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

The St. John's Biological Station of the Fisheries Research Board of Canada carried out fisheries and oceanographic researches in Subareas 2 and 3. The Bedford Institute of Oceanography and the St. Andrews Biological Station of the Fisheries Research Board of Canada engaged in researches in Subareas 1-3. Canadian landings by subarea were not available when this report was written 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. The status of the fisheries and special research studies on harp and hood seals in Subareas 2 and 3 are reported separately in Appendix I.

Subarea 1

A. Status of the Fisheries

There was no Canadian fishery in Subarea 1.

B. Special Research Studies

I. Biological Studies

1. Atlantic salmon, *Salmo salar* L. The *A.T.Cameron* took 54 Atlantic salmon in Subarea 1 between 17 September and 5 October. In offshore waters 5 drift sets (900 m/set) yielded 12 salmon; in fjords 4 sets yielded 23 salmon. Set-nets (180 m) in fjords yielded 18 salmon from 8 sets. Only 1 salmon was taken in 8 offshore longline sets (490 hooks/set); none in 4 sets in fjords. Most salmon were taken near the surface in water between 3.1 and 4.3°C; one was taken in water of 1.8°C. No salmon were taken in one drift-net set in Subarea 2 (J) (52°23'N; 52°18'W: surface temperature 5.9°C). Forty specimens were brought to St. Andrews for study of their parasites.

Subarea 2

A. Status of the Fisheries

I. Cod, *Gadus morhua* L.

Cod landings of 31,000 tons from the inshore Labrador area were slightly higher than the 24,000 tons landed in 1966.

B. Special Research Studies

I. Environmental Studies

The hydrographic section on the southern Labrador Shelf from Seal Islands across Hamilton Inlet Bank was taken on 26-27 October.

The marine geology program of the Bedford Institute of Oceanography included bottom sampling and a bathymetric survey along the Labrador Shelf, in cooperation with the Hydrographic Service charting program.

Drifter experiments were initiated in Div. 2J to study the surface and bottom circulation.

II. Biological Studies

1. Cod. Monitoring of age, length, sex and sexual maturity in the commercial cod landings was carried out in 5 inshore Labrador localities and the following numbers of cod were measured and otolithed: in Div.2G, 573 and 247; in 2H, 1,646 and 724; and in 2J, 8,618 and 1,432.

A survey by the *A.T. Cameron* was carried out from 18 October to 6 November to study autumn distribution of cod in the area. Fifty-three successful fishing sets were made on lines of stations extending from Cape Harrison in Subarea 2 to the La Scie Shelf in Div.3K. Best catches of cod occurred in depths of 145 and 180 m. Catches approaching 900 kg in 30 minutes were taken off Cape Harrison and near St. Anthony. Larger catches (up to 2,760 kg) occurred on Hamilton Inlet Bank. Comparative fishing trials with the German research vessel, *Walther Herwig*, were engaged in for 2 days during this cruise. The results are reported in another document.

Subarea 3

A. Status of the Fisheries

I. Cod

Newfoundland cod landings from Subareas 3 and 4 (mainly from the inshore fishery of Subarea 3) were about 143,000 tons, about 24,000 tons less than in 1966.

Landings from the inshore fishery during 1967 were generally lower than in 1966 although in a few areas catches were higher. An improved autumn fishery was insufficient to bring total landings up to the 1966 level. At Bonavista and St. John's the catch per haul in the cod trap fishery was below the 1966 level, at St. Mary's the catch was higher over a short period, while at Burin it was higher throughout the season. Generally small cod sizes reflect the low age (4 and 5 years) of the majority of fish in the catch.

In the gill net fishery in various areas, although there was seasonal success in some localities, such as Burin, with the rapidly increasing total effort annually the catch per unit of effort is declining, although the size of cod continues to be large in most localities.

In the inshore cod fishery it seems quite unlikely that additional increases in effort will yield a correlated increase in catch. Already in areas where different gears are operating on the same sizes of cod the competitive effects are noticeable.

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

Newfoundland landings of haddock (from Subareas 3 and 4) fell slightly to about 1,940 tons. The spawning stock of haddock in Subarea 3 is now at a very low level with no indication of successful year-classes on the Grand Bank and an indication of minor success for the 1966 year-class on St. Pierre Bank.

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

Newfoundland redfish landings (from Subareas 3 and 4), almost all *S. mentella*, decreased to about 28,500 tons from 34,850 tons in 1966 of which about half were from Subarea 3.

