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Canadian Research Report, 1966

A. SUBAREAS 1, 2 and 3

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

SUBAREAS 1 and 2

A. Status of the Fisheries

I. Cod, *Gadus morhua* L.

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

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

There was no Canadian fishery in Subarea 1.

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

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

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

III. Hood seal, *Cystophora cristata* (Erxleben)

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

B. Special Research Studies

I. Environmental Studies, Subareas 1 and 2

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

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

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

II. Biological Studies, Subarea 2

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

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

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

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

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

3. Hood Seal. An age sample of 200 adult animals, three quarters of them females, was obtained from the catch of a commercial sealing ship. Analysis shows no obvious change in mortality rates from a sample of similar size collected in 1953, and the mortality rate of the females does not exceed that of the males in spite of a higher hunting rate of females. The evidence therefore does not suggest that the stock

is yet receiving intensive hunting, which implies that hood seals in Subareas 2 and 3 are part of a stock which extends to the northward.

SUBAREA 3

A. Status of the Fisheries

I. Cod

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

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

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

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

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

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

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

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

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

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

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

VII. Herring, *Clupea harengus* L.

^{28,000} Newfoundland herring landings, mainly from Subareas 3 and 4, increased to ~~25,500~~ tons from 12,900 tons in 1965 (8,100 tons from Subarea 3 and 4,800 tons from Subarea 4). This was due to greatly increased purse-seine effort to supply herring for meal.

VIII. Atlantic salmon, *Salmo salar* L.

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

IX. Capelin, *Mallotus villosus* (Müller)

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

X. Swordfish, *Xiphias gladius*, L.

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

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

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

B. Special Research Studies

I. Environmental Studies

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

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

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

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

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

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

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

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

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

II. Biological Studies

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

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

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

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

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

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

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

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

7. Atlantic salmon. Between 21 March and 16 April 1966, 38 salmon were taken by the A.T. Cameron in 6 surface drift sets (each set about 21 nets and each net about 85 m long) over oceanic depths east of the Northeast Newfoundland Shelf in temperatures of 3.7-6.1°C. No salmon were caught in a set at 9.2°C. The greatest numbers of salmon were caught closer to rather than more seaward from the 1000 fathom (1,829 m) isobath. On 1 May, 7 salmon were taken in a similar surface set off the southwestern slope of the Grand Bank at a temperature of 5.4°C.

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

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

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

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

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

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

B. SUBAREAS 4 and 5

by J.L. Hart

Canadian researches in Subareas 4 and 5 were carried out by many scientists whose submissions on their researches were compiled in preparing this report and whose names are to be found in the list of ICNAF scientists. The contributing institutions are: the St. Andrews Biological Station, the Atlantic Oceanographic Group, and the Arctic Biological Station of the Fisheries Research Board of Canada; the Bedford Institute of Oceanography of the Canadian Department of Energy, Mines, and Resources; and la Station de Biologie marine du Ministère de l'Industrie et du Commerce of the Province of Quebec.

SUBAREA 4

A. Status of the Fisheries

I. Cod

Canadian landings of cod from Subarea 4 continued to outweigh those of any other single species. Preliminary figures indicate that total mainland landings of cod are about 4% below those of 1965. Landings of cod in northern New Brunswick have

been used for advance estimates of success in Div. 4T and they continued to decline. Beginning in 1965, however, these landings were not indicative of total landings from the southern Gulf of St. Lawrence (4T); we believe that total landings of cod from 4T probably remained steady. Most of the cod landed from Div. 4T were in the 34 to 70 cm length range, and 4-year-olds dominated the landings in the 3rd quarter of 1966 as they did in 1965. Discards of cod in the Gulf were reported to remain low, near the 1% level by weight. Cod landings between 1960 and 1965 for other divisions of Subarea 4 show downward trends in Div. 4R (6 to 1.5 thousand tons), 4S (16 to 7 thousand tons), and upward trends in 4Vn (7 to 13.5 thousand tons), and 4X (12 to 24 thousand tons). Landings in 1966 probably remained in the same pattern.

