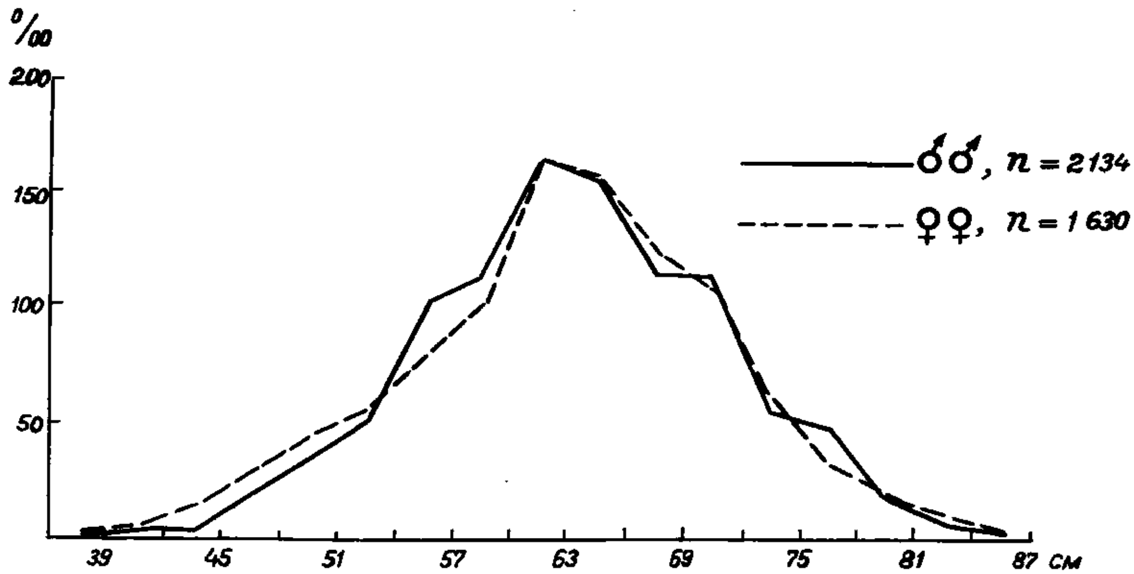

Fig. 2. Length composition of roundnose grenadier (*Macrurus rupestris*) in Div. 2G, December 1971.

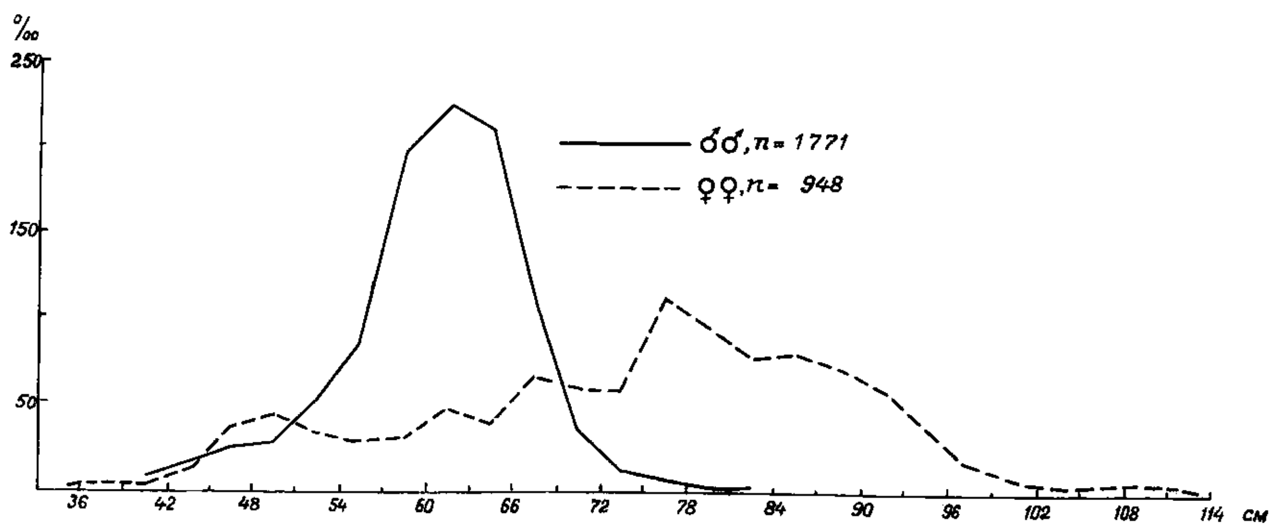

Fig. 3. Length composition of Greenland halibut (*Reinhardtius hippoglossoides*) in Div. 2G, December 1971.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

In March - July standard hydrographic Sections 1-A, 2-A, 3-A, 4-A, 6-A, 7-A, 44-A were made by R/V *Perseus III* and *Procyon*. Water temperature and salinity data are presented in a special report by Kudlo and Burmakin (Res.Doc. 72/105).

Over the shelf in Div. 3K, 3L and 3N the temperature was almost everywhere lower than the average long-term normal, which might have been due to the intensification of the Labrador Current. On the other hand positive anomaly was observed in the Cabot Strait and over the shelf in Div. 30 and 3P in March - June. In July, however, negative anomalies were recorded in the above-mentioned divisions, partly under the effect of the inflow of cold water brought by the coastal branch of the Labrador Current. The intensification of the Labrador Current also resulted in lower salinities in all the areas influenced by this current.

2. Biological Studies

a) Ichthyoplankton sampling. From 28 April to 28 May a series of ichthyoplankton samples were taken from R/V *Perseus III* and *Procyon* covering the area of Div. 3K, 3L, 3M and 3N. The samples were mainly taken along standard sections, with hydrographic observations made at the same time. The gear used was an egg sampler with an opening of 80 cm in diameter. Usually three hauls (vertical, surface and oblique) were made at each of the 234 stations worked. In 1971 the mean number of cod eggs in Div. 3K and 3L was somewhat lower than in 1970, possibly due to more severe hydrographic conditions. The later hatching of larvae in 1971 is another indication of the effect of this factor.

The analysis of all data collected confirms that the main cod spawning grounds are located near North Labrador from where the eggs and larvae are brought to Div. 2H, 2J, 3K and 3L by the current. There is some spawning in the above-mentioned divisions as well but to a much lesser extent than in Div. 2G.

b) Young cod and haddock survey. In May - August 1971 a young fish survey was conducted covering all divisions of Subarea 3. Altogether 240 one-hour hauls were made at standard points with a survey trawl. The young fish taken were counted and measured, and 5,000 young cod and 1,000 haddock otoliths were read for age. The results of the surveys made in 1971 and in earlier years are given in Tables 5 and 6.

Table 5. Average catch (numbers of young cod (age 1-4 by divisions) per hour trawling with a survey trawl.

Year-class	1 Year				2 Years				3 Years				4 Years			
	3K	3N	30	3P	3K	3N	30	3P	3K	3N	30	3P	3K	3N	30	3P
1958													10	1	0	2
1959									21	8	1	4	15	1	1	1
1960					5	3	0	3	11	1	2	5	11	1	0	1
1961	1	1	1	6	3	4	3	6	20	5	1	6	27	4	1	1
1962	1	1	7	42	2	8	2	7	15	18	2	12	24	1	1	2
1963	1	1	1	3	1	5	1	13	36	30	1	17	17	7	3	4
1964	1	41	24	31	3	137	13	22	8	73	42	58	28	16	7	10
1965	1	1	1	5	1	14	12	21	15	23	20	25	22	60	9	9
1966	1	2	15	7	3	27	17	32	27	37	34	28	40	10	4	4
1967	1	1	2	1	8	3	4	20	34	32	14	10	12	2	2	6
1968	1	6	18	40	7	109	28	66	40	91	23	64				
1969	1	2	4	15	4	11	6	50								
1970	1	6	1	6												

The 1971 survey confirmed the high abundance of the 1968 year-class of cod in the Labrador (as shown by the number of three-year-olds in Div. 3K), the South Newfoundland and the St. Pierre Bank stocks.