IV. Flounders, American plaice, *Hippoglossoides platessoides* (Fabricius); Witch flounder, *Glyptocephalus cynoglossus* (L.); and Yellowtail flounder, *Limanda ferruginea* (Storer)

Newfoundland landings of flounders, mainly American plaice from Subarea 3, increased slightly to 54,000 tons from 51,000 tons (88% American plaice) in 1966.

V. American plaice

On the Grand Bank, total Newfoundland effort for American plaice has been less, in recent years to 1966, north of 46°N and effort has increased rapidly on

the eastern Grand Bank from 46°N southward to the tail of the bank. On the western part of the northern area, landings by the Newfoundland otter trawling fleet per hour's fishing have remained at about 450 kg and on the eastern part have declined in recent years from about 900 kg or over in the late 1950's to about 730 kg per hour. In the southeastern area south of 46°N, Newfoundland landings of American plaice per hour's fishing in recent years to 1966 are still as high, at about 680 kg, as they were in the late 1950's and higher than they were in the early 1960's.

Although complete information is not yet available, it is probable that the Newfoundland effort for American plaice in 1967 was greater than that in 1966.

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

Greenland halibut landings, almost entirely from the deep east coast Newfoundland bays in Subarea 3, increased slightly to about 15,600 tons from about 14,900 tons in 1966. The average length of the 1967 commercial catch of Greenland halibut sampled in Trinity Bay was 61.4 cm compared with 62.7 cm for 1966. This small decrease, when a larger one might have been expected from the considerable decrease in catch per unit effort, may be due to the use of larger mesh. Gill nets with 203 mm mesh were mainly used in 1967 compared with chiefly 165 and 178 mm mesh gill nets in 1966.

From catch and effort data on the commercial fleet collected at 3 Trinity Bay localities, the average landings of Greenland halibut per 90 m gill net in 1967 was 68 kg round weight compared with 157 kg in 1966. The average landings per 90 m longline decreased but not so greatly to 20 kg round weight in 1967 from 24 kg for 1966.

VII. Herring, *Clupea harengus* L.

Newfoundland herring landings mainly from Subarea 3 (especially Div.3P but some from Subarea 4) increased greatly to 83,000 tons from 28,000 tons in 1966. This resulted from greatly increased purse seiner effort to supply herring for meal. Eighty-nine per cent of these landings were used for fish meal compared with 69% of the smaller landings of 1966.

VIII. Atlantic salmon

Newfoundland commercial landings of Atlantic salmon (total from Subareas 2, 3 and 4) increased to 1,760 tons from 1,400 tons in 1966.

IX. Capelin, *Mallotus villosus* (Muller)

Total capelin landings of 3,500 tons (from Subareas 2, 3 and 4) were lower than the 4,850 tons landed in 1966. These are mainly landings as estimated by fishery officers. The decrease is due to decreased effort not to lack of capelin. The use of capelin for fish meal is increasing slowly but its use as cod bait is declining because of the increasing use of gill nets, and its use as fertilizer for potatoes and as food for dogs is decreasing also. The proportion used for producing fish meal was 28.5% which was only 90 tons higher than the 18.7% used for meal from the larger landings of 1966.

X. Swordfish, *Xiphias gladius* L.

Expansion of the swordfish fishery in Subarea 3 continued in 1967. Landings increased 24% to about 1,480 tons, all taken within the July-October period. New fishing areas are chiefly in the warm waters east of the tail of the Grand Bank.

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

Squid landings increased to 6,300 tons from 5,000 tons in 1966.

B. Special Research Studies

I. Environmental Studies

1. Hydrography. The standard section, St.John's-Flemish Cap, was taken on 25-27 July and Station 27, 3.2 km off Cape Spear, was occupied once or twice per month throughout the year. These observations are reported in Res. Doc.68/3.

The survey, by the Bedford Institute of Oceanography, of the Sir Charles Hamilton Sound was continued for the third year, and will provide for new charts and current information in this area. A major hydrographic charting survey on the Grand Bank was continued with approximately 85,000 sq km being surveyed in 1967.

For the second consecutive year, drifter experiments were carried out in Subarea 3 (K, L, O, Ps) as part of a general program of circulation studies at the surface and along the bottom. Releases of drift bottles and sea-bed drifters were also made regularly at Station 27.

II. Biological Studies

1. Groundfish generally. The commercial inshore fishery for cod and the offshore otter trawl fishery for various groundfish species were sampled in important Newfoundland fishing ports. The information on age, growth, maturity, spawning, factors affecting distribution and abundance, catch per unit effort and the contributions of various year-classes to the fishery provide basic information for stock assessment.