II. Haddock

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

III. Flatfishes

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

American plaice. Landings from the southern Gulf of St. Lawrence (Div. 4T) increased slightly, even though many larger otter trawlers expended their effort for redfish. Increased efforts by smaller trawlers and seiners and an earlier start at fishing (mid April) sufficed to keep landings high. Landings from Div. 4Vs and 4W probably also increased with increased effort for flatfish there. Sizes landed were unchanged. Discards of small American plaice remained high; in Div. 4T they probably reached 70 to 80% by number.

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

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

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

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

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

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

V. Redfish

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

VI. Sea scallop, *Placopecten magellanicus* Gmelin

As in 1964, offshore landings came principally from Browns Bank (about 1000 metric tons whole weight). No effort was expended on Middle Bank in 1966, from which 1965 landings were approximately 700 metric tons. A general decline in inshore landings was noticed, both in the Bay of Fundy and the Gulf of St. Lawrence. Landings from the Fundy region (Div. 4X) declined from 4,200 to about 2,000 tons (247,000 kg meats). The southern Gulf of St. Lawrence (Div. 4T) showed a decrease in landings from 2,700 to about 1,400 tons (166,000 kg meats). Economic factors rather than reduced abundance are probably responsible for these declines.

VII. Herring

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

VIII. Swordfish

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

IX. Mackerel, *Scomber scombrus* L.

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

X. Tuna

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

XI. Sharks

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

XII. Atlantic salmon

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

XIII. Harp seal

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

XIV. Hood seal

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

B. Special Research Studies

I. Environmental Studies

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

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

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

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

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

Studies of the activity coefficients of major ions in sea water have been continued with special attention to NaCl and MgSO₄. Partial molar volumes of major salts in sea water have been determined. The distribution of total alkalinity, carbon dioxide and degree of saturation of calcium carbonate is being studied in the near-shore natural environment (4X) in relation to usual physical oceanographic parameters.

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

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

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

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

Studies of the total production system of a partially enclosed small bay have been undertaken (Division 4X) including observations of primary and secondary producers, benthos, and fish in an effort to better understand the relation of fisheries production potential to the availability and production of fish foods. Laboratory experiments designed to provide field measures of food intakes, growth and metabolism of offshore fish populations have been undertaken. It is expected that methods used in these special experiments will be applicable to the study of the dynamics of international commercial fisheries.

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

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

II. Biological Studies

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

2. Egg and larval studies. Two cruises with the A.T. Cameron and five with the Harengus to study egg and larval stages of groundfish and their recruitment to the southern Gulf of St. Lawrence (4T) were carried out during May-September.

Results from the May cruise indicate that cod spawned earlier in 1966 than 1965 and that total abundance of their eggs in the southern Gulf appeared about equal in the two years. In 1966, however, cod eggs were spread more evenly throughout the area than in 1965. American plaice eggs were taken with cod eggs on most stations.

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

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

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

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

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

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

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

6. Yellowtail flounder. Earlier work on stock definition indicated that differences between Middle Bank and Sable Island Bank in Div. 4W were clinal but Div. 5Z yellowtail stocks were discrete. Recent studies show that yellowtail from Banquereau (Div. 4Vs) tend to be larger than those from Sable Island Bank (4W). However, meristic studies indicate that differences are only clinal.

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

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

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

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

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

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

9. Scallop. Survey effort on the Nova Scotian side of the Bay of Fundy (Div. 4X) revealed low abundance of scallops on the inshore (Digby) beds. Most scallops were of an advanced age. Some hope for the future may be placed on young stocks recruited to the fishery in certain areas during the fall of 1966. The more offshore beds in the Bay of Fundy support good populations of scallops, although these are less attractive to the inshore fishermen because of their small meat size and the distance from port.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SUBAREA 5

A. Status of the Fisheries

I. Cod

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

II. Haddock

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

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

III. Scallop

Scallop landings from Georges Bank (Div. 52) increased slightly over 1965 from 38,000 to about 41,000 metric tons. Most effort was concentrated on the north-eastern edge of the bank.