In the last three years the abundance of young haddock in Div. 3P (from where they migrate to Div. 3NO) remained at a rather low level. There was no appreciable recruitment to the commercial stock on the southern Grand Bank.

Table 6. Average catch (numbers) of young haddock (ages 1-3 by divisions) per hour trawling with a survey trawl.

Year-class	1 Year 3NO	1 Year 3P	2 Years 3NO	2 Years 3P	3 Years 3NO	3 Years 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	2	4
1969	4	35	4	38		
1970	1	32				

c) Trawl survey. In May - August a trawl survey was made by R/V *Perseus III* in Subarea 3 aimed at the quantitative assessment of both young and mature cod and haddock. The results of this survey are presented in a special report by Postolaky (Res.Doc. 72/106).

Deep water redfish (*Sebastes mentella*) was found to be predominant both in numbers and in biomass in almost all the areas except Div. 3L where American plaice (*Hippoglossoides platessoides*) came first.

d) Recapture of tagged fish. As may be inferred from Table 7, American plaice (*Hippoglossoides platessoides*) is capable of performing quite lengthy migrations from the open sea shoreward.

Table 7. Tagged American plaice release and recapture data.

Released Date	Released Lat. (N)	Released Long. (W)	Released Length (cm)	Tag No.	Country	Recaptured Date	Recaptured Lat. (N)	Recaptured Long. (W)
26 May 1970	46°21'	47°37'	44	248014	Canada	20 May 1971	46°52'	55°48'
26 May 1970	46°21'	47°37'	42	248036	Canada	23 Nov 1970	47°23'	52°25'
26 May 1970	46°21'	47°37'	50	248062	USSR	29 Dec 1971	46°30'	47°30'
26 May 1970	46°21'	47°21'	50	248063	Canada	5 Mar 1971	47°10'	55°50'
26 May 1970	46°21'	47°37'	46	248078	Canada	10 Apr 1971	47°10'	55°50'
26 May 1970	45°51'	48°06'	48	248257	Canada	10 Sep 1971	46°30'	48°40'
26 July 1970	48°31'	50°09'	49	248876	Canada	19 Feb 1971	47°48'	48°52'

Subarea 4

A. STATUS OF THE FISHERIES

The 1971 USSR catch in this Subarea was 270,059 tons (Table 1).

1. Silver hake

The catches of silver hake, although rather high, were somewhat lower than in 1970. The total silver hake catch in 1971 was 128,600 tons against 169,900 tons in 1970 and 46,300 tons in 1969.

Since the silver hake fishery started in 1962 there was an increase in the catches to 123,000 tons in 1963 followed by a significant decline in 1964 and 1965, a drop to 2,500 and 3,400 tons in 1967 and 1968 and another sharp increase since 1969. The variations in the annual catch are chiefly explained by sharp fluctuations in the abundance of the stock caused by the recruitment to the commercial stock of variable year-classes. The fishing effort has not been constant during these years, increasing in the years when the abundance is high and decreasing in those when it is low.

Silver hake are fished in the Nova Scotian trough and on the slopes of Emerald, Middle and Sable Island

Banks mainly from March through September by large (>1,800 GRT) trawlers with bottom and pelagic trawls. As in previous years, the major part of the catch consisted of fish of age 3+ and 4+ (Table 8), which can be attributed to the fact that at the age of 4-5 years the majority of the fish are removed from the commercial stock by natural mortality.

The results of the trawl survey in the autumn of 1971 indicated that the abundance of silver hake remained at the same level as in 1970. The 1968, 1969 and 1970 year-classes are estimated to be relatively strong, which suggests that in 1972 and 1973 the silver hake stock is likely to remain at a rather high level of abundance.

2. Herring

The 1971 herring catch was 29,000 tons against 70,200 tons in 1970. The decline is explained by smaller concentrations on Banquereau Bank and by lower fishing effort. Herring were mainly fished with purse seines on Banquereau Bank in February and March and on Emerald and Middle Banks in March, April and May.

The majority of herring in the Banquereau Bank (Div. 4V) catches were fish of age 6+ to 12+, those of age 10 (the 1961 year-class) being predominant (Table 9). On Emerald and Middle Banks the major portion of the catch consisted of age 3+ to 9+ fish, with the predominance of ages 3 and 7 of the 1968 and 1964 year-classes.

Table 8. Percentage age composition of silver hake catches in Subarea 4, 1969-1971.

Year	Age 1	2	3	4	5	6	7	8	9	Total (%)	Mean Age
1969	6.1	6.1	34.0	35.7	12.7	3.6	1.2	0.6	-	100	3.6
1970	7.0	11.6	35.9	33.1	10.1	1.4	0.5	0.3	0.1	100	3.4
1971	-	8.8	43.2	36.8	8.8	1.2	0.5	0.5	0.2	100	3.5

Table 9. Percentage age composition of herring catches in Div. 4V and 4W in 1969-1971.

Div.	Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total (%)	Mean age
	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	7.36
4V	1970	-	-	-	-	0.2	1.1	6.8	9.7	17.8	17.5	17.2	14.4	9.8	5.5	-	100	9.61
	1971	-	-	0.1	1.4	5.0	6.8	16.5	13.9	19.3	19.3	14.2	6.6	1.8	0.3	0.2	100	9.4
	1969	-	-	0.2	2.1	18.8	36.3	18.0	12.7	8.1	2.6	1.6	0.1	-	-	-	100	6.5
4W	1970	0.1	0.2	2.8	16.0	27.7	13.6	26.5	6.2	4.9	1.4	0.9	-	-	-	-	100	6.1
	1971	-	-	20.7	6.3	12.6	12.7	29.5	11.2	6.7	3.7	1.3	0.3	-	-	-	100	5.3

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

a) Argentine. Argentine from the southwestern slopes of Browns Bank (Div. 4X), eastern slopes of Sambro Bank (Div. 4W) and southeastern slopes of Banquereau Bank were analysed for growth rate, vertebrae number, weight of otolith in relation to body length and length-width otolith ratio in relation to body length. Div. 4V argentine was found to have the highest growth rate, with lower growth rate observed in the fish from Div. 4W and still lower in those from Div. 4X.

As regards otolith weight with body length being equal, the fish can be arranged in reverse order. The highest otolith weight was recorded in Div. 4X argentine, with lower weight shown by Div. 4W fish and still lower by those from Div. 4V, *i.e.* argentine with lower growth rate appear to have higher otolith weight. These data suggest the existence of local argentine populations on Browns Bank (Div. 4X), Sambro Bank (Div. 4W) and Banquereau Bank (Div. 4V).

Observations on gonad condition suggest that argentine spawn from late February to May on the slopes of Browns Bank, in March - April on Sambro Bank and in April - May on Banquereau Bank.

