INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial Number 1331 (D.a. 63)

Document No. 36.

ANNUAL MEETING, JUNE, 1964.

Canadian Research Report, 1963

Canadian research of interest to ICNAF was carried out by the Fisheries Research Board of Canada at its laboratories in St. John's, St. Andrews, Dartmouth and Montreal. The Quebec Marine laboratory at Grand River and the Mines and Technical Surveys Institute of Oceanography at Dartmouth also made important contributions. Vessels used for research in 1963 were "Baffin", "Sackville", "Theta", "A.T. Cameron", "Harengus", "Investigator II", "Marinus", and "Edward W".

The report on research in subareas 2 and 3 has been prepared by the Biological Station at St. John's (W. Templeman). The Biological Station at St. Andrews (J.C. Medcof) has assembled the report on research in subareas 4 and 5. The scientists responsible for the research are listed in ICNAF Annual Proceedings Vol. 13, p. 41.

For location of the places mentioned in the text refer to ICNAF Redbook, 1962 Part 2, p.4.

At the time of writing, Canadian statistics of fish landings by subareas are not available except where fisheries are limited to single areas. The statements made on status of fisheries are therefore of a general nature.

SUBAREA 2

A. Status of the Fisheries

I. Cod.

There was an upward trend in the Labrador inshore catch of cod with an additional 12 schooners and longliners prosecuting this fishery and the operation of a floating freezing plant in the Labrador area.

Routine sampling of the inshore cod fishery by various gears was carried out in the spring, summer and fall in 15 separate localities on the Labrador coast between the Strait of Belle Isle and northern Labrador. Measurements of 15,000 cod were taken and 3000 pairs of otoliths collected. In all areas, there was a marked decline in fish sizes due to large numbers of young cod of ages 5 and 6 entering the commercial fishery for the first time. Cod of such early ages have contributed little to the Labrador inshore catch in the past several years, but their presence in quantity in 1963 indicates that these age-groups must be fairly abundant, and should contribute significantly to the success of the fishery for the next several years.

B. Special Research Studies

I. Environmental Studies.

1. Hydrography. The monitoring hydrographic section off Seal Islands (Fig. 1) was taken at approximately the usual time, August 5-6. Temperatures at all depths in the colder part of the Labrador Current, extending over the area from Hamilton Inlet Bank to shore, were quite similar to those of 1962. In the warmer part of the Labrador Current in the deeper water seaward of Hamilton Inlet Bank temperatures were slightly higher than usual.

II. Biological Studies

1. Cod. In April-early May 1963 the A.T.Cameron investigated the great cod concentrations on the eastern and southeastern slopes of Hamilton Inlet Bank where a new winter-spring fishery by European trawlers has arisen producing a very great increase in the Subarea 2 cod catch since 1960.

On April 9-12 on the southeastern slope of the bank the greatest cod concentrations were found at 275 m and 2.6°C. Here trawling was extended to 720 m, but only a few cod were found deeper than 370 m (2.6 to 3.4°C), and none between 545 and 720 m (3.3 to 3.4°C). On the northern part of the eastern slope the largest catch was at 250 m and 1.8°C. Here the fishery was at the edge of the ice and it was not possible to trawl deeper.

Sets in shallower water (175-190 m) and at lower temperatures (-0.1 to 1.6°C) on the eastern edge of the bank produced only a few small cod. Sets in deeper water in the western part of Hawke Channel at low temperatures (0.6 to 1.8°C) also produced few cod.

On May 2-3, 1963, very large catches of post-spawning cod were obtained on the southeastern slope of the bank just south of the ice edge at 225-280 m (2.8 to 3.0°C). From 90 to 100 large trawlers were fishing in the area within a radar range of 10 nautical miles (Fig. 2).

These spawning and post-spawning concentrations in April-early May appeared to be on the extreme eastern edge of the slope, and were chiefly at depths between 225 and 330 m at temperatures from 2.5 to 3.1°C. The larger mature fish were in the deeper water and higher temperatures, and smaller immature fish predominated in shallower water and lower temperatures.

In September moderately large cod concentrations were found in 290 m on the southwest edge of Hamilton Inlet Bank, and again in October at 135-175 m.

In the regions of heavy concentration on the southeastern slope during April 9-11, 43-75% of the mature female cod taken in different sets had completed spawning. Spawning was proceeding rapidly and by April 16, in the same area, 91% of the mature females in the only large catch were spent. In Hawke Channel to the west of Hamilton Inlet Bank at this time only 22-31% were spent in the 2 small catches which contained mature females but quantities of cod in this area were almost negligible. On May 2-3 in the same area on the southeastern slope of Hamilton Inlet Bank 78-92% of the mature female cod in various sets were spent. On all lines cod sizes and the percentages of mature cod, and in the areas of concentration the percentage of females among the mature cod, usually increased with depth and increasing temperatures.

During this period from April 9 to May 3 the cod of the spawning and post-spawning concentrations were feeding very little except on viscera, heads and backbones of cod being discarded from trawlers. There was no evidence from the net catches that any other food was abundant on or near bottom.

Cod were tagged in the inshore shallow-water area in August at Domino (770), Cape Harrison (1150), Hopedale (380) and Nain (770). Coastal tagging in 1962 has shown that the spawning concentrations on the eastern and southeastern slopes of Hamilton Inlet Bank in winter and spring receive contributions from inshore cod not only from Labrador but also from along the east coast of Newfoundland from St. Anthony to at least the Baccalieu area on the northern fringe of the Grand Bank.

2. Redfish, Sebastes mentalla Travin and Sebastes marinus (L.). A section on the northern seaward slope of Hawke Channel was fished by the A. T. Cameron from 230 to 730 m on April 9-11 and September 13-14. The April catches of mentella (per half-hour tow) at 365, 460, 550, 640 and 73[illegible] were 15, 1020, 860, 580 and 35 kg at bottom temperatures 2.6, 3.4, 3.4, 3.3

and 3.4°C and average weights of 1.0, 0.8, 0.5, 0.8 and 1.1 kg respectively. Catches of marinus were 480 kg at 460 m and 15 kg at 550 m with average weights of 2.8 and 4.9 kg.

As a contrast in the same area on September 13-14 significant catches of mentella were made from 310 to 620 m with the largest catches, 500 and 980 kg (average weights of 0.5 and 0.7 kg), being made at 310 and 540 m at 3.6 and 3.9°C. Also at this time the only marinus catch over 14 kg was one of 840 kg with an average weight 1.5 kg at 230 m and 2.4°C and only 1 marinus was caught below 310 m.

In spring the area from 230 to 365 m, deserted by both species of redfish and occupied by cod, had bottom temperatures of 2.5 to 2.6°C whereas in September bottom water temperature was slightly lower (2.4°C) in the 230 m area occupied by smaller marinus and higher (3.6 to 3.9°C) in the 310-620 m depths where mentella catches were made.

The marinus concentrated at the 460 m level in April were 87% females (83% pregnant females). The males were probably shallower, possibly near 410 m. Thus marinus were about 180-230 m deeper and mentella at least 90-140 m deeper in April than in September. All but insignificant catches of all redfish in this area were obtained in a 180 m range between 460 and 640 m in April whereas they ranged from 230 to 620 m in September. Thus the redfish in winter-spring and presumably winter are concentrated more than in summer-autumn and this concentration is likely to be most advantageous to fishing in an area with populations both of marinus and mentella which overlap in the winter-spring distribution but tend to become separated in summer-autumn.

Only 1 of 73 pregnant marinus females examined from the southeastern and eastern slopes of Hamilton Inlet Bank on April 9-16 possessed larvae 95% hatched and approximately ready for extrusion (Table 2). The remainder were all 50% hatched or less, the majority being less than 30% hatched and had moderately large or large external yolk sacs and were not ready for extrusion.

Only 7% of 149 pregnant mentella females examined at the same time from the same area were spent (Table 2) and it was our opinion that about half of these had spawned in 1962 and had not recovered.

During summer and autumn all mentella females in this area from 550 m and deeper are immature even at the largest sizes over 45 cm. In April 1963 the mature mentella females extended downward to 530-560 m where, also, no large immature females were present, but all mentella females at 710 and 730 m were immature although they reached lengths as great as 46-47 cm which was the maximum size of the mature females examined at the shallower depths.

Thus although the passage into deeper and warmer water in winter-spring is doubtless advantageous to the larval development and larval extrusion by females the movement is a natural one characteristic of both immature and mature fish since large immature females at the lower part of the redfish range also pass deeper in spring and presumably winter.

3. American plaice, Hippoglossoides platessoides (Fabricius). In the A. T. Cameron sets in April on the southeastern slope of Hamilton Inlet Bank the only 2 significant catches of American plaice (per half-hour set) were 180 kg at 320 m and 2.6°C and 140 kg at 640 m and 3.3°C. These fish were mainly mature males and mostly immature with a few mature females, the average weight being 1.0 kg. Although in summer plaice are usually in slightly colder water than the cod and the largest summer concentrations on Hamilton Inlet Bank were found in the Investigator II in September 1952 and 1953 at 179-183 m and -0.3 to 0.4°C, in these April sets the plaice concentrations encountered were much deeper and at higher temperatures than in September. The April catch at the greatest depth was well below the cod concentrations while in summer and early autumn plaice and cod on this bank are likely to be found at approximately the same depths with the plaice slightly shallower than the cod.

4. Witch flounder, Glyptocephalus synoglossus (L.). In 550 and 640 m at the mouth of Hawke Channel a concentration of large witch flounder (1180 and 680 kg per half-hour tow) was found; these fish averaged about 1.4 kg. The mature witch females had small opaque eggs and would not spa\ for about 2 months.

III. Gear and Selectivity Studies

The A.T.Cameron carried out selectivity cruises for cod in the Hamilton Inlet Bank area in August 1962 and October 1963 using a No. 41 trawl with codends of double twine, 50-yard, 4-ply manila. In the covered hauls the upper surface of the codend was provided with a cover of 50-mm courlene twice as wide as the codend, and in the alternate hauls the after belly and lengthening piece had meshes approximately the same size as those in the codend. All hauls were 1 hour long. The preliminary results are shown below (Table 1):

Table 1. Cod selection Hamilton Inlet Bank.

(Internal wet mesh size measured with ICES gauge and 4kg pressure).

Date	Av. codend mesh size (mm)	50% retention (cm)	Selection factor	No. hauls	Av. catch (kg)	Av. catch N
	Covered hauls					
Aug.1962	97	35.0	3.61	12	370	580
	113	38.2	3.38	4	620	1067
	120	47.5	3.96	8	560	857
	Alternate hauls with catches at larger mesh sizes compared with those with the 54 mm mesh codend					
Aug.1962	54	-	-	16	520	761
	95	31.0	3.26	8	470	614
	106	36.8	3.47	16	350	367
	113	38.0	3.36	8	330	363
	Covered hauls					
Oct.1963	109	37.0	3.39	9	1140	815
	120	42.0	3.50	12	930	667
	130	45.0	3.46	8	610	507

SUBAREA 3

A. Status of the Fisheries

I. Cod.

Inshore fishery. Sampling of the inshore fishery by the various gears was carried out at St. Anthony, La Scie, Twillingate, Bonavista, St. John's, Trepassey, Burin and Port-aux-Basques on the Newfoundland coast.