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

IV. Herring

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

V. Swordfish

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

VI. Tuna

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

B. Special Research Studies

I. Biological Studies

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

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

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

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

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

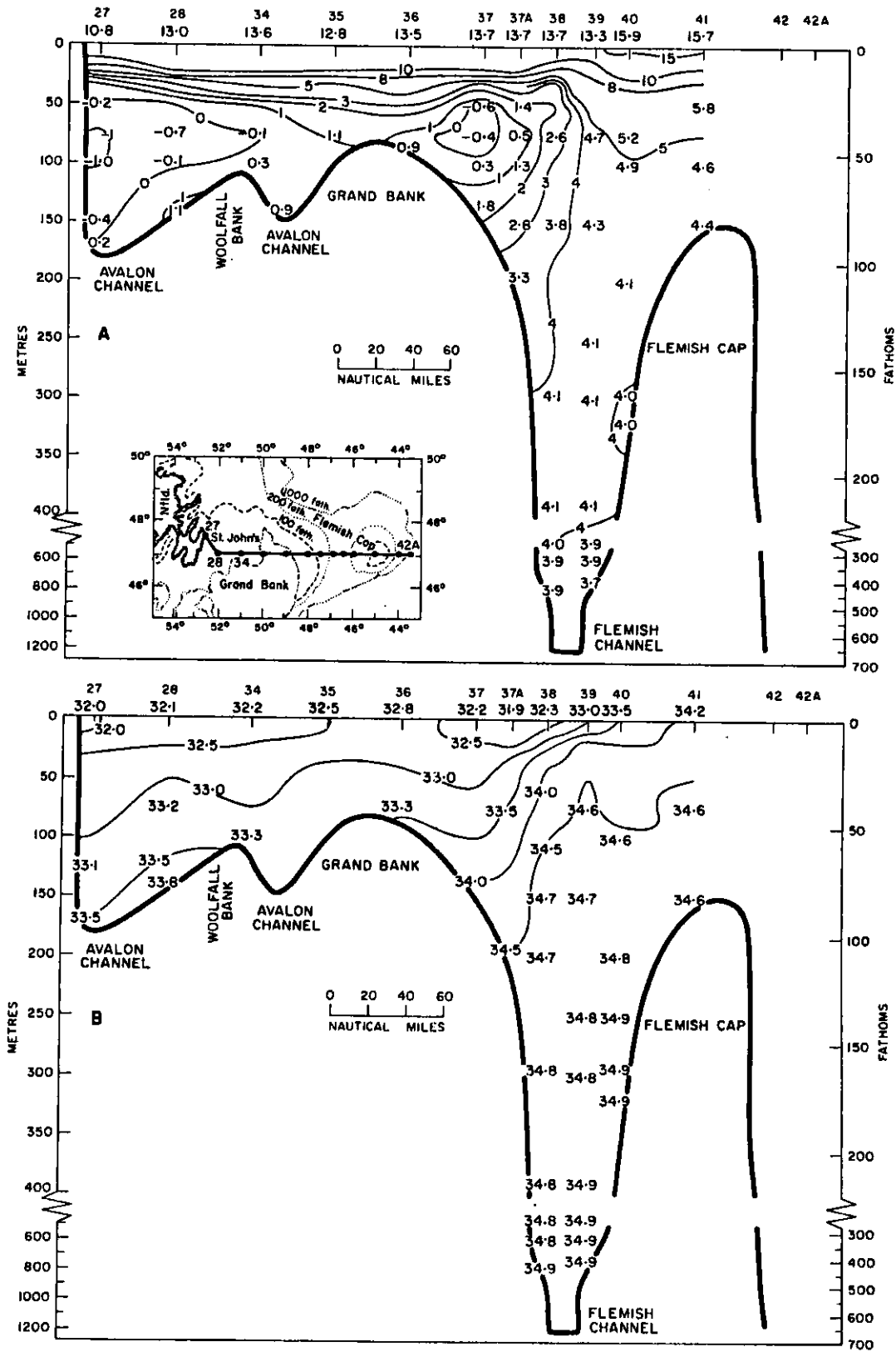


Fig. 1. A, temperature, °C and B, salinity, ‰, sections, St. John's-Grand Bank-Flemish Cap, 25-27 July 1966.