Subarea 5

A. STATUS OF THE FISHERIES

The USSR catch in this subarea was 292,754 tons (Table 1).

1. Silver hake

In 1971 the silver hake catch more than doubled compared to 1970, and was 81,500 tons against 29,000 in 1970. The higher catch in 1971 is attributed to increased commercial concentrations and a higher fishing effort. The results of the autumn trawl surveys suggested that the silver hake stock was somewhat more abundant in 1971 than in 1970. The greater portion of the catch was taken by large (>1800 GRT) trawlers on the slopes of the bank between Black and Corsair Canyons and on the Nantucket Shoal. Smaller quantities of silver hake were taken on the northwestern slopes of Georges Bank.

The catches were mainly composed of 28-35 cm fish (3 to 6 years old), with 3- and 4-year-olds predominating as in previous years (Table 10).

On the basis of data obtained during the trawl survey in the autumn of 1971, the 1971 year-class was estimated to be abundant, which suggests that in 1974 when these fish attain commercial age the stock and the catches are likely to increase.

Table 10. Percentage age composition of silver hake catches in Subarea 5 in 1969-1971.

Year	Age 1	2	3	4	5	6	7	8	9	10	Total (%)	Mean Age
1969	1.3	14.6	33.2	25.5	14.5	5.2	4.0	1.2	0.5	-	100	3.78
1970	16.4	13.4	16.2	27.5	16.3	4.0	4.0	1.7	0.3	0.2	100	3.54
1971	1.0	6.9	31.6	32.6	16.3	5.9	2.8	1.7	0.9	0.3	100	4.01

2. Haddock

The trawl survey data show the 1971 haddock year-class to be of moderate abundance. When these fish are recruited to the commercial stock in 1974, an increase in the stock abundance and in catches may be expected.

3. Red hake

The red hake catch was 25,300 tons, which in 19,000 tons more than in 1970. The increase in catches is attributed to increasing fishing effort. As in previous years, red hake were fished on the slopes of Georges Bank and on the Nantucket Shoal, mainly from May through October. The major portion of the catch was composed of 2-, 3-, and 4-year-olds (Table 11).

Table 11. Percentage age composition of red hake in Subarea 5, 1969-1971.

Year	Age 1	2	3	4	5	6	7	Total (%)	Mean Age
1969	3.4	17.5	35.5	35.4	7.6	0.3	-	100	3.27
1970	-	2.5	63.8	29.2	4.5	0.3	-	100	3.36
1971	0.4	47.7	29.0	14.4	6.9	1.5	0.1	100	2.85

4. Herring

The herring catch on Georges Bank increased as a result of the intensification of fishing and amounted to 63,900 tons, which is almost 25,000 more than in 1970. Herring were mainly fished by trawls from May through October. A small group of vessels fished with purse seines in May and June.

Herring were represented in catches mainly by ages 3+ to 7+, with the 1968 (age 3+) and the 1967 (age 4+) year-classes predominating (Table 12). In 1971, as in the preceding year, all the herring year-classes available to the fishery were poor. In 1972 no strong year-classes are likely to be recruited and the stock is expected to remain at the 1970 and 1971 level.

Table 12. Percentage age composition of herring catches in Subarea 5 in 1969-1971.

Year	Age											Total (%)	Mean Age
	2	3	4	5	6	7	8	9	10	11	12		
1969	+	5.1	14.3	33.6	21.1	15.1	9.3	1.4	0.1	+	+	100	6.22
1970	2.8	7.3	28.3	32.1	12.0	9.2	5.0	3.0	0.3	-	-	100	5.99
1971	1.5	28.7	31.5	17.9	10.2	7.0	2.6	0.5	0.1	-	-	100	4.41

5. Mackerel

The 1971 mackerel catch was 59,000 tons, 2,500 tons higher than in 1970. Mackerel were represented in catches by twelve age groups (1-12), with the bulk of the catch composed of the strong 1966 and 1967 year-classes. These two year-classes together accounted for three-fourths of the catch (Table 13). In 1972 the abundance of these year-classes is expected to remain at a high level and the stock is likely to be in good condition.

Table 13. Percentage age composition of mackerel catches in Div. 5Z in 1969-1971.

Year	Age												Total (%)	Mean Age
	1	2	3	4	5	6	7	8	9	10	11	12		
1969	-	83.8	12.7	3.2	0.2	0.1	-	-	-	-	-	-	100	2.2
1970	16.1	7.5	50.2	15.8	4.0	1.4	1.5	1.5	1.3	0.7	+	-	100	3.1
1971	0.4	8.8	8.1	51.2	24.2	4.4	0.8	0.3	0.6	0.7	0.4	0.1	100	4.2

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. As in previous years, a series of standard hydrographic sections were made in Subarea 5 and Stat. Area 6 in January, April, August and October. Water temperature measurements along these sections showed that the thermal level was higher in 1971 than in 1970.

An indication of the warmer water temperatures is provided by the minimum temperature of the cold intermediate layer which in the East Channel area (Section III) was 1.7° higher in spring, the same as in 1970 in summer and 0.5° higher in autumn (Table 14).

Table 14. Minimum water temperature along Section III, 1971.

Year	January	April	August	October
1970	2.3	1.7	5.2	4.2
1971	3.2	3.4	5.2	4.7

In the southern Georges Bank area the temperature of the intermediate layer in August was on the average 1.0° higher than in 1970. The calculations of the mean water temperature in August for the southern parts of Sections XXI, XXII, XXIII and for Section IV covering the southern part of the Bank as well as for Section V, XXIV and XXV west of 69°W also show a considerable increase in the mean water temperature in 1971 (Table 15).

Table 15. Mean water temperature along sections covering Georges Bank and the Shelf.

Year	Southern Georges Bank			US Shelf, 70-74°W			
	IV	XXI	XXII	XXIII	V	XXIV	XXV
1970	11.6	12.6	12.0	13.7	15.4	15.0	14.5
1971	12.7	13.4	14.4	15.7	14.9	17.3	14.9

In the northern Georges Bank area no appreciable changes in the temperatures of the surface and intermediate layers were observed but higher temperatures were recorded in the near-bottom layer. An example is a higher temperature in the deepest part of the Gulf of Maine as a result of the strong advection of transformed slope waters through the East Channel.

It is seen from Table 15 that an increase occurred at each of the sections mentioned except Section V. The lower mean temperature along this Section might have resulted from the intensification of the inflow of relatively cold water in the intermediate layer.

b) Hydrochemistry. Hydrochemical observations were made by R/V *Argus* in July at the time of the ecological survey in the Browns Bank - Hudson Canyon area. At 28 stations covering the entire ecological survey area, determinations were made of oxygen, phosphate, nitrite and silicon contents, pH, oxidizability and primary production (oxygen method). July was found to be a typical transitional month from the hydrological spring to summer. The concentration of dissolved oxygen in the photic layer was never observed to be below 5.5 ml/l, with a maximum of 8.8 ml/l in the photosynthetic layer.

In the photic layer the concentration of phosphates was found to be below the value (17 mg/l) limiting the development of phytoplankton. The values for nitrites in the 30 to 50 m layer were 0.02 to 0.05 mg/l. The silicon concentration of 100 to 200 mg/l on the surface increased with depth and amounted to 450-550 mg/l in the near-bottom layer. The oxidizability usually varied from 0.3 to 0.6 mg/l O_2 and was as high as 1.6 to 5.7 mg/l O_2 only in areas rich in phytoplankton.

c) Zooplankton. In summer and autumn zooplankton samples were taken with Juday net on the silver hake, red hake and herring spawning grounds in the Georges Bank area. Altogether 526 samples were collected, which are being processed at present. The processed data collected in 1970 show an appreciable decline in both the numbers and the biomass of zooplankton averaged over Georges Bank as a whole (Table 16).