On the east coast of Newfoundland, although the trap fishery in 1963 at St. Anthony, Twillingate and St. John's was fairly successful compared with the 1962 fishery, it was considered to be poor at La Scie and Bonavista. On the south coast, at Burin, the trap fishery was moderately good, at about the same level as in 1962, but at Trepassey it was generally poor, mainly because of adverse weather conditions. The handline fishery at St. Anthony, Twillingate and Bonavista was considered to be reasonably good, but at St. John's this fishery was very poor. Except for the fishery at Twillingate, which was considered fairly good, the linetrawl fishery was very poor in all areas with the result that many fishermen turned almost entirely to using gillnets. The gillnet fishery began in autumn at St. John's with good results while in the Trepassey area catches with gillnets were high all season with 230 kg (round) per net per haul being realized. At Burin and Twillingate however, the gillnet fishery was only moderately successful for most of the season, 70 kg per net per haul being obtained at Burin. The longline fishery was generally poor at Bonavista and Trepassey but was good at Twillingate.

More detailed information on catches is available for Bonavista and Burin. At Bonavista the total catch in 1963 by all gears was 4.4 million kg, 20% lower than in 1962. Of this total 42% was landed by baited handlines and jigger, 31% by traps, 24% by longlines and 3% by linetrawl. At Burin the 1963 total catch by all gears was 1.6 million kg, 20% higher than in 1963, with 47% from trap, 45% from gillnet, 5% from linetrawl and 3% from jigger.

In the trap catches cod 4 to 6 years of age were the most abundant numerically along the east coast and on the south coast, and cod aged 7 and 8 years were present in varying numbers in different localities. At Trepassey, however, large numbers of older fish up to 10 and 11 years of age were common in trap catches, although the majority were 5 to 8 years old. In the handline catches fish of ages 5 and 6 years were the most abundant with ages 4, 7 and 8 also being represented. In the linetrawl catches cod of ages 4, 5 and 6 years were the most important contributors. In longline catches fish aged 5 to 10 years were the most abundant in all areas sampled, although fish older than 10 years contributed significant numbers to the catches in most areas. Along the northeast coast area and in the Trepassey area 8-year-old fish dominated the longline fishery while in the southwest coast area 9-year-old fish were dominant. In Bonavista the average size of longline fish decreased because of the increased abundance of 6- and 7-year-old fish. In the gillnet fishery there was an abundance of 8-year-old cod and fish aged 7, 9 and 10 were well represented.

The age and length compositions of samples of cod caught by the various gears reveal the dependence of the trap fishery upon the younger ages of cod, whereas in the longline and gillnet fisheries cod of older ages are important contributors to the catch after they are generally no longer available to the traps.

The inshore cod fishery with nylon gillnets. The use of nylon gillnets in the inshore cod fishery in Newfoundland was begun in 1960. By 1961 many fishermen had procured nylon gillnets and were using them either in conjunction with other gears or as their principal fishing gear. Nets were generally of Japanese or English manufacture, usually 91 m long, 25 meshes deep, of twine size 210d/15, and with mesh sizes ranging from 6 to 7½ inches. By 1963, when it is estimated that about 13,000 nylon gillnets were used in the cod fishery, the main concentrations were in Trepassey, St. Mary's and Placentia Bays on the south coast and Notre Dame and Trinity Bays on the east coast.

Observations are being taken on the gillnet fishery at Twillingate, Trepassey and Burin. The nylon nets were fished in quantity at Trepassey in 1961, but at Twillingate and Burin not until 1962. The numbers of nets used per boat continues to increase each year as fishermen become more experienced in their use. Gillnets are used throughout the season in Burin, at Twillingate mainly in the spring, late summer and fall, and at Trepassey chiefly in the spring and summer.

Catches at Twillingate and Burin were low in the gillnet fisheries in 1963 but with low total yield from the inshore fishery in these areas the daily catch from nylon nets was generally above those obtained with oth gears fishing at the same time. At Trepassey, the longline boats equipped with gillnets have been very successful, with average daily catch per net per haul for the fleet amounting to 350 kg in 1961, 300 kg in 1962 and 230 kg in 1963. The average catch per net per haul has decreased each year as the number of nets has increased.

Large cod were caught by nylon gillnets in all areas, with about 90% ranging from 60 to 100 cm. The fish were mainly of ages 7 to 14, with fish of the 1955 year-class (age 8 in 1963) contributing heavily to the catches in 1962 and 1963.

Cod growth. Analysis of cod growth on an area basis for the years 1960-62 has shown that there is a progressive decline in average size at age proceeding from south to north. Also, fish from different areas, but inhabiting similar latitudes, exhibit similar patterns of growth. The differences between the area of slowest growth (in Subarea 2, northern Labrador) and fastest growth (southern Grand Bank) are so great that a fish from the latter area is 30% longer than the former at age 5, increasing to 75% greater length at age 15. Differences in weight at age are even more striking. These growth differences are considered to be related mainly to variations in temperature and food supply between areas.

II. Haddock, Melanogrammus aeglefinus (L.)

Trends in the commercial fishery and prospects for the future. The commercial haddock fishery, which began in 1945, rapidly increased and by 1949 the total haddock landings were 78 thousand tons. After a decrease to 43 thousand tons in 1953, an increase to 104 thousand tons occurred in 1955 as a result of the recruitment to the fishery of a very abundant 1949 year-class. However, by 1959 total landings had declined to a low of 35 thousand tons. Up to 1959 the haddock fishery was carried on almost exclusively by Canadian and Spanish trawlers, with the Spanish vessels particularly in the early years taking about three-quarters of the annual yield. However, Spanish landings declined in the late 1950's and early 1960's when the stock consisted mostly of small haddock. In 1960 and 1961 a very successful 1955 year-class, a moderately successful 1956 year-class, and the additional USSR exploitation of the haddock stock, increased the landings to 66 thousand and 80 thousand tons.

In 1962, while Canada maintained an annual landing of 28 thousand tons from the winter and spring concentrations, the summer concentrations did not occur or were not found and only very small quantities were taken other countries, the total being 35 thousand tons.

In 1963, after much effort in searching, Newfoundland trawlers were able to take only 8 thousand tons as compared with nearly 21 thousand tons in 1962. Also extensive surveys by Canadian research vessels in May and July failed to find any concentrations of haddock.

Although heavy exploitation has played its part in the present scarcity of haddock, the basic cause is the lack of successful survival of young haddock. The last very successful year-class was that of 1955, which dominated the catches during 1960-62. Since 1955-56 survival has been relatively poor and consequently the haddock fishery must inevitably continue to decline until a good brood occurs and is recruited to the stock.

Length and age composition of the Grand Bank stock. From the length and age frequencies of samples taken during the May survey, haddock of the 1955 and 1956 year-classes which were dominant in the catches during the surveys of 1959-61, were out-numbered in 1963 by 1- and 2-year-old fish of the 1961 and 1962 year-classes. However, when it is considered that the research vessel catch per unit effort was considerably lower than those of previous years both in number and weight, the apparent abundance of these and 2-year-old fish may be only in relation to the presently reduced year-classes of earlier years. For example, the average number of haddock per

half-hour tow was 70 in 1963 and 80 in 1962, while in 1960 it was 590.

III. Redfish

Redfish landings were higher than in 1962 mainly from increased fishing effort for small redfish on the southern part of the eastern slope of the Grand Bank.

IV. American plaice

The Newfoundland catch per unit effort for plaice on the Grand Bank showed a decline in 1962. At the same time there was a marked increase in total effort. In 1963 Newfoundland plaice landings were 60% higher than in 1962, mainly because of increased fishing effort.

V. Witch flounder

Newfoundland landings of witch flounder were 20% less than in 1962, mainly due to the decreased effort for haddock. A large proportion of the witch landings is taken on the southwest slope of the Grand Bank during the winter-spring haddock fishery. The analysis of the logs of 2 commercial trawlers indicates that the catch per unit effort for American plaice is greater for daylight fishing than it is at night.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. The 5 monitoring sections across the Labrador Current and continental shelf from Bonavista to the southern Grand Bank were occupied by the Investigator II between July 27 and August 22.

In Fig. 3-7 the temperature and salinity profiles of the sections are illustrated.

In the triangular section extending eastwardly from Cape Bonavista, thence southwardly to the northern Grand Bank (Fig. 3) temperatures were fairly similar to those of 1962. The cold water, with temperatures below -1°C, extended deeper near the coast. Temperatures in the deep water offshore at the continental slope were slightly higher than in 1962 whereas temperatures at the core of the eastward-moving branch of the Labrador Current were lower.

In the section from St. John's across the northern part of the Grand Bank and Flemish Cap (Fig. 4) there was a much greater volume of water with temperatures below 0°C and below -1°C in the area from the Avalon Channel to the northeastern slope of the Grand Bank than was present in 1962.

In the section from St. John's to the southeastern slope of the Grand Bank (Fig. 5), apart from the occurrence of higher surface temperatures at the eastern edge of the Grand Bank, the temperature picture was generally similar to that of 1962.

In the section at about 75 m extending along the southwestern slope of the Grand Bank (Fig. 6) surface and upper layer temperatures over the bank were higher and bottom temperatures generally a little lower than in 1962.

In the section at 275 m along the southwestern edge of the Grand Bank (Fig. 7), minimum temperatures were lower than in 1962 and a considerably greater volume of water with temperatures below 1 and 2°C was present in the eastern section of the Labrador Current at stations near the southern part of the bank. Temperatures at the surface and in the upper layers were generally higher than in 1962. To the west, at Station 5 considerably higher midwater temperatures were present than in 1962.

II. Biological Studies

1. Cod. The annual survey designed to obtain information on the inshore distribution and relative annual abundance of small cod up to 2 ye of age was carried out from September 19 to October 31. Beaches in areas selected in previous surveys were seined using a small-meshed Danish seine with the codend lined with fine-meshed nylon.

During the survey 141 successful sets were made on beaches from St. Mary's Bay to the northern part of Notre Dame Bay, and from 1 to over 600 small cod (total 5366) were taken in 89% of the sets. Cod of the year (zero cod) occurred in 71% and were in the majority in 40% of the successful sets. Zero cod made up 39% of the total cod catch from all areas. Cod of age 1 and older (1+) occurred in 88% and were in the majority in 48% of the successful sets. Of the total cod catch from all areas 1+ cod made up 61%. From St. Mary's Bay to Conception Bay the 1+ cod were generally more abundant than the zero cod whereas from Trinity Bay to Notre Dame Bay zero cod were somewhat more abundant in the catches. The numbers of 1+ cod taken in the northern areas were not consistent with reports of large numbers of these fish seen in harbours and around fish plants during the summer as was anticipated from the relatively large catches of zero cod during the 1962 survey. The numbers of zero cod caught in 1963 suggest only moderate survival and settlement of the 1963 year-class.

Survey cruises by the A.T.Cameron over the Northeast Newfoundland Shelf in April and May produced several good catches of cod between 220 and 320 m and a good catch was obtained on the northern slope of the Grand Bank in June. Length frequencies of cod from the Northeast Newfoundland Shelf indicate the presence of significant numbers of 3- to 5-year-old fish.

Catches in the Halibut Channel in January, on St. Pierre Bank in June, and on the Grand Bank in January, May, June and July were usually less than 450 kg per half-hour tow at all depths.

Cod were tagged in the following places, times and numbers: Halibut Channel, January, 770; off Port-aux-Basques, March, 1540; off Rose Blanche, March, 770; Penguin Islands-Ramea area, March-April, 1150; Burego Bank, March-April, 1150; northern St. Pierre Bank, May, 1150; Virgin Rocks, July, 1150; off Fermeuse, October, 1150; Cape Ballard Bank, October, 1150; off Cape Fogo, October-November, 1150; Grey Islands, November, 1150 and off Cape Pine, November-December, 1150.