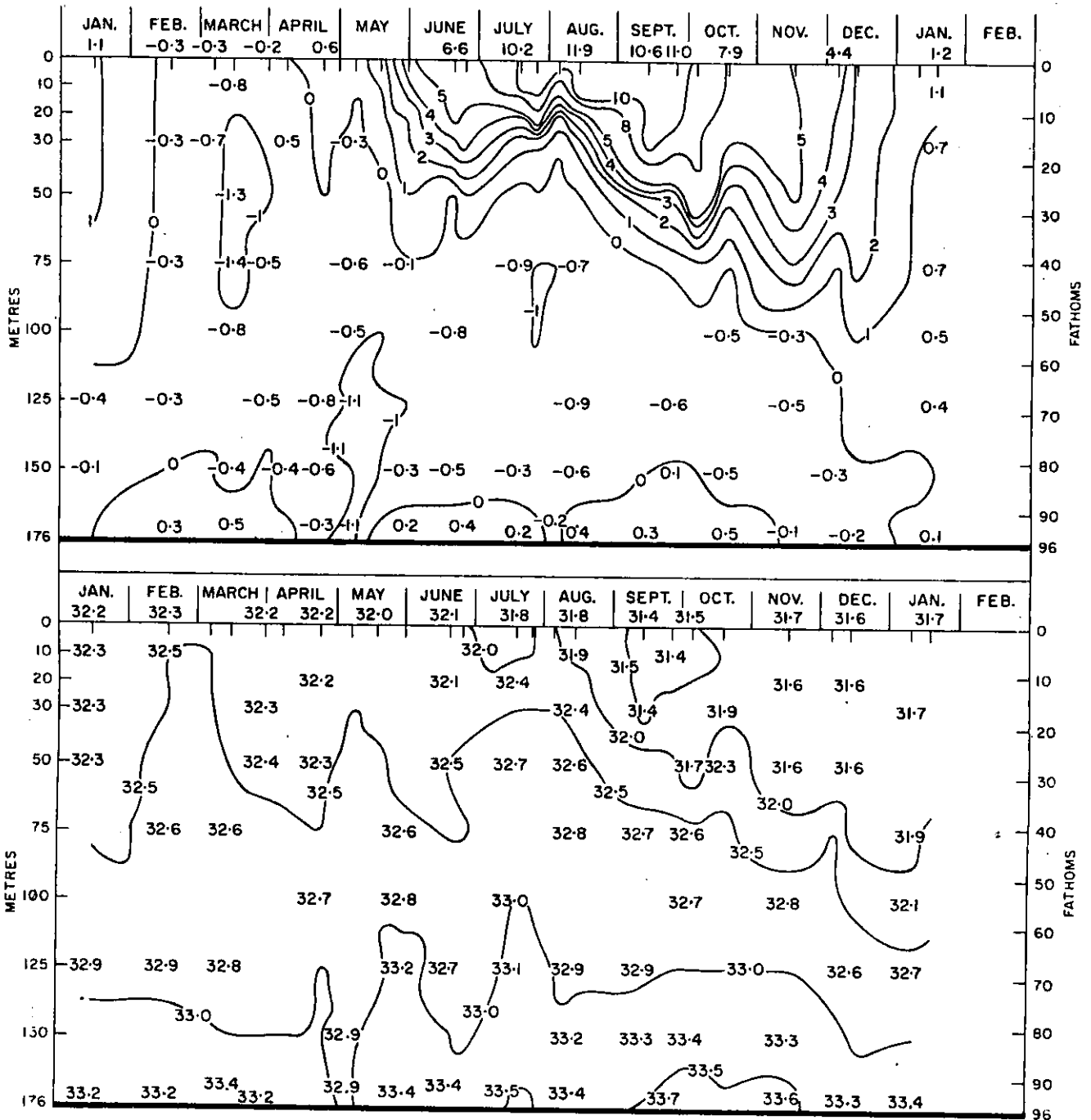


Fig. 2. Above, temperature, °C, and below, salinity, ‰, January 1966-January 1967, from surface to bottom at Station 27 (see Fig. 1 insert), 2 nautical miles off Cape Spear near St. John's.