Table 16. Numbers (thousands per sq m) and biomass (mg/m^3) of zooplankton on Georges Bank in August and November, 1965-1970.

Month	Year					
	1965	1966	1967	1968	1969	1970
August - number	173	122	260	410	-	114
- biomass	373	353	210	472	-	279
November - number	114	82	128	50	93	79
- biomass	483	510	280	211	341	221

Over the southern slopes of Georges Bank the abundance of zooplankton was found to be slightly higher than in 1968 but lower than in 1965 (Table 17).

Table 17. Abundance (thousands per sq m) of zooplankton on the southern Georges Bank in August, 1965-1970.

Year	1965	1966	1967	1968	1969	1970
Abundance	283	149	139	83	-	116

Generally, over Georges Bank as a whole the numbers and the biomass of zooplankton have recently followed a downward trend, which may affect the condition of the young and adult fish feeding on zooplankton. This may also have an adverse effect on the strength of year-classes in herring, haddock and other species.

2. Biological Studies

a) Silver hake

Eggs and larvae. In summer 1971 studies were continued on the effectiveness of spawning on Georges Bank. Ichthyoplankton, zooplankton and hydrographic surveys of the area were conducted. The amount of eggs and larvae on the main spawning grounds on the southern slopes of Georges Bank was found to be much higher than in previous years. The study of the food of the silver hake larvae collected in 1968 was completed and showed that as in 1965-1967 the major part of the food consisted of nauplii, copepodites and adult copepods. Small larvae (3.0 to 7.9 mm long) caught on the northern slopes in August were feeding more intensively than those caught in the same area in October or those on the southern and southwestern slopes in July - August.

Young fish survey. 1971 autumn trawl survey data show the 1971 year-class to be strong.

Race analysis. In 1971 material on race differences was summarized and the data on population dynamics, growth rate, weight of otoliths, biochemical variations and spawning characteristics made it possible to distinguish the following local silver hake stocks:

1. Sable Island Bank stock
2. Browns Bank stock
3. Georges Bank stock
4. Southern New England stock.

b) Herring

Eggs and larvae. The distribution and abundance of eggs and larvae were studied on Georges Bank in September - October. The amount of eggs on the main spawning grounds in the northern part of the Bank was found to be as low as in 1970. In October the greater part of larvae are to be found on Georges Bank (data of survey according to ICNAF program). The study of the feeding of larvae collected in 1968-1969 shows that in October the larvae feed mainly on nauplii and copepodites as well as on bivalve larvae. The stomach contents of the 1968 larvae showed no nauplii but they occurred in the stomachs of the 1969 larvae. In 1969 larvae were found to feed more intensively than in 1968. In the plankton the abundance of nauplii was in 1969 seven times and that of copepodites twice as high as in 1968.

Spawning stocks. The abundance of the spawning stock estimated from the quantities of eggs laid in 1971 appeared to be at the same low level as in 1970. The spawning stock was estimated to be 60,000 tons in 1969, 12,000 tons in 1970 and 11,000 tons in 1971.

Since the main mass of herring larvae occur in October on Georges Bank, it can be said that the abundance of the Georges Bank spawning stock is much higher than in the Gulf of Maine and in southern Nova Scotia and that this spawning stock plays a decisive role in the reproduction of the New England herring.

c) Groundfish trawl surveys. In 1971 two trawl surveys were made: the first was conducted on R/V *Argus* in July and the second on R/V *Blesk* in August and October according to the joint USSR, USA and Canada program. The abundance indices for the main species were determined and the silver hake and red hake year-classes in Subarea 5 and Stat. Area 6 were found to be strong. The 1971 Georges Bank haddock year-class appeared to be of moderate abundance.

The minimum abundance of the stock of spiny dogfish in the Browns Bank - Hudson Canyon Shelf area was estimated to be 300,000 tons and the stock of short-finned squid in the same area was estimated at 110,000 tons. As the hauls were made with a bottom trawl, only a small part of squid concentrations was available, which suggests that the actual squid stock may be about three times higher, *i.e.* about 300,000 tons. Squid appears to be a promising species for a fishery in this area.

Statistical Area 6

A. STATUS OF THE FISHERIES

In 1971 the catch in Stat. Area 6 was 11,600 tons higher than in 1970, which can be explained by increases in the silver hake catch from 3,000 tons in 1970 to 7,000 tons in 1971, in the red hake catch from 800 tons to 8,200 tons and in the catches of other species. Fisheries were mainly conducted by big and medium trawlers in shallow waters in winter and in spring. The objectives were mackerel and herring. Silver and red hakes were taken on the shelf slopes in late April - early May and in November. The mackerel and herring taken in Stat. Area 6 belong to the stocks fished on Georges Bank. The results of trawl surveys suggest that no appreciable changes are likely to occur in the stocks of silver and red hake but a considerable increase is expected in 1974 due to the recruitment of the strong 1971 year-classes.

The age composition of herring catches in Stat. Area 6 differed from that on Georges Bank (Table 18), with older herring (ages 5+ to 7+) predominant in Stat. Area 6 and ages 3+ and 4+ dominating on Georges Bank. A possible explanation is that in winter older herring at age 5+ and older migrate from Georges Bank to Stat. Area 6, while younger fish remain on Georges Bank or in the Gulf of Maine.

The silver hake in the 1971 catches were represented by fish at age 1+ to 10+, with the 1969, 1968 and 1967 year-classes predominating (Table 19). The 1969 silver hake year-class appears to be more abundant than the 1967 and 1968 year-classes.

Table 18. Percentage age composition of herring catches in Stat. Area 6 in 1969-1971.

Year	Age														Total (%)	Mean Age
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1969	-	-	4.4	12.5	30.1	18.6	16.6	16.2	1.5	0.1	-	-	-	-	100	5.88
1970	-	-	2.9	7.8	29.7	15.3	14.9	14.5	14.9	-	-	-	-	-	100	6.10
1971	-	-	0.8	5.9	38.1	23.9	24.0	4.9	2.4	-	-	-	-	-	100	5.57

Table 19. Percentage age composition of silver hake catches in Stat. Area 6 in 1969 and 1971.

Year	Age										Total (%)	Mean Age
	1	2	3	4	5	6	7	8	9	10		
1969	-	8.2	40.7	30.1	10.4	3.8	4.4	1.4	0.8	0.2	100	3.85
1971	3.5	31.1	37.5	17.3	4.2	2.3	2.2	1.3	0.4	0.2	100	3.14

UNITED KINGDOM RESEARCH REPORT, 1971

Subareas 1-3

A. STATUS OF THE FISHERIES

by

D. J. Garrod

Fishing effort which was confined to Subareas 1 and 3 increased from 4,600 hours in 1970 to 9,500 hours in 1971; this was still well below the level of UK fishing effort in ICNAF Areas in earlier years.

Total catches of cod were only 5,800 tons, 500 more than in 1970. About two-thirds of this was from Subarea 3, the remainder from Subarea 1. There was no fishing in Subarea 2.

Hours fishing, number of arrivals and landings of cod from the Northwest Atlantic.