2. Cod. Near the mouth of Trinity Bay on 3-6 March, cod caught in 255-285 m were feeding heavily on capelin. Although the cod were mainly large, younger fish 1-3 years old were also included in the catch. On 5-6 November in the same area in 148-320 m, the cod caught were mainly small.

In cruises of the *A.T. Cameron* to St. Pierre Bank in April-May and November-December, few large cod were caught, but fairly large numbers of small, 2- and 3-year-old cod were taken in depths of 75-145 m. Meristic studies suggest a separation of northern and southern St. Pierre Bank cod.

On the northeastern Grand Bank on 10-12 June, cod was generally the most abundant species caught. In the shallower depths (64-115 m), 3-year-olds were most abundant, but deeper the cod were generally aged 5 years and older.

In cruises of the *A.T. Cameron*, good cod catches were taken in June on the southeast slope of the Grand Bank and in July-August on the northern part of the Southeast Shoal. These cod were mainly less than 45 cm in length. The cod catch per 30-min tow with a No. 41 net (24.1 m headrope) on the southwestern Grand Bank in November was only 23 fish (15 kg).

Studies on the biology and distribution of cod caught in the commercial gill net fishery in the inshore area are continuing. Observations on these cod have shown that the majority of cod caught in drift nets on the east and southeast coasts of Newfoundland spawn in the bays and coastal areas in spring, in contrast to the smaller mature cod in cod trap and line catches in summer which apparently spawn before coming to the coast from offshore.

The inshore commercial cod fishery in Subarea 3 was sampled by 60,000 length measurements of random samples and the collection of otoliths from 7,000 fish.

3. Haddock. The catch of haddock per 30-min tow was 6 fish (4 kg) on a cruise to the Grand Bank in November. On St. Pierre Bank, the catches per 30-min tow in April and December were 254 (44 kg) and 186 (22 kg) respectively. Catches of one-year-old fish were good, but this year-class is apparently not as strong as the 1955 year-class was at the same age on St. Pierre Bank and there is doubt that it will become of much commercial importance.

4. Redfish. During the period 18-25 December, several good catches of baby redfish were taken by the *A.T. Cameron* on the southwestern slope of the Grand Bank. On each of the 4 lines visited, covering almost the complete range of the southwest slope of the Grand Bank, at least one catch of over 2,900 juvenile redfish was taken during the 30-min hauls which were standard for the trip. The largest catch, 9,570 juvenile fish, was obtained at a depth of 141-152 m at 43°22'00"N, 51°26'30"W. These young fish formed a well separated group with a mean length varying from 11.1 to 11.7 cm.

5. American plaice. A comparison of day and night catches was made during 3 days fishing, eight 1-hour otter trawl sets per day, by the *A.T. Cameron* at a locality on the northeast slope of the Grand Bank at a depth of 110 m. The catches at 0200 and 2300 hr (Newfoundland Standard Time) were on the average the smallest,

103 and 151 kg, and the early morning 0500 hr and the early evening 2000 hr average catches were the largest, 381 and 347 kg. There was not much difference, however, in the catches in the six 3-hour periods between 0500 and 2000 hr, the catches from 0800 to 1700 hr ranging from 230 to 318 kg. American plaice grow slowly and do not reach minimum commercial length (30 cm) until between ages 6 and 7 on the southern half of the Grand Bank and between 8 and 10 years in the more northerly areas of this bank.

6. Herring. Beginning with the 1966-67 fishing season, herring investigations were concentrated on the population biology of the stocks supporting the major fisheries. Routine procedures were established for collecting, processing and reporting catches, spawnings and sampling data.

Fishing areas, based on land boundaries for the Department of Fisheries landing areas and ICNAF fishing areas, were described for the Newfoundland herring fishery. These areas were incorporated in an area map for Canada's east coast herring fisheries, developed, in cooperation with the St. Andrews Station, for use in a standard log book. Catches for the 1964-65, 1965-66 and 1966-67 seine fisheries were compiled by area and week of capture from log books and/or plant records. Landings by other gears were compiled by herring fishing areas from records supplied by the Department of Fisheries. These data were reported along with an historical study of Newfoundland herring landings in a manuscript entitled "Herring landings and catches in Newfoundland and their implications concerning the distribution and abundance and stocks" submitted for publication as an FRB Technical Report.

Reports of herring spawnings in 1966, solicited from fishery officers and other interested parties, were compiled and reported in Circular No.14 distributed by this Station in July 1967. A similar report on the 1967 spawnings is in preparation, indicating some rather major shifts in the location and/or timing of spawnings from previous years.