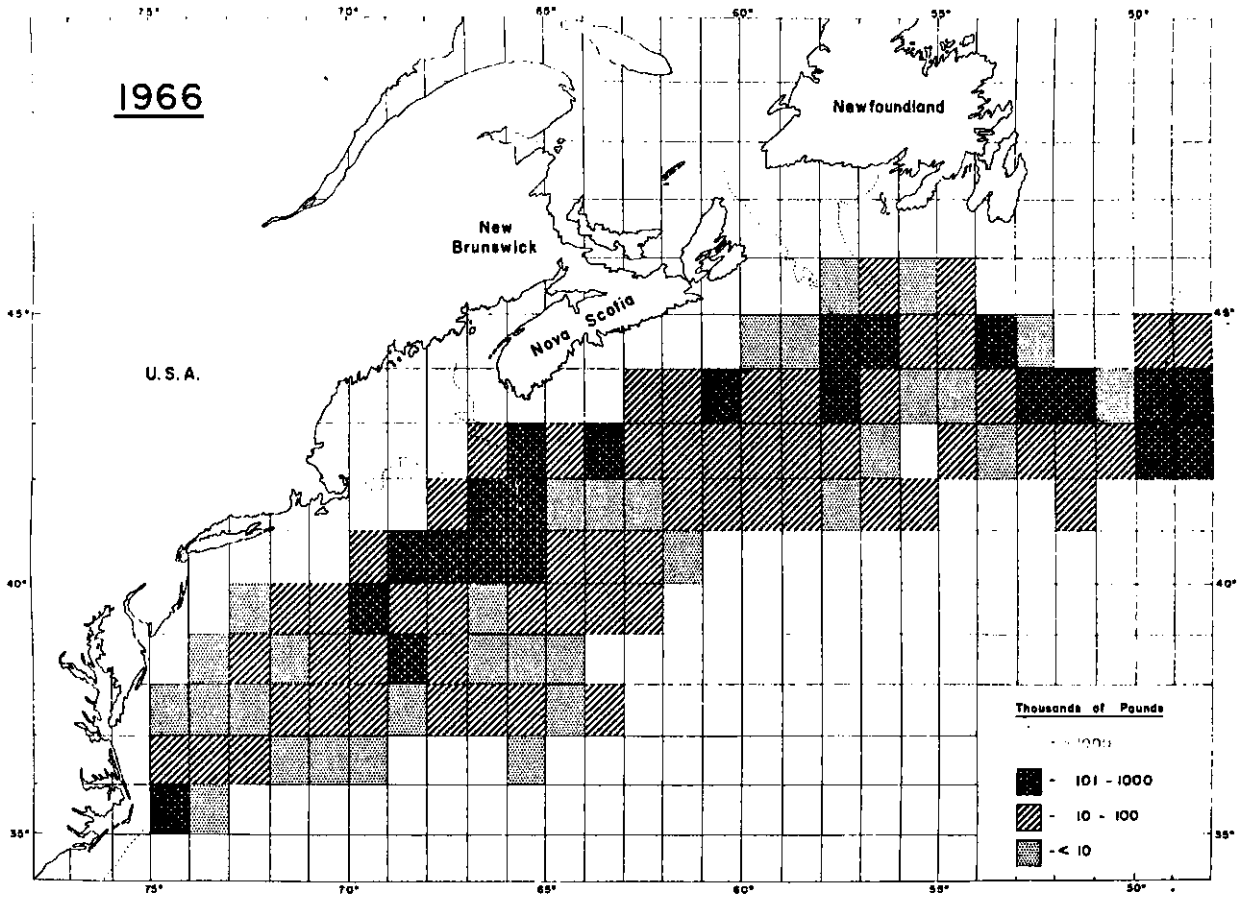


Fig. 3. Distribution of Swordfish Catches in 1966