Year	ICNAF Subareas 1	2	3	Total
	Landings (statute tons)			
1970	2,760	2,107	424	5,291
1971	1,993 (808)*	-	3,799	5,792 (808)*
	Hours fished			
1970	2,034	1,897	709	4,640
1971	3,154 (1,251)*	-	6,356	9,510 (1,251)*
	Number of arrivals			
1970	14	5	5	24
1971	23 (8)*	-	13	36 (8)*

* Wet-fishers included in total.

B. SPECIAL RESEARCH STUDIES

by

K. A. Pyefinch

Biological Studies

In collaboration with Danish fishery workers, UK scientists continued their investigations of the West Greenland salmon fishery in 1971. The main items in the program were further drift-netting experiments (in preparation for the International Tagging Experiment planned for 1972) and the collection of samples of salmon blood for further serological studies. Four UK scientists took part in these investigations.

The results of the drift-netting program were disappointing because, owing to circumstances beyond the investigators' control, fishing was restricted to thirteen days within the period of the experiment (10 September to 14 October). In all, 348 salmon were caught, of which 105 (about 30%) were tagged. One of the fish caught had been tagged, as a hatchery-reared smolt, in Maine in May 1970; it was released after re-tagging. Two local recaptures have since been reported.

The blood sampling program was more successful. With the cooperation of a Danish commercial fishing vessel, 1,830 blood samples were collected; these are now being analysed.

Two of the 21 salmon tagged in 1970 from floating long lines have been recaptured, one in the Solway

Firth (Scotland) and the other in Nova Scotia (Canada). In addition, two of the 56 salmon tagged from coastal gillnets in 1970 have been recaptured, one off Dunmore East (Eire) and the other in the Ungava River in Labrador.

To date, 125 recaptures have been recorded at West Greenland from wild smolts tagged in UK rivers in 1970 as well as 8 recaptures from UK hatchery-reared smolts.

Smolts were again tagged in home-waters during the spring of 1971. In England and Wales a total of 17,140 (5,619 wild and 11,521 hatchery-reared) was tagged and in Scotland 20,706 wild and 5,247 hatchery-reared smolts were tagged, giving an overall total of 25,953.

Subareas 1-5

B. SPECIAL RESEARCH STUDIES

by

G. A. Robinson

Environmental Studies

The survey with Continuous Plankton Recorders, operated from the Oceanographic Laboratory, Edinburgh, continued in 1971 on the same basis as in other years. The survey was financed by the UK Natural Environment Research Council.

Recorders are towed at a depth of 10 m, at monthly intervals, along standard routes by cutters of the US Coast Guard and by merchant ships from Denmark, Iceland and the United Kingdom. During 1971, recorders sampled for 1,092 miles in Subarea 1, 2,315 miles in Subarea 2, 13,244 miles in Subarea 3, 3,345 miles in Subarea 4 and 1,258 miles in Subarea 5. This sampling forms part of the laboratory's standard survey of the North Atlantic and the North Sea.

The data processing of the results from the survey is fully automated; the survey area is divided into statistical rectangles, each 2° of longitude by 1° of latitude, which are then grouped into a system of standard areas (see Annual Report of the Scottish Marine Biological Association for 1970-71). The monthly distributions of all species, or groups of species, are plotted as mean numbers per statistical rectangle and per standard area. At the end of every year, the annual and seasonal fluctuations in abundance of each species are calculated for each standard area for the period 1948 onwards in the North Sea and northeastern Atlantic and 1962 onwards for the western Atlantic; routine statistical analyses, such as Principal Component Analyses, are then carried out. Further details may be obtained on application to the Director, Oceanographic Laboratory, Institute for Marine Environmental Research, 78 Craighall Road, Edinburgh, EH6 4RG.

In 1971 phytoplankton was below average in the oceanic parts of Subareas 2 and 3 with the spring peak in April in Subarea 3 and in May in Subarea 2, that is about a month earlier in both cases than the long-term mean. *Thalassiothrix longissima* was abundant earlier than usual whereas the other dominant spring diatoms, *Phaeoceros* spp. and *Thalassiosira* spp., were below average. Over the Grand Banks, the spring peak in March was also earlier than usual, but it was close to the long-term mean in the coastal region of Subarea 4, although in both these areas *T. longissima* was abundant in February and March and scarce from April onwards.

Copepods were correspondingly early in the oceanic section of Subareas 2 and 3. Numbers were highest in both areas in May, about a month earlier than usual. Over the Grand Banks, peak numbers were found in March, and from July onwards, whereas in Subarea 4, they were already abundant in June. Numbers of adult *Calanus finmarchicus*, which is the dominant copepod in the oceanic parts of Subareas 1, 2 and 3, were close to the average in both abundance and time of occurrence. In Subarea 2, high numbers were found from April onwards, but further south in Subarea 3 it was common throughout the year except in June in the oceanic section and from May to July over the Grand Banks. Numbers were much above average in Subarea 4 in January, June and August.

In contrast to the copepods, the peak abundance of euphausiids was about a month later than usual (April instead of March) in Subarea 2; in both the oceanic and coastal sections of Subarea 3 they were very abundant in March and high numbers were found again over the Grand Banks in August.

Numbers of larvae of *Sebastes* spp. were low in all areas; the non-pigmented variety was present in the oceanic part of Subarea 3 in April and the pigmented variety in the coastal waters of Subarea 5 in August. *Ammodytes* spp. were abundant in Subarea 3 in March but less common than usual over the Grand Banks.

UNITED STATES RESEARCH REPORT, 1971

The United States landed fish from ICNAF Subareas 4 and 5, and Statistical Area 6. Research was conducted in Subareas 3, 4, and 5 and in Stat. Area 6.

Table 1 gives a summary of US finfish and sea scallop landings for each Subarea for 1970 and 1971.

Table 1. US finfish and sea scallop landings for 1970 and 1971 (metric tons, round weight).

Species	Year	Subarea 1	2	3	4	5	6[1]	Total
Haddock	1971	-	-	-	1248	8486	1	9735
	1970	1	1	-	2319	9872	1	12194
Cod	1971	-	-	-	335	22983	125	23443
	1970	278	502	55	615	22347	364	24161
Redfish	1971	-	-	-	10967	16262	-	27229
	1970	-	-	-	9541	15534	-	25075
Pollock	1971	-	-	-	164	4724	2	4890
	1970	-	-	-	385	3592	-	3977
Yellowtail	1971	-	-	-	12	22312	2993	25317
	1970	-	-	-	21	31920	4050	35991
Silver hake	1971	-	-	-	1	13325	542	13868
	1970	-	-	-	-	19379	2248	21627
Red hake	1971	-	-	-	-	2783	356	3139
	1970	-	-	-	-	4281	659	4940
Sea herring	1971	-	-	-	-	33884	263	34147
	1970	-	-	-	-	30484	708	31992
River herring	1971	-	-	-	-	940[1]	5980	6920
	1970	-	-	-	-	1463	14858	16321
Menhaden	1971	-	-	-	-	6355	5148	11503
	1970	-	-	-	-	5122	218304	223426
Other finfish	1971	-	-	-	322	31482[1]	3115	34919
	1970	1	2	-	352	40413	34771	75539
Total finfish	1971	-	-	-	13049	163536[1]	18525	195110
	1970	280	505	55	13233	184407	275962	474442
Sea scallop	1971	-	-	-	-	14142	2285	16427
	1970	-	-	-	-	12938	8828	21766

[1] Landings incomplete for 1971.