During the 1966-67 fishing season, 222 samples were taken on a regular basis from the commercial catches at the two major ports of landing and at seven government bait depots. An additional 65 samples were taken on research cruises. Data on age, length, weight, sex, maturity and the number of vertebrae are being compiled for inclusion in an annual series of data records. They will be analyzed in 1968 along with similar data for the 1964-65, 1965-66 and 1967-68 seasons.

Techniques and procedures for estimating and recording the age of Newfoundland herring from otoliths were established in 1967. Age determinations at St. John's compared favourably with those by three other agencies in an otolith exchange program. However, there was appreciable disagreement between the various readers on the age of individual fish, indicating the need for further refinements in ageing techniques. This study is reported in a manuscript entitled "Ageing of herring at the St. John's Biological Station" submitted for publication as an FRB Technical Report. During 1967, age determinations were carried out for the 18 samples collected during the 1964-65 season, the 43 samples taken during the 1965-66 season and 50 of the 287 samples taken during the 1966-67 season.

In the 1966-67 season the herring moved onshore in quantity in the Bonne Bay area of the west coast of Newfoundland in the latter part of November and were found there until January. The onshore movement in quantity in the bays and inlets of the western half of the south coast of Newfoundland apparently begins in December and the main purse seiner fishery was from January to March. The fishery increased in April in the most western part of the south coast and the southern part of the west coast in the La Poile-Port aux Basques-St. George's Bay area. On the eastern parts of the south coast, in Fortune Bay and St. Mary's Bay, the main fishery was in April to early May, after which only small amounts of herring were caught by seine. Spring spawnings have been reported from most areas of the coast. Although no autumn spawnings were reported in 1966, the state of maturity of the herring samples suggests that many and perhaps most Newfoundland herring spawn in the late summer or later.

Additional information on herring researches is reported in another document.

7. Pink salmon, *Oncorhynchus gorbuscha* (Walbaum). From 3,300,000 eggs of pink salmon from Lakelse River, British Columbia, planted in a controlled flow channel in North Harbour River, St. Mary's Bay, Newfoundland, 25 November-

3 December 1965, about 3,000,000 fry left the river in May 1966. A few juvenile pinks from this run were seen in St. Mary's Bay as late as August and October 1966, the length in the latter month being 20 cm.

In 1967 the known returns of adult pink salmon from this planting were 8,440 of which 5,334 entered North Harbour River and 122 were noted in 10 other rivers (9 in Newfoundland and 1 in Quebec). Of these, 40 entered Come by Chance River in Placentia Bay and 31 Colinet River in St. Mary's Bay. The catch in the commercial fishery was 2,961 of which two-thirds were taken in Placentia Bay and St. Mary's Bay on the south coast of Newfoundland and the remainder on the east coast from White Bay to the Avalon Peninsula. Because a close check could be kept only on St. Mary's Bay where 1,169 pink salmon were caught commercially, it is certain that large numbers, possibly several thousand, of pink salmon escaped notice and were unrecorded in the commercial fishery in the other areas of Newfoundland. Three pink salmon were reported from Nova Scotia, 2 from Quebec and 2 from Labrador, at Forteau in the Strait of Belle Isle.

Spawning in North Harbour River occurred during September and was distributed along 5 miles of the main river and on 1 mile of a tributary. Egg deposition was estimated to be 4,400,000.

The 1967 returns were considerably different from those of 1966 when only 638 pink salmon (419 to North Harbour River) returned from the plantings of a similar number of eggs (3,400,000)in 1964, from which the estimated number of fry descending in 1965 was 2,900,000. It is apparent that conditions of survival at sea were unusually favourable for the 1967 fish and this agrees with the higher returns than usual of Atlantic salmon in 1967 despite the toll of the new Greenland fishery, although in the latter case where the numbers of smolts are unknown, the favourable survival may equally well have been in the river life.

8. Capelin. Research in 1967 was concentrated on a year-round investigation of the distribution, feeding, growth and maturation of an inshore population of capelin and on a comparative study of beach and offshore spawning stocks of capelin. The first of these two projects was carried out in Trinity Bay, whose extended length and wide range of depths made it well suited for this purpose. Capelin spawning on the beach at Outer Cove on the outer coast of the Avalon Peninsula and a few miles north of St. John's provided convenient access to an inshore spawning, and offshore spawning was examined on the Southeast Shoal of the Grand Bank.