2. Haddock. Otter-trawling surveys over the southern half of the Grand Bank were carried out in May and July. During the May cruises, from a total of 75 half-hour tows in depths ranging between 45 and 275 m only o tow produced more than 135 kg of haddock. This catch of 680 kg was taken 145 m at 3.6°C on the western part of the southwest slope. At most of the fishing stations on the slope and adjacent bank areas water temperatures were favourable for haddock.

The survey in July resulted in even poorer catches throughout the entire area. The best catch of 195 kg was obtained in 120 m at 4.6°C near the station where the best catch was taken earlier in the spring survey. A number of exploratory tows were made on the Southeast Shoal, where in past years large concentrations of haddock were often found feeding on capelin eggs and capelin, but no significant quantities were taken. An interesting feature of the July survey was the presence of capelin in most tows, coincident with the scarcity of cod and haddock.

On St. Pierre Bank an otter-trawl survey in June once again produced very little haddock. In most of the tows no haddock of just a few individuals were caught, the best catch being 80 kg. Haddock fishing has been insignificant on this bank since the large fishery on the very abundant 1949 year-class came to an end in 1956.

3. Redfish. Funk Island Bank is the deep water ridge or bank with depths mainly greater than 220 m lying between Funk Island Deep and the continental slope. The western and eastern slopes and surface of the northern part of this bank were fished on April 17, May 8-9, 28-30 and September 8-9 in the general vicinity of 51°24'N to 51°28'N. On the first 2 of these occasions sets were limited to depths of 460 m and less. In the latter 2 periods the sets extended from 230-245 to 640 m. All tows were of half-hour duration.

In April redfish catches obtained in the 4 sets between 230 and 460 m (2.0-3.5°C) were insignificant. There were, however, redfish in the vicinity since on the same day we had observed a trawler taking back a very large catch of redfish at 51°44'N, 51°00'W in about 320 m and another trawler was fishing at about 350 m about 3 nautical miles north of this position.

On May 8-9 the largest redfish catch was 4300 kg of mentella in a standard half-hour tow at 275 m (2.3°C) on the Funk Island Deep side of the ridge. On the top of the bank in a tow at 230 m, 750 kg of marinus were caught of which 93% were males.

On May 28-30 the only significant catches were 2050 and 2270 kg of mentella per half-hour tow at 550 and 640 m (3.4 and 3.3°C) on the eastern slope of the bank. These were large mentella averaging 1.0 and 1.3 kg respectively and the females were immature. The only notable catch of marinus at this time was an unusual catch at 550 m of 34 marinus averaging 7.3 kg each: 13 of these were females of which all but one were spent.

In September the largest catch was 600 kg of mentella at 255 m.

A few female redfish apparently do not recover from the previous year's spawning in time to produce new eggs for the next season and are thus in a spent condition before spawning begins. Hence the small numbers of spents recorded at the beginning of the spawning season are maximal in relation to the present year's spawning. It is very likely, therefore, that in this area of the Northeast Newfoundland Shelf to the northern Grand Bank (Table 2) approximately two-thirds of the mentella spawning occurs between mid-April and the end of May and most of the remainder in early June with a very small amount in early April. Spawning is delayed slightly in the more coastal areas (off the Grey Islands and St. Anthony) where temperatures are lower in relation to the continental slope areas in which most of these redfish are found. Spawning in marinus on the slopes of Funk Island Bank was almost over by the end of May.

SUBAREA 4

A. Status of the Fisheries

I. Cod.

Cod continues to be the species of greatest international interest in Subarea 4. The mean size of the cod taken in parts of the Bay of Chaleur area (4T) was larger in 1963 than in 1962. The use of large mesh in trawls and the increasing market acceptability of small fish have reduced discards to 2% by weight and 1 to 3% by number in the Gulf of St. Lawrence where the average size of discards is 35 to 38 cm. On the Nova Scotia Banks (4V-W) the rate was higher (3 to 35% by weight and 10 to 55% by number). Recruitment and size-composition of cod stocks have not altered conspicuously from last year.

II. Haddock.

Incomplete 1963 records indicate heavier Canadian landings than in 1962 from 4X where this is the principal species. Partial records also indicate decreased landings from 4W. Trawls with 4½-inch (114 mm) mesh and market acceptability of small fish have conservation value but discards were high (2 to 7% by weight and 4 to 21% by number) compared with those for

cod in the Gulf of St. Lawrence. This may be because of recruitment of an abundant 1959 year-class. The year-classes in 4W (except that for 1959) seem to be below average strength. Those in 4X seem strong and prospects for 1964 fishing in 4X are good.

III. Redfish.

Total landings in Canada increased in 1963 in spite of the fact that the catch in the Gulf of St. Lawrence (4R-S-T) declined from 1955 to 1962 which is the last year for which complete statistics are available. The good fishing of the 1950's depended on an accumulated stock. The catches are lower now because this stock has been substantially reduced and because recruitment has been slow. In 4S the fish were mostly of small size (15 to 25 cm fork length). Discards in this area by Quebec fishermen averaged 1% by weight. There are indications that a new year-class is being recruited. Good recruitment seems to be the exception, not the rule.

IV. Pollock, Pollachius virens (L.)

This is a species of increasing importance. For the most part the fishery appears to be regulated more by demand than supply but there are variations with area and season that appear in the statistics.

V. Halibut, Hippoglossus hippoglossus (L.).

This species is fished both in the Gulf of St. Lawrence (principally 4R-S) and on the Nova Scotia Banks (4V-W). Because of its high market value it is more important to Canada than the size of landings would indicate. Statistics of catch and effort for 1963 are not available.

VI. American Plaice.

This species continues important in the Gulf of St. Lawrence. The 1950, 1953, 1954 and 1957 year-classes are strong but there are many discards (up to 85% by count) because fish less than 7 or 8 years (length 32 cm) are not used.

VII. Sea Scallop, Placopecten magellanicus (Gmelin).

In 1963 the offshore fleet landed approximately 727 metric tons of scallop adductor muscles (equivalent to 6033 tons of whole scallops) from Division 4X. Most of the fishing took place on Browns Bank and in the lower Bay of Fundy. An additional 545 metric tons of meats (4524 tons, whole scallops) were landed from this area by the inshore fleet.

VIII. Herring, Clupea harengus L.

This is our most important pelagic species. Statistics of effort and catch by subareas are lacking but general observations indicate no spectacular changes from 1962. In most areas landings are regulated more by demand than by supply.

IX. Swordfish, Xiphias gladius L.

This fishery expanded several fold for the reasons outlined in the report on Subarea 5. There are no data from which to judge abundance changes. Conditions seem to favour further expansion in 1964.

X. Mackerel, Scomber scombrus L.

Statistics on effort and catch in 1963 are not available but changes from 1962 seem to have been minor except that there were almost no catches in the Newfoundland area which is the northern extremity of this species' range in the ICNAF area. There is no basis for predicting for 1964.

XI. Harp Seal, Phoca groenlandica.

The fishery for this species in Subarea 4 centres in the region between the north shore of Prince Edward Island and Cape Breton including the Magdalen Islands (4T). In 1963, 87,015 seals were killed on the ice and in 1962, 95,083. Spring assessment of stocks in this area by aerial photography is difficult because the moulting animals spend less time on the ice here than they do in Subareas 2 and 3. This and irregularities in distribution patterns make it difficult to predict the prospects for the 1964 fishery.

B. Special Research Studies

I. Environmental Studies.

1. Hydrography. The coastal surface temperatures were monitored at several stations from the Gulf of St. Lawrence to the Bay of Fundy. Long series of yearly records have shown clear patterns of change and in recent years the annual means have shown a downward trend. The 1963 means for most coastal stations were higher than those for 1962 but means for both these years were below the long-term average. Cooling during the latter part of 1963 was more pronounced than usual.

Monitoring sections were occupied in the Bay of Chaleur (4T) in July and August. The data are being analyzed.

The Halifax monitoring section (4W) extending from shore to the edge of the continental shelf was again occupied throughout the year (Fig.8). This project looks for patterns in the long-term changing conditions over the Nova Scotia fishing banks and the continental shelf in general. This year accumulated data from several points were analyzed. The analysis shows that bottom temperature trends on the Scotian Shelf (4V-W), in the Bay of Fundy (4X), and in deeper layers of the Laurentian Channel (4V) are similar to those of surface temperatures at St. Andrews (4X). Comparisons of series of water temperatures recorded since the 1920's with series of air temperatures recorded since 1880 show that the trends are the same. Thus we can say that the banks waters warmed, 1880-1900; cooled, 1900-1920; warmed between approximately 1922 and 1953, but in this period showed a secondary maximum and minimum centred in the middle thirties and early forties respectively; and, finally, cooled rapidly since 1953. This generalization should help explain parts of the past history of fish stocks on the Nova Scotia Banks, in the Bay of Fundy, and probably the Gulf of St. Lawrence, because distribution and recruitment are related to temperature. A method of multiple correlations and regressions is now being used for forecasting annual temperatures 10 months in advance.

Temperature-salinity relationships of bottom waters on the shelf in Subarea 4 indicate year-to-year variations in the composition of water masses. This suggests that in warming and cooling periods the shelf water is constituted of different proportions of Atlantic and Labrador water.

Substantial year-to-year variations of surface water conditions (temperature and salinity) in the Magdalen Shallows were observed in early spring (1960, 1963). The fate of the biological content of the surface waters is undoubtedly related to such variations.

Studies of non-tidal drift, as inferred from drift-bottle and seabed drifter recoveries, were continued. These support larval distribution studies and also monitor the year-to-year hydrographic variations themselves. The 1963 results indicate active circulation within the Bay of Fundy and a weak circulation along the coast of the New England States. In the western Gulf of St. Lawrence there was a relatively strong, predominantly easterly surface drift in 1963, contrasting with a south-easterly drift in the previous two years.

In 1963 twelve years' observations on bottom temperature distribution throughout the Gulf of St. Lawrence were compiled and are being

plotted by months to show bottom temperature distribution in two-degree zones. Preliminary results are already clarifying our understanding of relationships between hydrography and fisheries.

2. Benthic studies. Bottom sampling in the southwestern part of the Magdalen Shallows (4T) was carried out with a 0.1m^2 VanVeen bottom grab. The composition of the benthic communities at various stations in this predominantly sandy area was remarkably uniform. Annelids and crustaceans constituted a small fraction of the total wet weight of the samples. The major constituents were molluscs, echinoderms, coelenterates and bryozoans.

3. Other environmental studies. A beginning was made in the study of water transparency as it is affected by suspended material. In rocky areas the water is clearer than in silty areas.

Mapping of the southern Gulf of St. Lawrence (4T) according to the type of bottom was begun. The character of bottom deposits was determined from grab samples and the depth of superficial deposits was determined by echo sounding. Shallow gullies tributary to the Laurentian Channel were shown to have accumulated 7 to 10 m of a soft mixture of silt and clay. Geochemistry of these deposits is under study. Bottom photography was found helpful in this work.

II. Biological Studies.

1. Cod. July plankton tows east of Gaspé (4T) yielded no cod larvae.

Much progress has been made recently in identifying cod stocks and in working out their annual migration patterns. To further this effort, 2,700 cod were tagged in September 1963 in 4S and vertebral counts and otolith studies were provided for. This complements earlier taggings of a stock resident in 4S-T.