Subarea 3

B. SPECIAL RESEARCH STUDIES

The US Coast Guard conducted oceanographic surveys in support of the International Ice Patrol in Div. 3N, L, and O.

Subarea 4

A. STATUS OF THE FISHERIES

1. Haddock

US landings of haddock from Subarea 4 amounted to 1,248 tons, 46% below 1970 landings. US landings from Div. 4X were 751 tons, 57% lower than 1970 (Table 2). Landings from Browns Bank, the principal area fished by US vessels in Div. 4X, decreased 971 tons. Landings per day decreased again on Browns Bank and predictions are that no significant recruitment to the fisheries can be expected before 1975. The decrease in quota allowance for 1972 may prevent a further decline in abundance.

Table 2. US 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
1971	751	605	242	2.5

2. Cod

The US fleet landed 335 tons of cod from Subarea 4, 280 tons less than in 1970. This decrease in landings is probably a reflection not only of reduced effort but also lower abundance.

3. Redfish

US landings of redfish from the Gulf of St. Lawrence (Div. 4R, S, and T) decreased by 38% (Table 3). Redfish landings by the USA from the Scotian Shelf (Div. 4V, W, and X) increased 4,312 tons (Table 4). Landings per day decreased for the Gulf of St. Lawrence, but was slightly higher for the Scotian Shelf. These indices, however, are probably not very sensitive measurements of abundance trends.

Table 3. US 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
1971	4,706	490	9.6

Table 4. US 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	1,949	135	14.2
1971	6,261	404	15.5

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

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

2. Biological Studies

a) Haddock. Monitoring of haddock stocks in Div. 4X through commercial catch-effort statistics and *Albatross IV* groundfish surveys show stock abundance to have declined to the lowest level recorded during the 1956-1971 period. Estimates of the strength of the 1971 year-class showed only a slight improvement over the extremely poor year-classes of 1964-1968 and 1970. Thus, although the 1971 quota of 18,000 tons was reduced to 9,000 tons for the 1972 catch, a significant improvement in recruitment and stock abundance cannot be expected prior to 1976 at the earliest, and then only if the 1972 year-class is very large.

Studies on sexual maturity and spawning cycles continued jointly with the St. Andrews Biological Station, Fisheries Research Board of Canada. Over 1,000 haddock were examined: samples were taken through April in Div. 4W and through May in Div. 4X. Spawning in Div. 4X and 4W began in early March and the 50% spawned-out point was reached in mid-May. Spawning probably ended in June.

b) Herring. Studies on herring in Div. 4X are reported under Subarea 5.

Subarea 5

A. STATUS OF THE FISHERIES

1. Haddock

Haddock landings in 1971 were limited by the 12,000 ton quota set by the Commission. Only 80% of this quota was attained. The USA landed 8,486 tons, about 1,386 tons less than the 1970 landings (Table 5). Landings per day values 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.

Age composition of haddock in 1971, based on commercial landings, indicate that fish 8 years old and greater (predominantly 1963 and 1962 year-classes) continued to represent 50% of the 1971 catch (Fig. 1). The *Albatross IV* autumn groundfish survey catches indicate a slight improvement in the 1971 year-class over 1970; however, the index continues low. Poor reproduction now extends to eight years (Table 6), and recruitment through 1973 will be very low.

Table 5. US haddock statistics, Subarea 5 (metric tons).

Year	Subarea 5 landings	Div. 5Y landings	Subdiv. 5Zw landings	Subdiv. 5Ze Landings	Subdiv. 5Ze Adjusted landing/ 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	9,872	1,457	15	8,400	2.1
1971	8,486	1,180	5	7,301	1.6

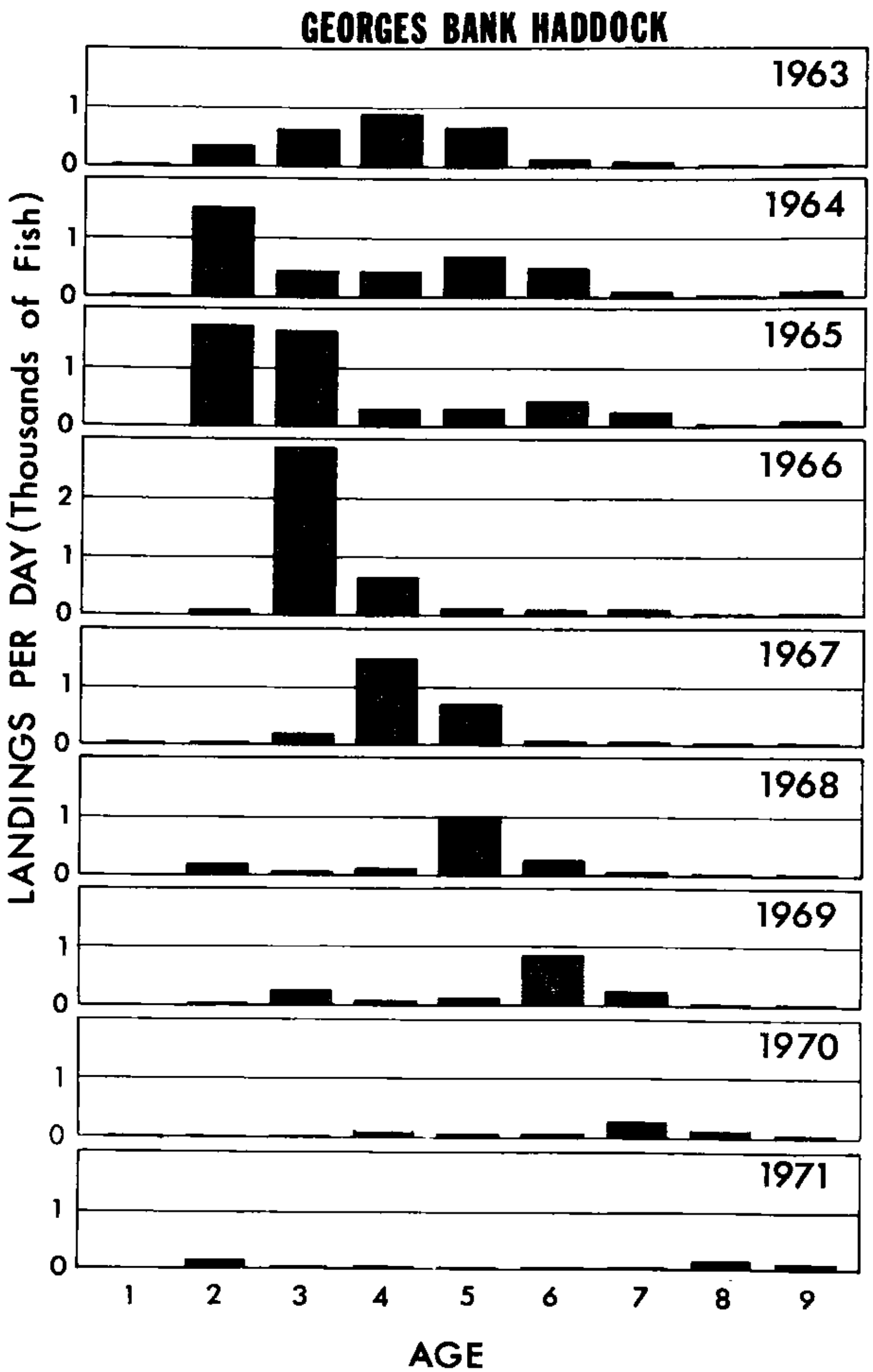

Fig. 1. Age composition of Georges Bank haddock.