The Trinity Bay capelin population was surveyed and sampled in early March by the *A.T.Cameron* and in early June and early November by the *Investigator II*. In early March echo-sounder tracings showed the capelin concentrated near the bottom in relatively deep (130-220 m), cold (-0.4 to 0.5°C) water. The older (4-6 years) maturing fish had resumed feeding after cessation of feeding in winter and had a higher fat content. They were schooled separately from the younger (2-4 years) immature fish. By early June, the capelin had moved up into warmer shallower (less than 35 m) water inside the 183 m contour on the northern side of the bay. The older, mature capelin had ripened and had moved in toward the beaches where they were easily taken in gill nets. They had ceased feeding and their fat content was much lower than in March. They were still segregated from the younger, unripe fish which were feeding farther offshore in depths of 9-35 m, where they were readily captured by mid-water trawl. By November the capelin had scattered and could not be detected by echo-sounder. A few were trawled from the bottom in depths of 165-255 m where the water temperature ranged from -0.5 to 1.1°C.

The spawning of capelin on the Southeast Shoal of the Grand Bank must have taken place in late June in 1967. On the *A.T.Cameron* cruise in late July and early August, capelin were taken in significant quantities in only 3 of 41 bottom drags. These fish were all spent and were much smaller than the maturing capelin taken there in early June. The spawning ridges on the males were in an advanced state of regression and many of the capelin, particularly females, were feeding. No capelin eggs were taken in bottom grabs but large numbers of capelin larvae from 7 to 9 mm in length were taken in surface plankton tows.

Observations of beach spawning at Outer Cove were carried out from 1 June to 10 August. Capelin began rolling on 19 June and spawning continued until 10 July. The rapid rise in temperature during this period (from 5.7°C to 10.4°C) probably forced the younger (2-3 years), late-maturing fish, to spawn offshore as the beach spawners were mainly older fish.

9. Swordfish. Biology and distribution of swordfish were investigated during one cruise on the commercial fishing vessel *Jane R.* and another on the research vessel *A.T.Cameron*: 144 specimens were examined for size, sex, food, and parasites, and 8 others were tagged and released. Individual weights ranged from 18.5 to 135 kg with a mean of 59 kg for 137 fish. The catch was predominantly female (3:1). Hooking rates were low (less than 1%), presumably as a result of competition from other large pelagics. Fishing was most productive in areas where surface temperatures were above 18°C. Preliminary analysis of stomach contents indicates greater variety in diet than in most areas north of Cape Cod.

10. Short-finned squid and cephalopods generally. Weekly random samples of short-finned squid were obtained from Holyrood, Conception Bay, for biological studies on growth, maturity, parasites, and feeding. A total of 6,500 specimens was examined. The program initiated there in 1966 to investigate the relationship between squid catch and physical factors was continued.

Work continued on collections of cephalopods from off all Canadian coasts. A synopsis of the recent Cephalopoda of Canada (48 species collected to date) is in press and two larger systematic papers (one a bulletin on the squid of the Northwest Atlantic and adjacent Arctic, the other on systematics and biology of the sepiolid squid *Rossia*) are nearing completion.

3. Subareas 4 and 5
by F.D.McCracken

Research on oceanography and fish stocks in Subareas 4 and 5 was carried out by the following Canadian establishments: the St. Andrews Biological Station, the Marine Ecology Laboratory (Dartmouth), the St. John's Biological Station of the Fisheries Research Board of Canada; the Bedford Institute of Oceanography of the 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. Reports on researches by many scientists, whose names appear in the list of Canadian scientists engaged in work concerned with ICNAF problems, were used in preparing this submission. Final division of Canadian landings by subarea were not available at the time of writing this report. The statistics used throughout this report are either preliminary or approximate, except where special circumstances permit more definite compilation. The status of fisheries and special research studies on harp and hood seals are reported separately in Appendix I.

Subarea 4

A. Status of the Fisheries

I. Cod

Landings of cod on the Canadian mainland were again the highest in weight for any single fish species, comprising about 32% of total groundfish landings. However, the total was down about 10% from 1966. Statistics of landings in northern New Brunswick from the Div.4T population indicated that the decline reported in previous years had stopped. The decrease in total landings is probably due to reduced landings from Div.4X (and Subarea 5). The range of sizes and ages of cod landed from the Div.4T fishery remained much the same as in 1966, with peak numbers at 46 cm. The 1963 year-class was dominant. Discards remained low, about 1%.