Laboratory feeding studies with 50 to 51 cm fish for 30 weeks were carried out. Results verify earlier conclusions. With raw herring as food, feeding and growth in length and weight were highest at 12°C, intermediate at 8°C, and lowest at 5°C.

Field studies in 4T indicate that some of the factors regulating vertical migration are light, feeding and spawning, in that order of importance. In May and in the period mid July to October, upward movement is nocturnal and in June and part of July it is diurnal. Other field studies from January to March, using echo sounders in Divisions 4V, W and X, showed that nocturnal upward movement is great (as much as 30 m) in deep water compared with that in shallow water (see Fig. 9).

Laboratory experiments with cod show that lactic acid accumulates in the blood to such an extent during enforced exercise that the fish may die. The practical significance of this has yet to be demonstrated but it is possible that some fish which escape through the large mesh of "savings gear" may die from swimming fatigue.

2. Haddock. In March 1963 a research cruise was made to the shelf area of 4X. Interest centred on distribution patterns related to temperature, depth and bottom type. Catches alongshore east of Cape Sable were poor in depths less than 100 m. Here the fish are partly protected from exploitation by the unusually rough bottom which makes trawling difficult even with heavy steel rollers. Fish were also scarce on Roseway and LaHave Banks where temperatures were < 3°C. They were more abundant between Browns Bank and Yarmouth but the bottom there was also rough. However, bottom character favoured trawling on Little LaHave and Browns Banks and good catches of both large and small fish were made in 60 to 180 m at temperatures of 3 to 5°C. It appears that some 4X grounds are rich but that high temperatures in March 1963 encouraged dispersal.

3. Redfish. July plankton tows east of Gaspé (4T) yielded very few redfish larvae. Since 1950 research sampling of the most likely fishing areas in the Gulf of St. Lawrence (4R-S-T) has been carried out at 2-year

intervals. A conventional otter trawl (No. 41.5) with a nylon liner (mesh 27 mm) in the codend has been used for this work. Size-frequency distributions of these redfish samples always show a stationary mode at about cm for males and 38 cm for females. These modes represent the accumulated stock. Data gathered in the early years of the fishery (1950's) showed that fish of these sizes composed a great part of the population, and catches were high (50,000 metric tons in 1955). Since then, their relative numbers have decreased, the modes are less conspicuous in the size-distribution, and the catches have dropped (6500 metric tons in 1962). Plots for the research samples now show other modes more clearly. These represent smaller and faster-growing fish. A mode was observed in 1953 at 24 to 25 cm, representing both males and females. By 1955 it had progressed to 28 cm for males and 31 cm for females. But by 1957 these had merged with the modes representing the accumulated stock.

A mode at 8 to 16 cm (apparently mostly 3-year-old fish) was detected in 1959 and has been followed closely in catches made in 1960, 1961 and 1963. In 1963 when these fish were 7 years old, the mode was at 26 cm for males and 28 cm for females. From these data it was possible to check growth rates determined by other means.

This new size-group is abundant. Research trawl catches as high as 3 metric tons per 30-minute haul were made in 1963. These came from the same areas that gave the highest catches of accumulated stock in the 1950's. It expected that the growth rate of these new fish will decrease from now on d that the modes representing them will soon merge with those of the accumulated stock. It seems that there was a gap of 8 years between the appearance of the last strong size-group and the appearance of this new group which is now exploitable.

In November it was found that the level of greatest abundance of these larger fish was deeper (300 to 350 m) than that of 20-cm fish (280 m). Thus better catches of large fish and some savings of small fish could be obtained by selectively fishing the deeper water.

4. Halibut. The 1963 returns from 1962 taggings in Divisions 4V and 4W indicate extensive movement but mostly to the eastward from the areas of release. The commercial fishery depends on large fish caught with bottom longlines. More information about migration is needed before we can decide whether it is worth trying to limit the wastage of young halibut caught incidentally in otter trawls. Information is also needed about what sector of the population is affected by trawls. For this purpose comparisons of catches by these two gears are being made.

Studies of age- and size-composition of catches are complicated by the t that males and females grow at different rates. Results show that fish in southwest Nova Scotia (4X) are younger (Fig. 10) and smaller (mainly 6 to 14 years, 61 to 148 cm) than those from the Gulf of St. Lawrence (4R-S) (mainly 7 to 21 years, 61 to 166 cm). Thus the Gulf fish resemble those on the Grand Bank (Subarea 3). The tagging work is to continue in 1964 but other studies will be reduced.

5. American Plaice. A study of this species in the Magdalen Shallows was completed in 1963. Tagging indicates that there are two groups of fish in this area -- a northern group that concentrates in summer at 40 to 100 m in the Bay of Chaleur and in Shippegan Gully (4T) and a southern group found off the western and eastern shores of Cape Breton (4T and 4V). In January, February and March, the fish are found in deep water (200 to 500 m) along the Laurentian Channel at 3 to 6°C. In April they move back to shallow water.

Males grow slower than females; 50% of males mature at 25 cm (6 years) and 50% of females at 41 (10 years). Adults feed largely on echinoderms and molluscs; 75 to 80% of discards die after 25 minutes of deck exposure. There has been a decrease in the mean size of fish in catches since 1950. The total annual mortality calculated from catch curves is 0.4 stantaneous, i = 0.5).

6. Witch (Greysole). Substantial quantities are landed every year and in 1963 a study was begun in the Cape Breton area (4T and 4V). In winter the fish are found in muddy gullies as deep at 800 m. In summer they are taken in shallower water with best catches at 100 to 200 m. In October, 324 fish were tagged in this area. Males grow slower than females. Adults have a restricted diet, mostly annelid worms, amphipods and small crustaceans.

7. Wolffish (Anarhichas lupus L.) and Cusk (Brosme brosme (Müller)) are taken in southwestern Nova Scotia (4X) in small quantities --wolffish mostly from April to July and cusk from April to October. Samples of commercial landings were taken for preliminary biological studies. The fisheries in this area are becoming more and more diversified and the study aims to assess possibilities of expanding catches of these under-exploited species.

Wolffish are taken in otter trawls and with bottom long-lines. Their otoliths are small and hard to read but vertebrae and scales show rings that may be less difficult to interpret. The modal value for fork (total) lengths of commercially-caught wolffish was 97 cm for offshore and 85 cm for inshore landings.

Cusk are usually taken incidentally on halibut longlines. Their otoliths show clear rings that may prove useful for age determination. The range in total lengths was 46 to 94 cm for offshore and 37 to 73 cm for inshore f' h.

8. Herring. Annual June-to-September larval studies in the Gulf of St. Lawrence (4T) begun in 1951 and continued in 1963. A net with a rectangular mouth, 4m by 1 m, is towed at the surface for 30 minutes. The average catch of larvae per tow was 0.5 in 1959; 750 in 1952 and 730 in 1962. The aim is to discover relationships between larval abundance and subsequent recruitment to the commercial fishery. So far, no clear relationships have appeared.

Larval studies in the Bay of Fundy and southwestern Nova Scotia (4X) are designed to discover the source of supply of "sardine" herring to the Bay of Fundy. There is little spawning in the Fundy area but catches are maximum. Several years' catches are now being analyzed.

A study of water temperatures and the herring fishery of Magdalen Islands (4T) suggests the possibility of forecasting the starting date of the fishery and of the relative size of the landings in April.

The monitoring study of size-composition of herring stocks in Division 4X was continued in 1963. Mean lengths of weir-caught fish in the Bay of Fundy were 10.4 to 11.9 cm in April-May and 14.0 to 19.9 cm in August-September.

9. Mackerel, and Capelin, Mallotus villosus Müller. July plankton tows east of Gaspé (4T) showed that mackerel and capelin were dominant in the catches.

10. Sea Scallops. Laboratory studies of spawning of adults and rearing of larvae on cultured algae were continued. Spawning of ripe adults was induced by holding them in air for 3 hours then returning them to water. Larvae were reared up to 125 days to a size of 293 microns (length), although most larvae had died by 49 days and reached a size of approximately 250 microns. They are believed to settle at 300 microns. Mortalities in our cultures were believed due to bacterial or virus infections although a fungus-like organism was noted in two of the cultures. The larvae have never been described and their behaviour is unknown. Even the post-settlement stages less than 3 years old are little known. This makes it difficult to forecast recruitment.

SUBAREA 5

A. Status of the Fisheries.

I. Haddock.

Scarcity of haddock in Subarea 3 encouraged more fishing on westward grounds including Georges Bank (5Z). Statistics of effort and landings and results of sampling of landings for length composition are still to be compiled. They are to be analyzed by investigators of the Fish and Wildlife Service of the U.S.A. with whom we are collaborating in this project.

II. Cod.

Considerable quantities were taken along with haddock but we have not studied the landings.

III. Herring.

Indications are that there was little Canadian fishing in Subarea 5.

IV. Swordfish.

The 1963 Canadian landings along the edge of the continental shelf (see Fig. 11) were three times those of 1962 and showed increases in all areas exploited including the edge of Georges Bank (5Z). This resulted from an increase in the number of boats and a change in fishing methods, from harpooning to longlining.

V. Bluefin tuna, Thunnus thynnus, L., and Skipjack, Euthynnus pelamis L.

Canadian Atlantic purse seining for tuna began in August 1963. Two new 30-m boats landed approximately 300 metric tons of bluefin tuna and 50 tons of skipjack, taken partly from the Convention Area (5Y and 5Z) and the adjacent area southward to Long Island, New York, U.S.A. These fish were substantially smaller than the "giants" taken in Subarea 4 trap fishing.

VI. Sea Scallops. Placopecten magellanicus (Gmelin).

Preliminary statistics list 1963 Canadian landings of 7,390 metric tons of scallop meats (adductor muscles only) from Georges Bank (Division 5Z). This is equivalent to 61,360 metric tons of whole scallops and an increase of 10 to 15% over 1962 landings by this vigorous young Canadian fishery. This gain is attributed to an increase in fleet size from 39 to boats. There appears to have been some decrease in abundance--catch per unit effort dropped and the maximum size of discards dropped from 95 to 90 mm. Besides this, the fleet fished parts of the bank that have previously been considered too poor, and all boats used 3-inch (76 mm) rings although many had used 4-inch rings in 1962. Toward the end of the 1963 season a few boats entered the lucrative and less strenuous swordfish fishery. The size-composition of the stock indicates no unusually abundant year-classes. There are indications that abundance of usable scallops will be lower in 1964 than in 1963.

B. Special Research Studies.

I. Environmental Studies.

Bottom photography on Georges Bank (5Z) with an Edgerton underwater camera was used to study bottom characteristics and abundance of scallops.

Drift-bottle and seabed-drifter releases were made in 5Y as part of a co-operative study, with the U.S.A., of water circulation in the Bay of Fundy, Gulf of Maine and Georges Bank areas.

II. Biological Studies.

1. Herring. Analysis of 1963 research samples from Georges Bank is incomplete.

2. Swordfish. Biological studies chiefly involved length-weight measurements. Unexplained differences between mean lengths of fish caught in October and November were observed. A wide range of length-weight data which were available this year permitted us to plot this relationship.

III. Gear and Selectivity Studies.

Conservation and ring-size of scallop dredges. Analysis of data previously collected on Georges Bank (5Z) was completed. Increasing the ring size of offshore (Georges Bank) scallop drags from 75 mm (3 inches) inside diameter to 102 mm (4 inches) does not reduce the catch of 5-year-old scallops (height 95 mm) sufficiently to be an effective conservation measure, although it does reduce the catch of trash by 18%. This failure to produce "savings" effects may be because the increase in ring-size was not great enough or because scallops do not struggle to escape through the rings or because the large amounts of trash brought up by scallop drags (sometimes as much as 75% of the entire contents of the drag) interfere with mechanical sieving of the scallops caught, just as meshing of redfish interferes with the selectivity of otter trawls.