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

Year	Index	Year	Index
1959	9.6	1966	1.7
1960	2.4	1967	1.0
1961	1.4	1968	1.0
1962	2.6	1969	1.1
1963	12.6	1970	1.0
1964	2.0	1971	1.4
1965	1.2		

2. Cod

Cod landings by the USA in Subarea 5 for 1971 were similar to 1970 landings (Table 7). Total catch over the last several years by all countries (*e.g.* 49,176 tons in 1968 and 45,376 tons in 1969) has been considered higher than the sustainable yield. Although the US commercial abundance index remained unchanged, research surveys indicate a slight decrease and it is probable that abundance has declined in 1971. The lack of decrease in the commercial index may be due to changing fishing practices causing greater directed effort for cod.

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

Year	Subarea 5 landings	Div. 5Y landings	Subdiv. 5Zw landings	Subdiv. 5Ze Landings	Subdiv. 5Ze 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	22,347	7,812	1,182	13,353	2.1
1971	22,983	7,188	728	14,999	2.0

3. Silver hake

Total US landings of silver hake from Subarea 5 in 1971 decreased 6,000 tons from 1970 (Table 8). Food fish landings from the Gulf of Maine (Div. 5Y) and Georges Bank (Subdiv. 5Ze) decreased moderately. Landings from Subdiv. 5Zw, which are predominantly for industrial use, decreased sharply.

Abundance has been low; however current research cruise data indicate significant increases in pre-recruit (*i.e.* ≤10 cm) numbers which would improve abundance by 1973 if fishing levels do not increase greatly on the small fish.

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

Year	Subarea 5 landings	Food Fish: Div. 5Y landings	Food Fish: Subdiv. 5Ze landings	Food Fish: Landings/ day	Industrial Fish: Subdiv. 5Zw landings	Industrial Fish: 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	19,379	11,384	4,238	3.7	3,757	2.2
1971	13,325	8,256	3,069	2.6	2,000	3.4

4. Redfish

US landings of redfish from Subarea 5 in 1971 increased slightly over 1970 (Table 9). Landings from Div. 5Y, however, declined by 1,000 tons. Effort continued an increase which began in 1969. Landings per day declined from 1970 and abundance is possibly lower, although good fishing does occur in many areas.

Table 9. US 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	15,534	13,551	1,473	9.2
1971	16,262	12,536	1,694	7.4

5. Yellowtail flounder

Total US catch in Subarea 5 for 1971 was about 29,000 tons (Table 10), which equaled the quota set by the Commission. This represented a 31% decrease from 1970. Yellowtail landings for food were lower by 26% while landings of yellowtail for industrial purposes, mainly from Subdiv. 5Zw, declined 84%. Regulations limiting catch of yellowtail to 10% of the total for vessels not fishing the regulation mesh size, contributed to the great decrease in industrial landings.

Commercial landings per day declined on both major fishing grounds (Georges Bank and southern New England). Survey cruise data also reflect lower relative abundance, particularly for southern New England (management area W of 69°) (Table 11).

Age composition of commercial data show that 3- and 4-year-old fish made up about 66% of the landings. Survey cruise data indicate continued below average pre-recruits. Assessments based on autumn survey cruises and 1971 catches suggest that 1972 abundance will be about the same or slightly less than in 1971.

Table 10. US yellowtail flounder statistics, Subarea 5 (metric tons, round weight).

Year	Food landings	Landings/ day fished	Estimated discards	Est. Indus. landings	Catch
1965	36,218	3.1	12,893	972	50,083
1966	28,656	2.0	8,253	2,364	39,273
1967	20,819	2.2	14,407	4,587	39,813
1968	28,645	3.0	10,627	3,939	43,211
1969	28,739	2.7	5,202	4,265	38,206
1970	29,825	2.5	10,689	2,095	42,609
1971	21,970	2.1	7,106	342	29,418

Table 11. Yellowtail flounder abundance indices from US survey cruises.

Year	Southern New England (W of 69°)		Georges Bank (E of 69°)	
	Nos. per tow	Weight per tow[1]	Nos. per tow	Weight per tow[1]
1963	50.6	32.1	30.1	22.0
1964	60.8	41.9	22.5	23.4
1965	38.7	28.0	15.0	15.7
1966	50.2	20.8	14.8	6.7
1967	57.7	31.0	18.6	13.0
1968	40.2	22.1	25.6	18.1
1969	54.7	31.7	23.1	15.9
1970	49.5	30.1	16.0	11.6
1971	33.9	21.0	15.3	11.1

[1] Weight in pounds.

6. Red hake

Red hake landings by the USA from Subarea 5 in 1971 were 2,783 tons, a decline of 35% from 1970 (Table 12). This decrease was associated with a general reduction of landings by the industrial fishery. The commercial landings per day index was greatly improved in 1971 and survey cruise data showed increases in pre-recruits. Abundance should improve by 1973.

Table 12. US red hake statistics, Subarea 5 (metric tons, live weight).

Year	Subarea 5 landings	Food fish		Industrial fish	
		Div. 5Y landings	Subdiv. 5Ze landings	Subdiv. 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	3,932	6.3
1971	2,783	268	111	2,404	8.4

7. Industrial groundfish fishery

New England industrial groundfish landings from Subarea 5 declined significantly in 1971 (Table 13). The decline was attributable to general market conditions. Species composition in commercial landings reflect increases in importance of the hakes, while flounder, particularly yellowtail, decreased 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
1971	8,823	10.5	26.2	6.6	30.4	26.3

8. Sea scallops

US sea scallop landings from Georges Bank increased slightly in 1971 over 1970 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. US 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]
1971	1,697	3,394	0.5	- [1]

[1] There were no research vessel cruises for scallop abundance estimate since 1968.

9. Herring

The herring catch from Div. 5Y for 1971 was 31,400 tons, about equal to 1970. This fishery is now primarily harvesting adults (age 4+ and older). Only 23% of the Div. 5Y catch in 1971 consisted of juvenile fish. Prior to 1967, the fishery was almost exclusively for juvenile fish.

US catch in Div. 5Z was 2,400 tons, 84% above the 1970 landings.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Data gathered in 1971 at the environmental recording unit at Boothbay Harbor showed that annual mean water temperature was slightly lower (0.2°C) than in 1970, while that for air temperature was slightly higher. The total precipitation for 1971 was 25% below normal, while the mean annual salinity was 0.2°/₀₀ lower than those recorded for 1969 and 1970.

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 US 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.

The Oceanographic Observation Post Program was continued through the cooperation of the Woods Hole Oceanographic Institution and the US 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.

2. Biological Studies

a) Groundfish surveys. Research vessel surveys of groundfish stocks were conducted in the spring (March - April) and autumn (October - November) from Cape Hatteras to central Nova Scotia. The autumn survey was again conducted jointly with the USSR from Cape Hatteras to Georges Bank; also the USSR conducted a survey of the Scotian Shelf in August and these data were incorporated into the joint USA-USSR series. Finally, joint USA-USSR trawl comparison studies were carried out in September in a continuing effort to develop a better survey trawl. The USA-USSR studies are reported in other documents of the 1972 Annual Meeting.

b) Haddock spawning. The progress of haddock spawning in Subarea 5 was monitored from 2,137 samples collected by commercial and research vessels. The curve for Georges Bank females shows spawning began in late February, was 50% completed in mid-April, and ended in early June. This curve is similar to the 1970 curve.