II. Haddock

Haddock landings, which increased about 25% in 1966, showed a decline of about 14% in 1967. Ports with lower landings were located in the Bay of Fundy and Cape Breton regions. This indicates lowered landings from Div.4X (and Subarea 5), and from the eastern Nova Scotia banks (4V-W). Sizes of haddock landed did not change significantly from 1966.

III. Flatfishes

Combined landings of the various flatfish (plaice, witch, yellowtail, winter flounder) decreased about 10% from those in 1966. Statistics by port of landing indicate a significant decrease in plaice, witch, and winter flounder landings from Div.4T, accounting for much of the loss.

Total Atlantic halibut landings were also lower by about 10%, but the affected areas are as yet unknown.

IV. Pollock

Pollock landings continued a downward trend, decreasing from 1966 by about 5%. The decline is recorded from ports in Div.4X and is likely related to changes in pollock fisheries there.

V. Redfish

Redfish landings were mainly from Div.4R-S-T and were about the same as in 1966. Recent landings have been much higher than in the early 1960's. Most of this increase came from greater fishing effort on a series of new year-classes.

VI. Sea scallop, *Placopecten magellanicus* Gmelin

Offshore landings came principally from Browns Bank (4X) and increased by 40% to about 1,400 metric tons whole weight. Inshore landings from the Bay of Fundy continued to decline from 2,000 tons in 1966 to about 1,400 tons in 1967 (172,000 kg meats). Landings increased markedly from the southern Gulf of St. Lawrence, reaching 3,800 tons (1,400 in 1966), the highest recorded for this inshore fishery.

VII. Herring

Herring landings, excluding Div.4R, amounted to more than 263,000 tons, an increase of about 42,000 tons (20%) over 1966. Increases occurred in Div.4T (23,000 tons) and 4X (19,000 tons). Landings decreased slightly in Div.4S and 4W, but less than 1% of the herring catch is taken there.

VIII. Swordfish

Landings of swordfish at about 1,200 tons were the same as in 1966. They contributed about 40% to total Canadian landings of this species.

IX. Mackerel, *Scomber scombrus* L.

Mackerel landings amounted to about 11,000 tons, a decrease of 400 tons from 1966. Landings increased in all divisions except 4T, where there was a decrease of more than 40% to about 3,100 tons.

X. Tuna

The total catch of tuna amounted to about 300 tons, a 50% increase over 1966 landings. The increase was due chiefly to larger bluefin catches in St. Margaret's Bay (4X). Offshore catches include several species not recorded separately in statistics.

XI. Sharks

Landings of porbeagles, makos, and hammerheads amounted to little more than 50 tons in 1967.

XII. Atlantic salmon

The catch of Atlantic salmon from Subarea 4 at about 1,350 tons (commercial plus angling) was about the same as in 1966. Grilse made up about 70% of the angling catch.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic Studies. Observations of coastal surface temperatures were continued at six monitoring stations from the Bay of Fundy to the Gulf of St. Lawrence. Negative anomalies were predominant almost everywhere except in the central Gulf of St. Lawrence (4T) from Gaspé Peninsula to Magdalen Islands. However, Northumberland Strait (4T) experienced below-normal temperatures. The average surface temperatures at St. Andrews (4X) during the second and third quarters was the lowest since the 1920's. In general, surface temperatures were lower in 1967 than in 1966 in Div.4W-X by 0.1 to 0.5°C.

The annual mean temperature on the bottom (90 m) at the entrance of the Bay of Fundy was the lowest since the 1930's, with a negative anomaly of 1.2°C. Temperatures of the deep warm layer in Cabot Strait (4V) showed continued cold period conditions, 4.2 to 4.5°C compared to 4.3°C in 1966. Low bottom temperatures in northern Northumberland Strait during August resulted from a slow warming of the bottom layer.

Unusual environmental conditions, highly stratified waters with extreme temperatures, were studied during the summer in Chaleur Bay and northern Northumberland Strait in relation to herring and lobster fisheries respectively.

Circulation studies, based on recoveries of drift bottles and sea-bed drifters, were continued in all areas, with the largest number of releases since 1960. Special efforts were made in the eastern Gulf of Maine, Georges Bank (5Y-Z), and central and western Scotian Shelf (4W-X).

Material collected for primary productivity studies in the Gaspé region of Div.4T between May and November is being analyzed. Analysis of data on hydrography, zooplankton, and benthos, collected between 1952 and 1963, was a main concern of la Station de Biologie marine, Grande-Rivière, Qué.

A survey of the western Gulf of St. Lawrence was carried out in June and July. Current meters were installed at eight sites from Cabot Strait to Pointe des Monts to learn more about the scale of response of the water to meteorological disturbances and to observe the Gaspé current system in more detail.