Table 2. Numbers of mentella and marinus redfish obtained in 1963 in various stages of larval development and extrusion.

Locality	Date of capture	Depth m	Species	Numbers of pregnant females with various percentages larvae hatched: 0% hatched (also includes pre-larval stages)	5-20% hatched	30-60% hatched	70-90% hatched	95-100% hatched	Partly spent (several 100 to several 1000 larvae remaining	Spent	Total	% spent and partly spent
SE slope Hamilton Inlet Bank N of Hawke Channel	Apr.9-16	366-560	Mentella	60	48	21	5	4		11	149	7
Funk I.Bank NE Nfld. Shelf	Apr.17	229-457	"	3	14	10	5	1		1	34	3
N slope Grand Bank immediately E of N Cape	Apr.18	457	"	13	37	25	20	16		5	116	4
Funk I. Bank NE Nfld. Shelf	May 8	265-329	"	4	6	4	3	8	6	6	37	32
E of Grey Islands NE Nfld. Shelf	May 10	274-278	"		3	3	5	4	3		18	17
Funk I. Bank NE Nfld. Shelf	May27-30	227-655	"	1	3	3	1	9	6	36	59	71
E of St. Anthony NE Nfld. Shelf	May 31	220-377	"		2	1	4	3		15	25	60
Off Bonavista NE Nfld. Shelf	June 2	291-327	"			2	1	1		19	23	83
SE slope Hamilton Inlet Bank N of Hawke Channel	Apr.9-16	448-560	Marinus	6	51	15		1			73	0
Funk I. Bank NE Nfld. Shelf	May 8	223-227	"		1	1					2	0
Funk I. ...k	May27-29	262-558	"			1		1		18		

17

C4

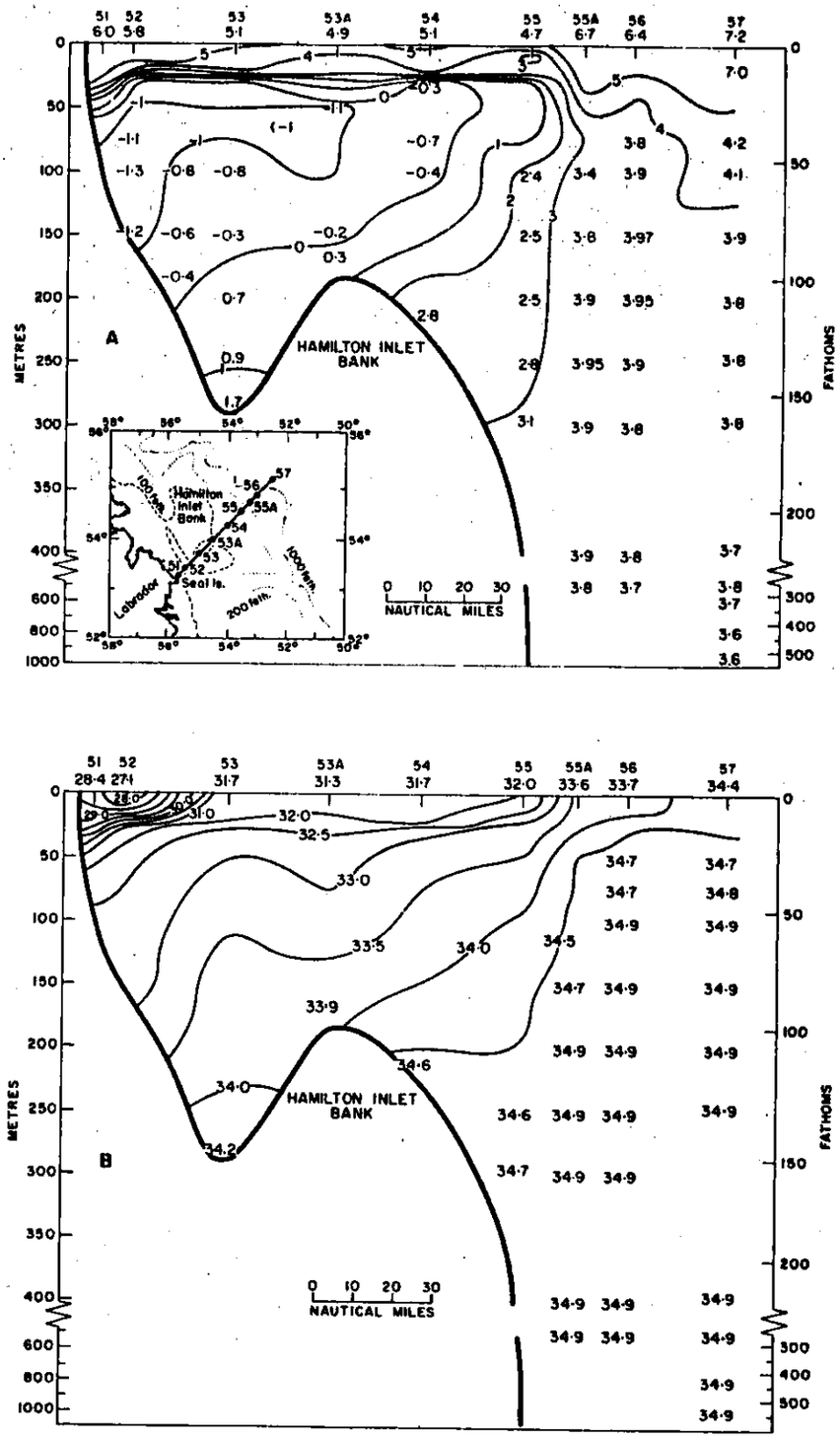

Fig. 1. A, temperature and B, salinity sections, °C and ‰, off Seal Islands across Hamilton Inlet Bank, August 5-6, 1963.

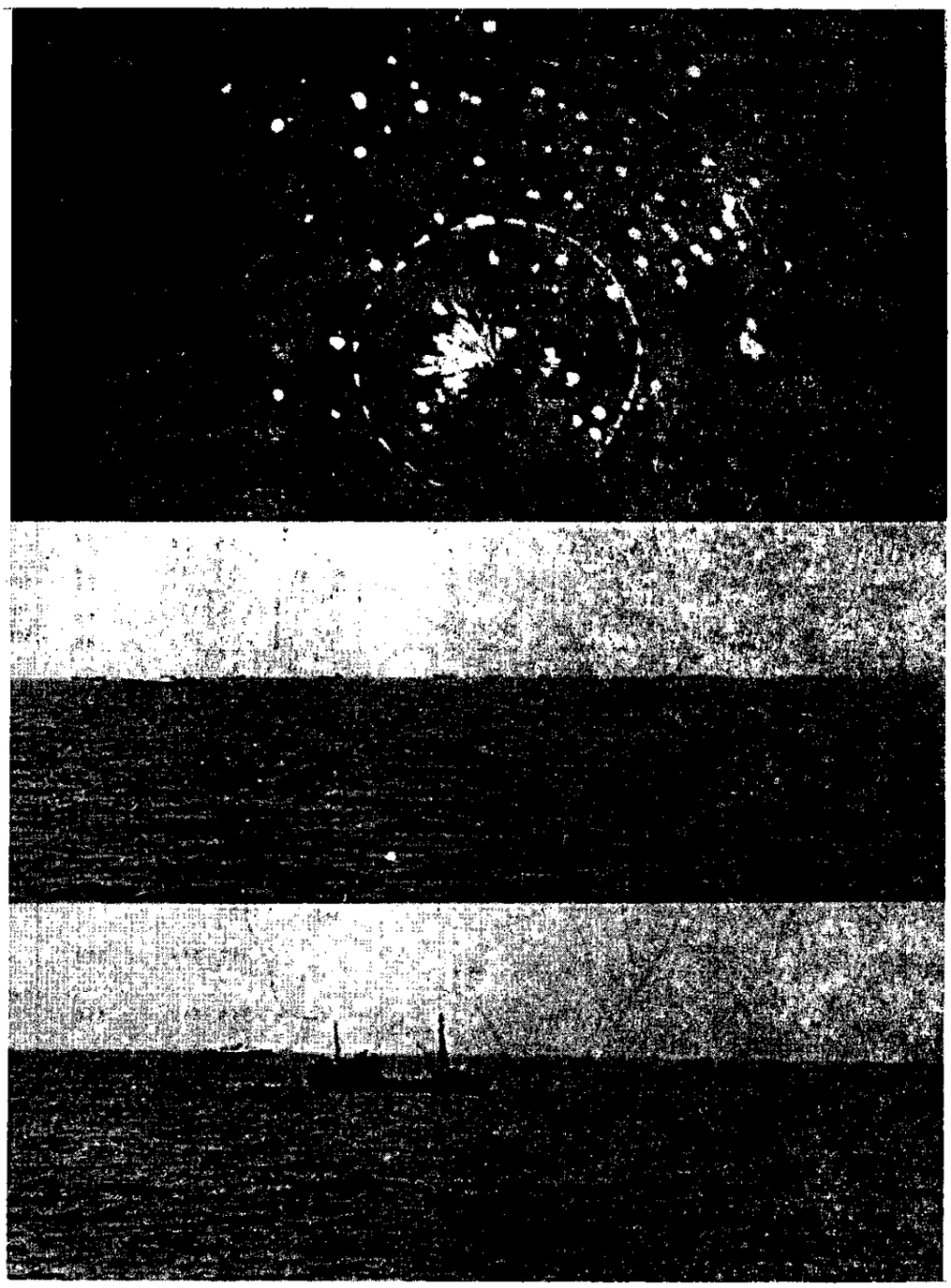

Fig. 2. Above, composite photograph, made from movie film, of part of the A.T. Cameron's radar screen showing part of concentration of trawlers on the southeastern slope of Hamilton Inlet Bank, May 3, 1963. (The photograph represents a circular area of radius 5 nautical miles with the A.T. Cameron at the centre. In the missing sector, now blank, the ships were also abundant. At this time there were 90-100 trawlers within a radar range of 10 nautical miles.) Below, 2 groups, each showing traces of about 15 trawlers in the original photograph. Photograph taken at the same time as those of the rader traces. (Photo by A. W. May).