Since 1969 we have been studying fecundity of the Div. 4X, W and 5Z haddock stocks with the St. Andrews Biological Station of the Fisheries Research Board of Canada. In 1971 the USA agreed to take over the Georges Bank part of the study while St. Andrews continues to cover Subarea 4. United States activity in 1971 primarily involved (1) subsampling preserved ovaries of known volume by removing plugs with cork borers, and (2) cleaning and preparing subsamples for egg counting.

c) Herring. During the autumn of 1971 the USA took part in the ICNAF joint survey to estimate the dispersiion of larval herring in Div. 4X, 5Y and 5Z. The USA R/V's *Delaware II* and *Albatross IV* participated.

During the first of these offshore cruises from 21 September to 4 October all the herring larvae taken were located in two distinct geographical areas; northern Georges Bank and off the southwest coast of Nova Scotia. The largest concentration was found on Georges Bank where the larvae fell into two size groups; one with a mode at 6 mm, the other with a mode at 15 mm. In the group of larvae off Nova Scotia, only a single size group occurred with a mode at 12 mm.

During the last of these cruises (*Albatross IV* Cruise 71-7, 2-17 December) larval herring were found at all inshore stations (7,200 m) from eastern Nova Scotia to Cape Cod. The most extensive concentration and largest catches of larval herring occurred in an area extending from the eastern part of Georges Bank to Nantucket Shoals. The northern, eastern, and southern boundaries of this concentration were roughly delineated by the 100 m isobath. Herring larvae ranged in length from approximately 8 to 30 mm, with the mean length increasing from east to west in both the Gulf of Maine and on Georges Bank.

Four consecutive coastal cruises from Massachusetts Bay to Machias Bay were made on the M/V *Rorqual* as part of the cooperative survey of larval herring. Preliminary analysis of the collections showed that larval herring appeared first in the catches obtained in the eastern sector of the Maine coast during late September and their numbers increased progressively westward with time. This shift in distribution was attributable to the occurrence of larval concentrations (1000/1000m^3) within three locations along the coast; (1) between Penobscot and Machias Bays, (2) between Penobscot Bay and Cape Ann, and (3) east of Cape Ann. In the first location larvae were abundant during the second and third cruises; and in the third location, only during the third cruise. Usually, larval catch rates were lowest at the offshore stations and frequently no larvae were captured beyond the 50-fathom isobath. Isolines of catch rates often paralleled this isobath and the coastline during the first three cruises, but the distribution of isolines was complicated during the final cruise in early November. The larvae concentrated in location 1 were not recently hatched and their source cannot be definitely established, but the concentrations in locations 2 and 3 contained larvae sufficiently small to be considered as recently hatched.

During the year, samples were obatined from fisheries taking primarily adult herring from ICNAF Div. 5Z, 5Y, 4X and Stat. Area 6 for comparative studies of year-class contribution, length and gonadal development. In addition, some samples were obtained from cruises of research vessels in the offshore waters of these areas. Although fish of age-group II are immature, those present in the samples (primarily collected from the research vessels) were included to encompass the entire age-group composition.

Three-year-old fish (1968 year-class) dominated the samples from Div. 5Z (primarily Georges Bank) and Stat. Area 6. Fish of age-group VIII+ (1962 year-class and older) dominated the samples from Jeffreys Ledge (Div. 5Y), while fish of age-group VI (1965 year-class) were dominant in the samples from the remainder of Div. 5Y and from Div. 4X.

Data on gonadal maturity indicated that the onset of spawning in Div. 5Z, Div. 5Y (exclusive of Jeffreys Ledge) and Div. 4X occurred in late August. The onset of spawning on Jeffreys Ledge occurred in September. The peak of spawning in all the areas was reached in October. A few spring spawned fish were collected from Div. 5Y (Provincetown, Massachusetts), while spring spawners were prominent in Div. 4X (St. Mary's Bay area - Nova Scotia). No spring spawned fish were collected from Div. 5Z and Jeffreys Ledge.

In Div. 5Z herring (age-groups II-VIII+) ranged in length from 12.7 to 34.7 cm; herring from Jeffreys Ledge (age-groups II-VIII+) ranged in length from 11.8 to 40.0 cm; herring from the remainder of Div. 5Y (age-groups II-VIII+) ranged in length from 19.7 to 36.8 cm; herring from Div. 4X (age-groups III-VIII+) ranged in length from 20.7 to 36.5 cm; and herring from Stat. Area 6 (age-groups II-VIII+) ranged in length from 10.9 to 34.2 cm.

The USA continued biochemical studies on the stock structure of herring in the Gulf of Maine, Georges Bank, and adjacent areas. Included were studies of the genetic inheritance and variation of phosphohexose isomerase (PHI) enzymes found in adult herring from those areas. It was concluded that the three major spawning groups (SW Nova Scotia, NE Georges and SW Gulf of Maine) are discrete populations and, also, that the overwintering fish in the Mid-Atlantic Bight appear to conform to the Georges Bank stock. Analysis of variance of the PHI allele frequencies (angular transformation) indicates that there is little variation between spring and autumn (spawning) adult herring taken from the three spawning areas. Continuing the search for additional enzymes which are capable of discriminating between stocks of fishes, gels were stained for hexokinase. A new staining method has revealed the presence of hexokinase polymorphisms in adult herring tissue homogenates.

d) Ichthyoplankton. An atlas summarizing the distribution of the common fish eggs and larvae in Continental Shelf waters, Nova Scotia to Long Island is nearing completion. This atlas will include monthly distribution charts for 10 species of eggs and 30 species or genera of larvae and is based on collections obtained on 46 cruises conducted during the period 1953-71.

With the aid of Dr Carl Price of Rutgers University, it has been established that fish eggs and larvae may be separated from the bulk of invertebrate zooplankton by isopycnic centrifugation in gradients of silica (Ludoz AM). A zonal rotor is currently being constructed that will accept up to one liter of a standard plankton sample and will provide semi-automatic sorting of ichthyoplankton. It is proposed to extend these studies to the resolution of invertebrate zooplankton into classes, the continuous flow harvesting and resolution of phytoplankton, and the integration of these techniques into systems suitable for shipboard operations.

e) Food habits. Stomach contents were examined from 6,000 specimens, representing 16 species of fish. They were collected during the spring and autumn groundfish survey cruises of *Albatross IV*. Areas sampled were Nova Scotian Shelf, Gulf of Maine, Browns Bank, Georges Bank, and southern New England, south to Cape Hatteras.

As expected, the diet varied enormously from one species to another. Also, it was not uncommon to find substantial differences in diet within species that were collected from widely separated geographical areas. Considering all species, the major foods were: crustaceans, polychaete worms, fish, mollusks, and echinoderms. The crustacean components that were especially common were: shrimps, crabs, euphausiids, and amphipods.

Research on the offshore benthic invertebrate communities continues. Distribution of the benthic biomass in relation to geographic locations and depth of water was emphasized. A review and analysis of the commercially important benthic invertebrate resources (with the exception of mollusks) in New England waters was completed.

Statistical Area 6

Biological studies on herring in Stat. Area 6 are reported under Subarea 5.