A Scotian Shelf moored-buoy program was initiated in January to obtain time-series temperature, current speed and direction data for an extended period of time at four sites ranging in depth from 80 to 1,000 m. The hoped-for data series at surface, intermediate, and deep water, are incomplete owing to instrument failures, losses, and insufficient ship time to recover and reset moorings. However, they give potentially valuable information on the magnitude and frequency of short-term variations, and it is intended to maintain the moorings throughout 1968.

In August, temperature and salinity were observed over a rectangular grid of approximately 80 stations covering the central Scotian Shelf. The grid was occupied three times during the month. Results indicated a high stability of water masses during the whole period.

The Halifax Section was monitored five times during the year, and the Gulf of St. Lawrence ice forecast survey was undertaken in November.

Detailed study of an inshore Bay (St. Margaret's) (4W) was intensified as part of a system production investigation. The sampling program is designed primarily to yield information on rate of exchange of Bay with outside water, circulation patterns within the Bay, and seasonal temperature and salinity distribution. The results indicate that partial flushing occurs intermittently within periods of a day or two. The degree, frequency, and relation to events in the approach area are of interest in the data analysis.

2. Benthic Studies. Sedimentological and geochemical studies of several parts of the Gulf of St. Lawrence were continued with increased emphasis on use of current meters in conjunction with sediment collections at selected sites. Mineralogical and geochemical analyses were concerned with sources and patterns of dispersal of sediments, and indicate the influence of glaciation and sea-level rise, relative to recent current patterns, wave actions, and ice-rafting. Significant chemical modifications of iron- and manganese-bearing sediments are still taking place in the sediment.

A physiographic chart of the lower Laurentian Channel and Gulf of St. Lawrence has been prepared and will extend the coverage provided by the US Geological Survey Chart of the Atlantic Seaboard from Florida to Nova Scotia.

3. Other Environmental Studies. Daily sea surface temperature and surface layer depth charts were prepared for Subareas 3, 4, and 5 from over 100,000 sea surface temperatures and 16,600 bathythermograph reports. The analyzed data were broadcast daily by Canadian Forces Maritime Command Weather Office, as radio facsimile. In addition, synoptic wave data charts were prepared and broadcast twice daily.

II. Biological Studies

1. Cod. A study of changes in the status of the southern Gulf of St. Lawrence cod stock since mesh regulation was introduced indicated that density-dependent changes, particularly in recruitment, had occurred. The Div.4T cod stock is surveyed each year by otter trawling, and the 1967 survey indicated a larger than usual 1964 year-class, which should enter commercial landings in 1968. However, a change of vessels used in the survey may have influenced results. Relative catching abilities of these units (R/V *Harengus* and *E.E.Prince*) will be tested in 1968.

Groundfish ecology studies in the southern Gulf of St. Lawrence included investigation of recruitment mechanisms for cod and other groundfish species, using a variety of catching gears, in egg, larval, and juvenile fish surveys.

Measurements and otolith collections from the commercial inshore fishery were obtained between June and September from Div.4R cod.

2. Haddock. Haddock of all sizes were scarce in catches of R/V *E.E.Prince* in Div.4W in July. Previous estimates that the pre-commercial 1964 and 1965 year-classes are small were confirmed. In addition, the 1966 year-class was poorly represented in survey catches.

Analysis of year-class strengths from 1943 to 1961, as represented in landings, showed the marked influence on the fishery of some relatively large fluctuations. Maximum number of fish landed from a single year-class appears to have been about 34,000,000 (excluding the recent USSR fishery in 1965). Minimum numbers were about 7,000,000.

3. Hake. Hake (*Urophycis tenuis*) were tagged in the eastern Northumberland Strait (4T) to study their distribution and movements. Of 2,270 individuals tagged in August, 378 (17%) had been returned by the end of December. Gradual movement away from the tagging area was indicated.

4. Pleuronectids. In the Sable Island region (4W) yellowtail flounder are infected by *Ichthyophonus*, a fungal epizootic. Photomicrographs indicate that there are often serious lesions in the liver, kidney, heart, mesenteries, and nervous tissue, sometimes leading to death. The build-up of fall fat also appears to be reduced by the disease, which could decrease winter survival.

5. Silver hake. The suggestion that the Georges Bank and Scotian Shelf stocks are separate populations has been investigated but no significant differences in morphometric or meristic characters have been found. A high incidence of gill disease, particularly in the more northerly stocks, has been discovered and is being investigated as a means of separating populations and as a factor in periodic fluctuations in abundance.