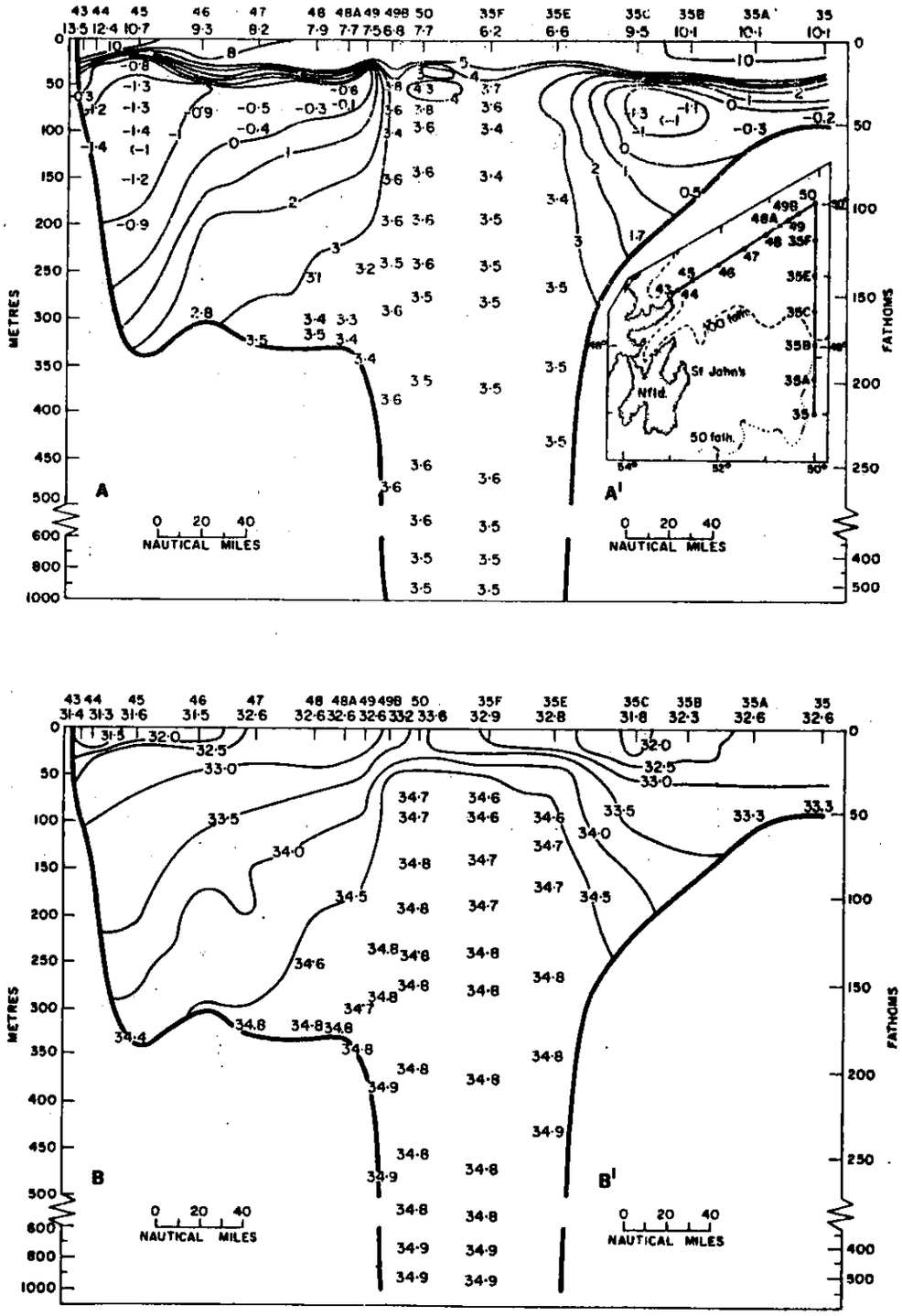

Fig. 3. A, A^1, temperature and B, B^1, salinity sections, °C and ‰, off Cape Bonavista and southward to northern Grand Bank, A, B, August 1-2, 1963 and A^1, B^1, July 28-August 1, 1963.

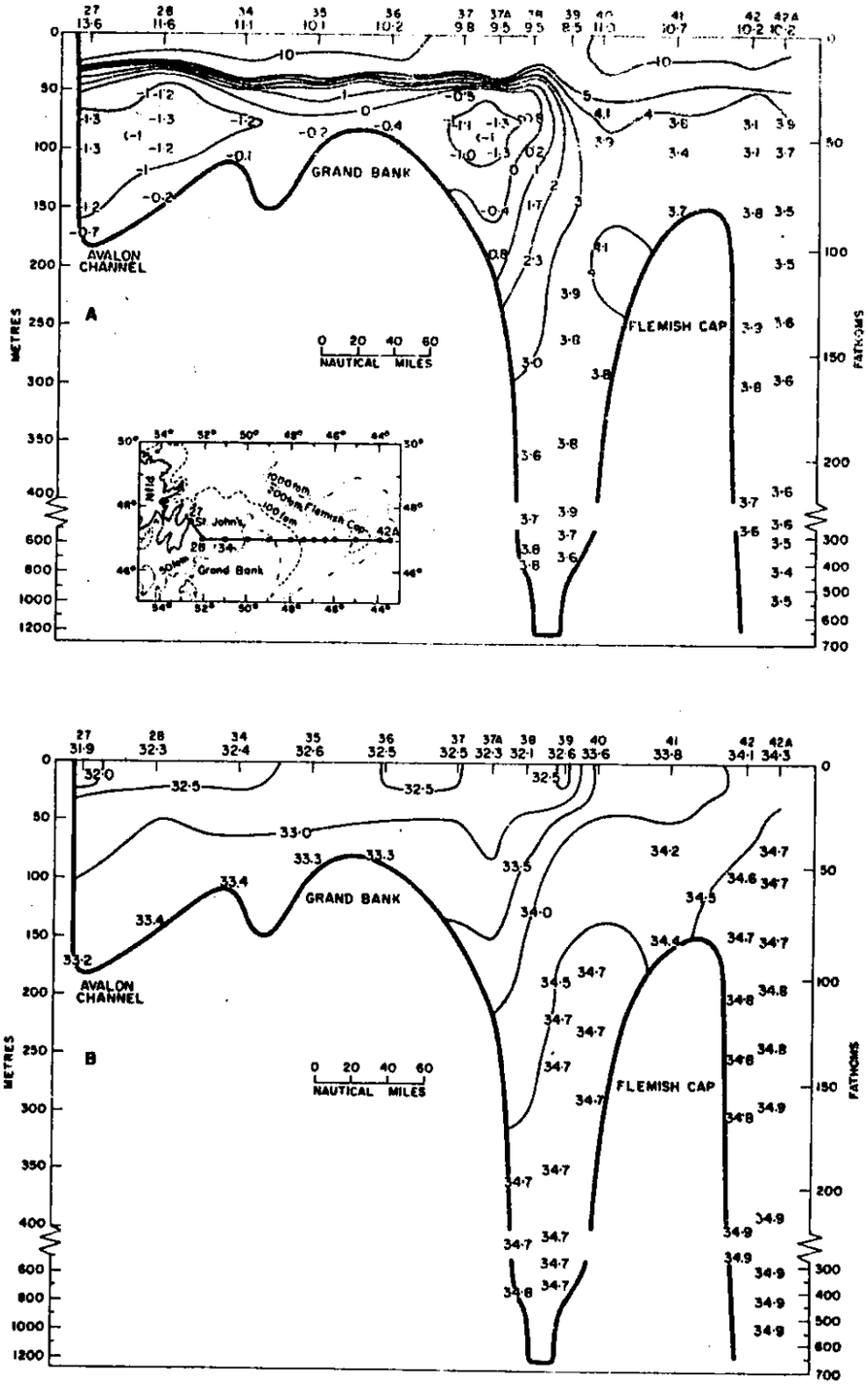

Fig. 4. A, temperature and B, salinity sections, °C and ‰, St. John's-Grand Bank-Flemish Cap, July 27-30, 1963.

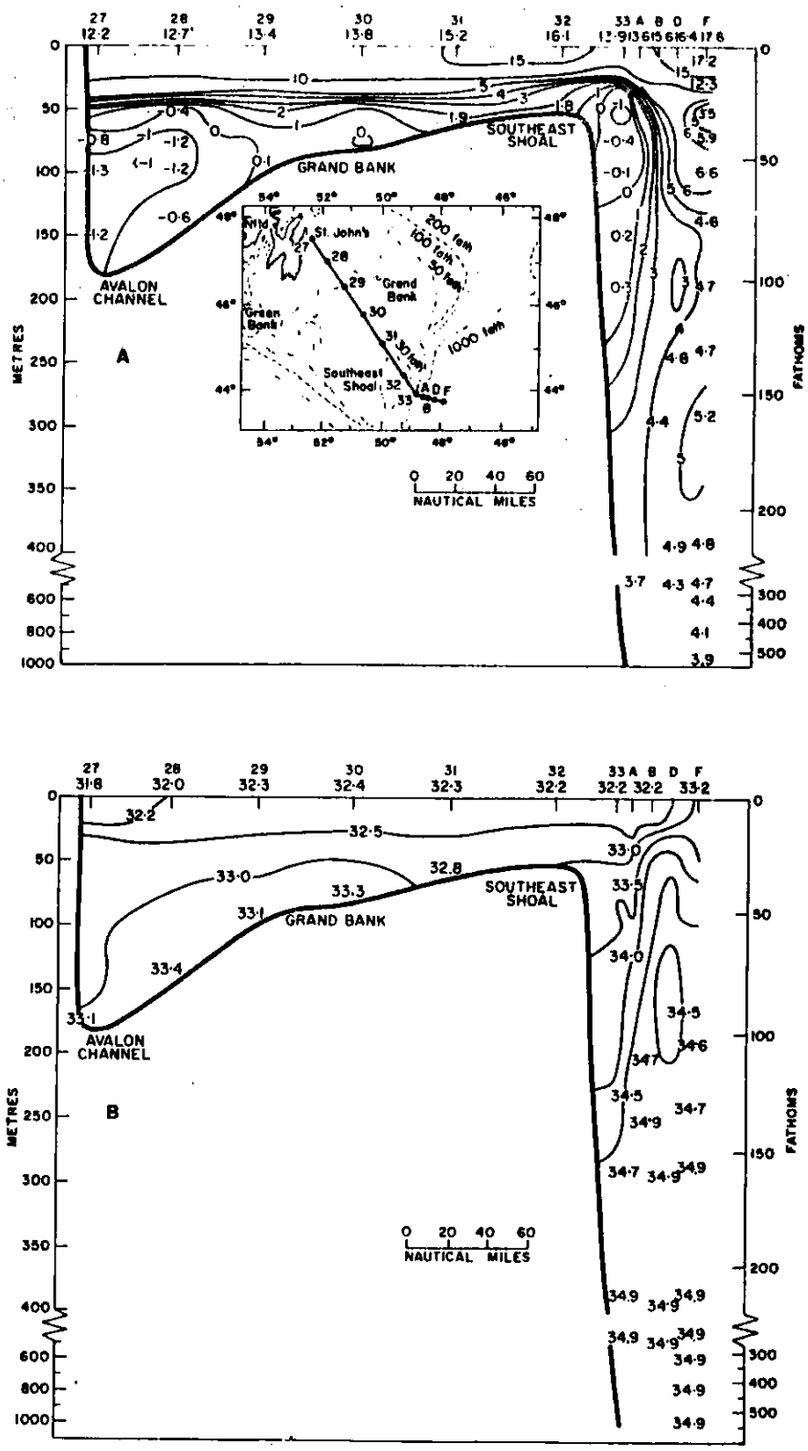

Fig. 5. A, temperature and B, salinity sections, °C and ‰, St. John's-SE slope Grand Bank, August 16-18, 1963.

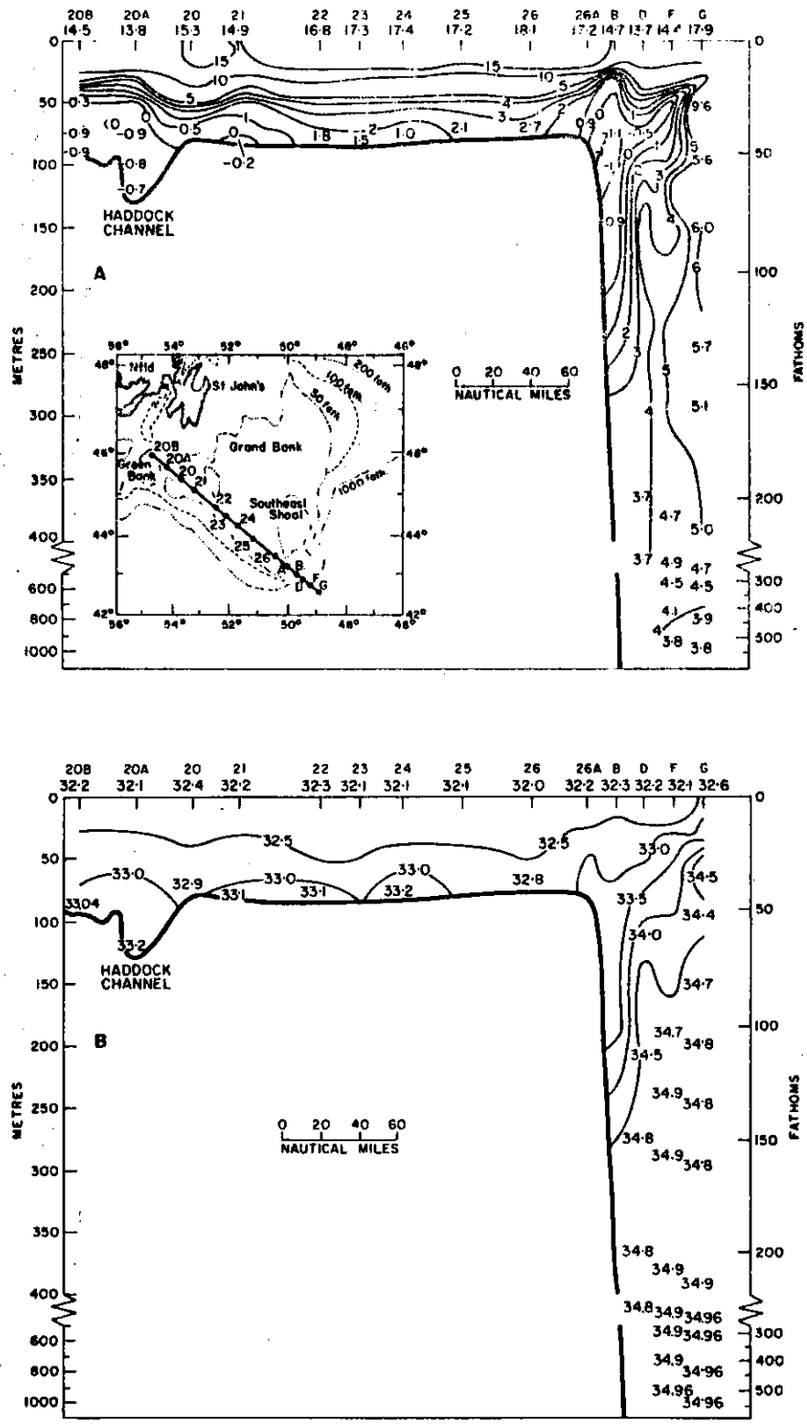

Fig. 6. A, temperature and B, salinity sections, °C and ‰, Green Bank-SE Grand Bank, August 19-22, 1963.

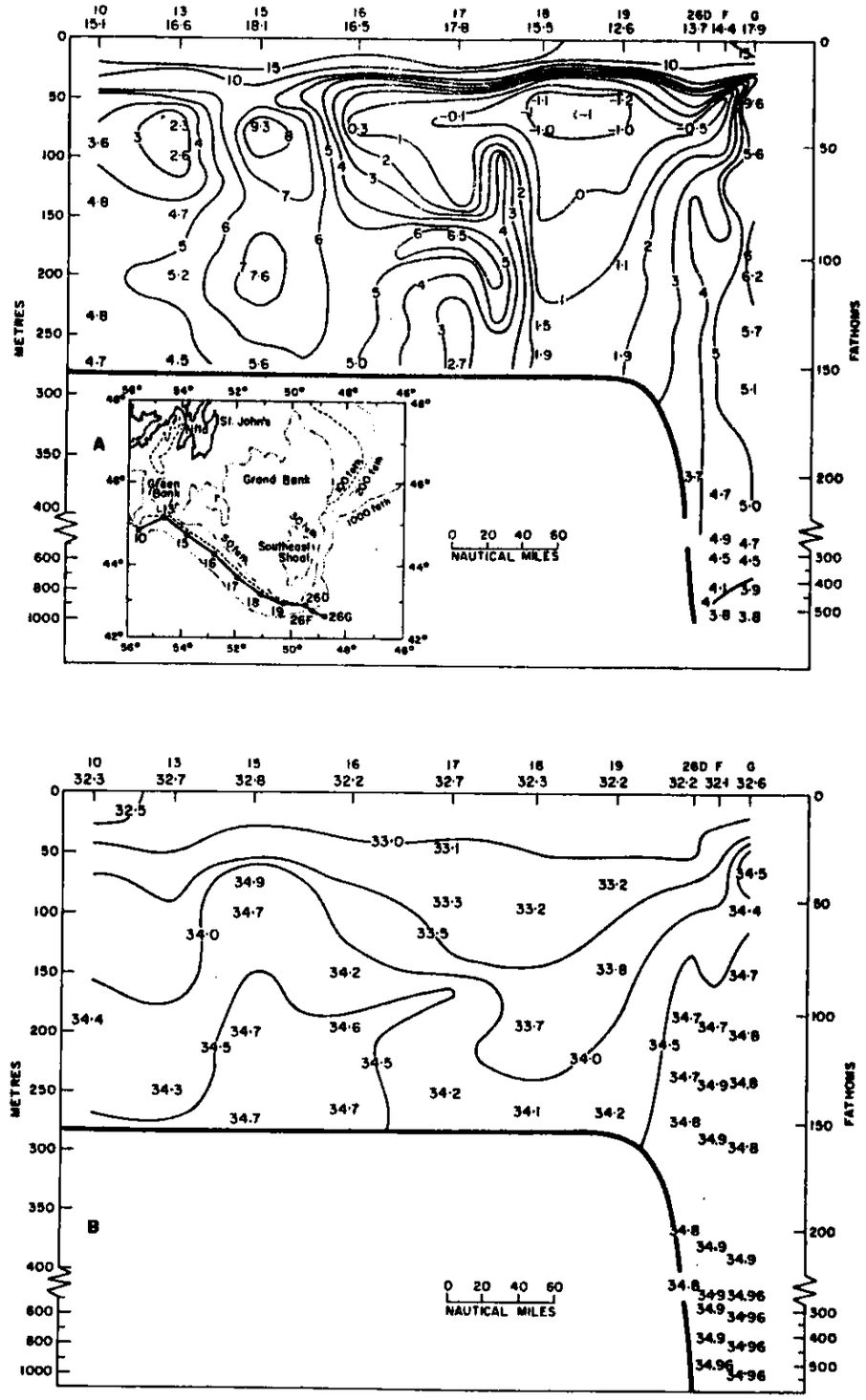

Fig. 7. A, temperature and B, salinity sections, °C and ‰, along the southwest slope of the Grand Bank, August 19-22, 1963.

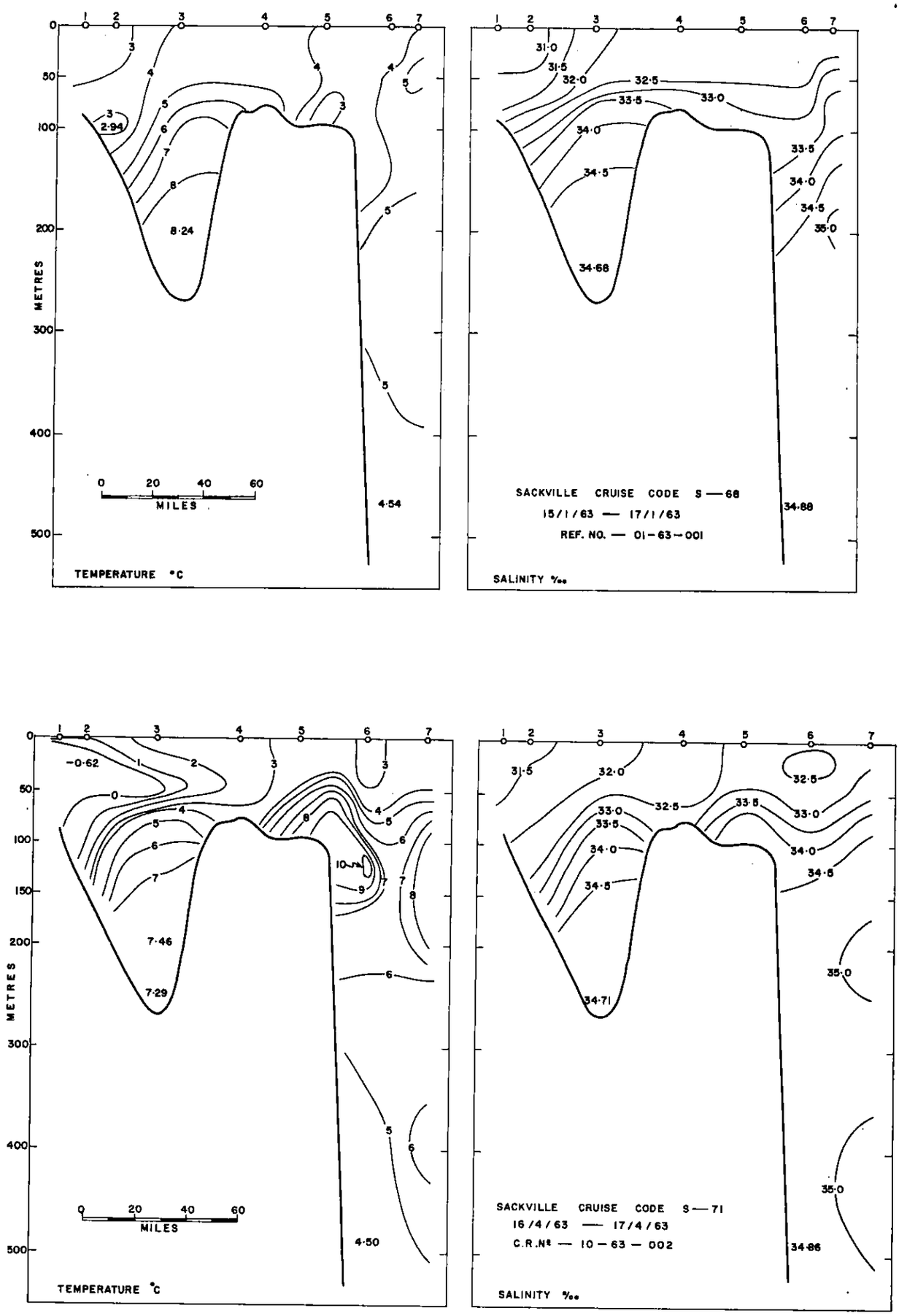

Fig. 8. Hydrographic section off Halifax, N.S. 1963.

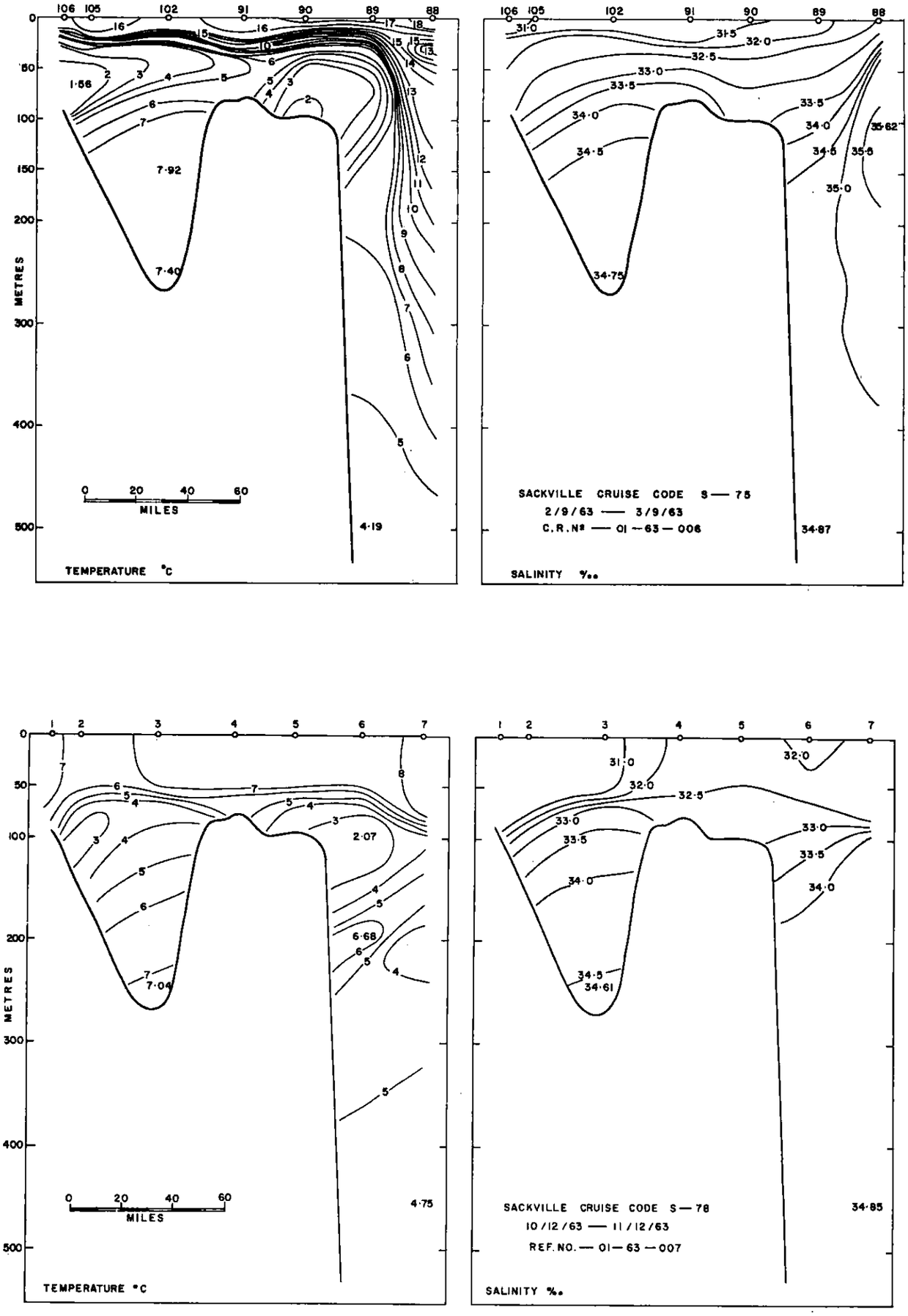

Fig. 8. (cont'd) Hydrographic section off Halifax, N.S. 1963.

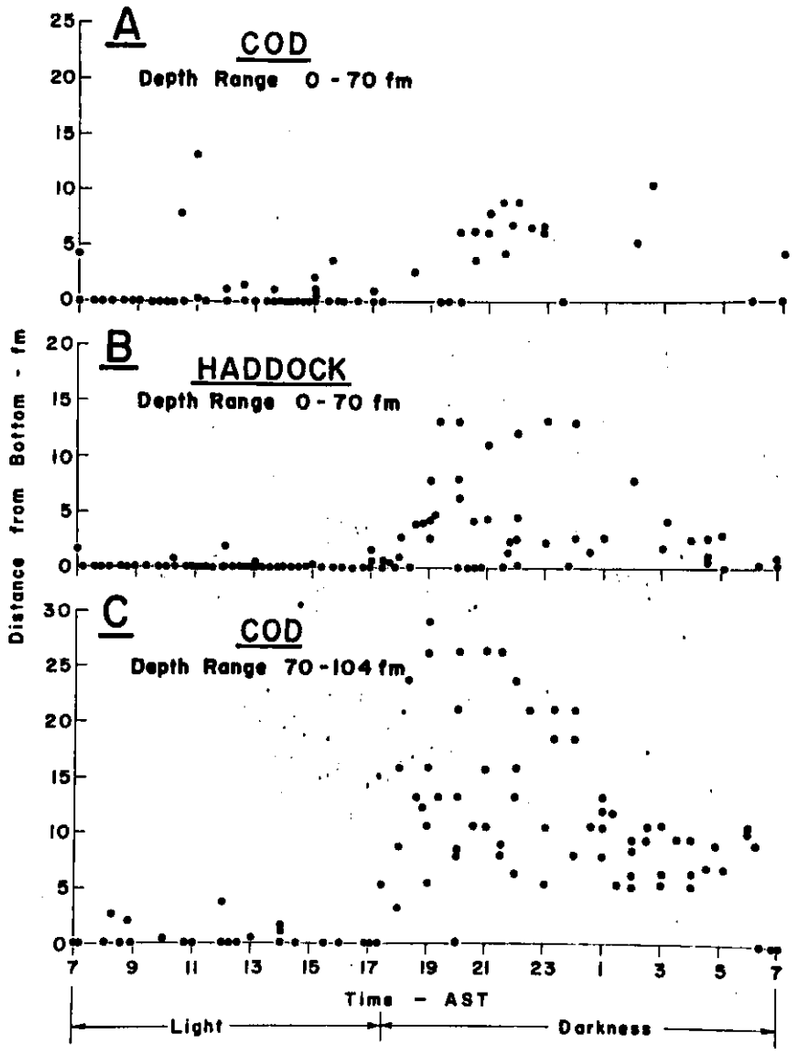

Fig. 9 Day-to-night differences in vertical distribution of cod above bottom in deep and shallow water (distances in fathoms: 1 fathom = 2 metres).

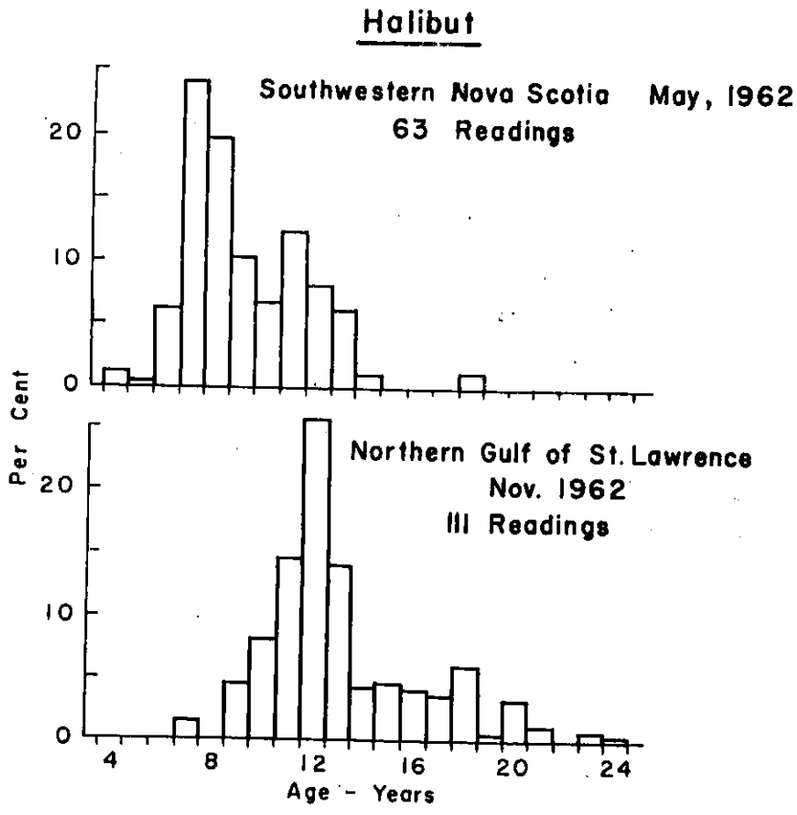

Fig. 10 Age-composition of halibut samples caught in 1962 with commercial longlines in Divisions 4X (63 fish) and 4R-S (111 fish).

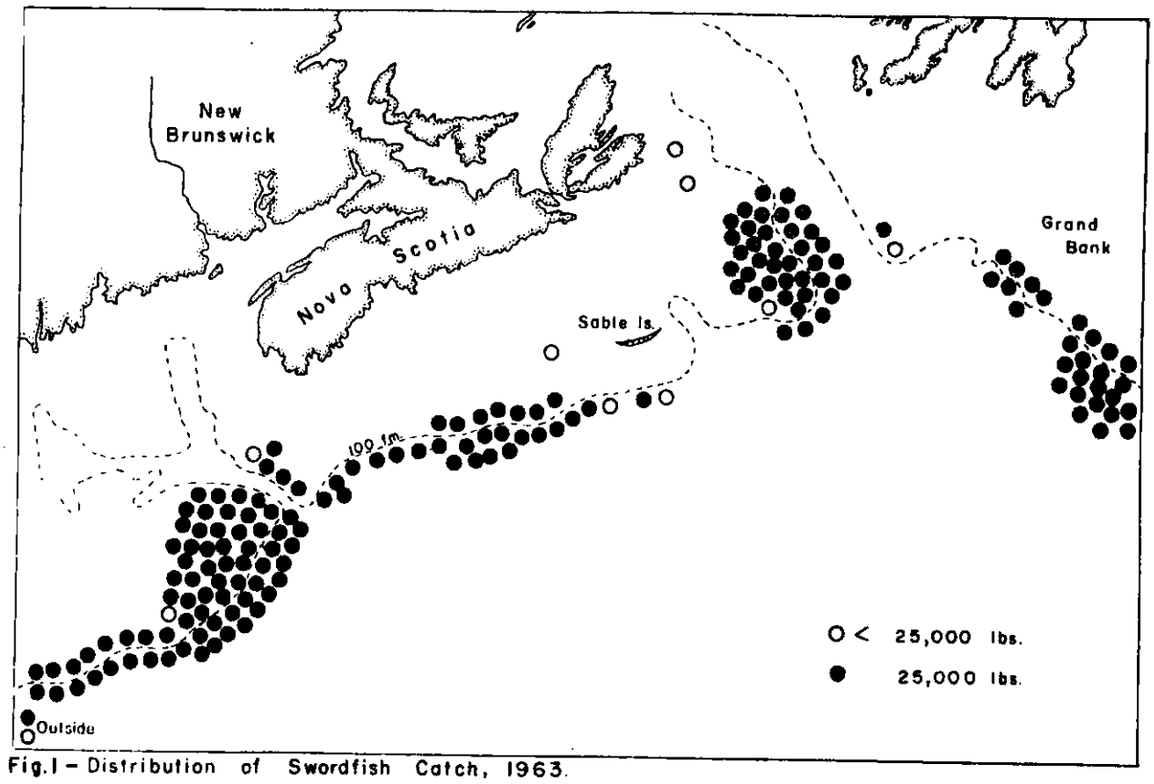

Fig.1 – Distribution of Swordfish Catch, 1963.

Fig. 11 Distribution of 1963 Canadian catches of swordfish (6000 metric tons) in relation to the 100-fathom (200 m) depth contour.