6. Sand launce. Catch records and records of launce in stomach contents of predators show that the fish is widely distributed in shallow water at all seasons (Fig. 1), occurs in local concentrations, and is an important food item to many commercial species, particularly cod. The fish matures in its second year and has a short, well-defined breeding season (December-January). Meristic counts indicate that the launce on the banks is *Ammodytes dubius*, although its large size and winter breeding season are not in accord with what is recorded elsewhere for this species.

7. Argentines. The spawning concentration of argentines in Emerald Basin (4W) was sampled on four occasions. Spawning had begun by mid-March, continued through April and May, reaching completion before the end of June. Length and age compositions and fecundity estimates were obtained from this stock.

Egg and larval surveys, using a 6-foot Isaacs-Kidd net, in Emerald Basin and off the edge of the adjacent Continental Shelf (4W-X) took small numbers of eggs below 100 fathoms throughout the area sampled, with no evidence of large concentrations.

Vertebral counts from various localities from Georges to St. Pierre Bank showed small variability, suggesting there is little separation into distinct stocks. However, variations in the species composition, incidence and intensity

of infestation of the intestinal parasites indicate the existence of separate populations of the fish host, and also furnish evidence of differences in distribution and feeding habits of the fish at different ages.

8. Food-resource division. Data analysis was completed for a study of food-resource division in a community of Passamaquoddy Bay (4X) fishes. There are four components of the fish community: summer seasonal fish species, winter seasonal fish species, non-seasonal or regular species, and occasional or uncommon species. The summer seasonals use major food-energy sources not utilized by the regulars. The winter seasonals and regulars utilize the same major food-energy sources.

9. Short-finned squid, *Illex illecebrosus*. A survey cruise of the *A.T. Cameron* studied the distribution and biology of the short-finned squid from 16 March to 13 April on the Continental Shelf and Slope from southern Nova Scotia to Cape Hatteras. Data were obtained on distribution, size, and sexual maturity of *Illex* in this area.

10. Redfish. Studies on the new, good year-classes in Div.4R-S-T are of particular interest as they followed a period of about eight years when the production of new year-classes of redfish in the area was negligible, and appeared at a time when the stocks of old redfish were almost exhausted.

In research vessel hauls in the Gulf of St. Lawrence in May, relatively few adult redfish had extruded their larvae and redfish larvae were scarce in plankton samples. A successful 1966 year-class of redfish was found with a modal length of about 8 cm.

11. Scallop. Surveys begun in 1966 on the Nova Scotia side of the Bay of Fundy were completed and revealed low abundance of scallops on the inshore beds. Most scallops were of an advanced age. The offshore beds in the Bay of Fundy support good populations of scallops, although these are unattractive to the inshore fishermen because of their small meat size and the distance of the beds from port. A survey of the Lurcher area (4X) was also completed. Present abundance is too low to support a fishery.

Underwater observations on scallop dispersion were continued in Passamaquoddy Bay, using Scuba diving techniques. Similar observations on the Richibucto beds (4T) concerned the role of swimming activity in reducing scallop drag efficiency.

12. Herring. Research was concerned chiefly with the effects of increased exploitation on the stocks, and 199 samples (29,517 fish) from the Bay of Fundy and Gulf of St. Lawrence were examined for size and age. Preliminary analysis indicates little change in these parameters during 1967. In southern New Brunswick (4X) stocks, consisting chiefly of juveniles (sardines), the 1965 year-class was predominant (69.9%) in landings until September when the 1966 year-class entered the fishery. From October through December, 71.4% of the fish examined were of this year-class. The 1963 and 1964 year-classes which had contributed most to the 1966 fishery, were relatively unimportant in 1967 (12.8 and 8.1% respectively).

Off southwest Nova Scotia (4X) both juveniles and adults contribute to the fishery. A slight increase in mean length and mean age is consistent with the continued dominance of the 1963 and 1961 year-classes.

Herring spawning surveys were carried out in Chaleur Bay during both spring and autumn spawning seasons. Spring spawning was light to moderate over a large inshore area on the south side of the Bay. Autumn spawning occurred in deeper water and later than usual, presumably as a consequence of abnormally high water temperatures early in the season. Examination of purse seine catches indicated that the major autumn spawning area was near Cape Gaspé.

Fecundity studies are in progress for all major herring stocks. Preliminary results show a mean of 55,000 eggs for 32.4-cm (mean length) herring from spring spawning stocks in Div.4T.

Condition (fatness) studies were continued and expanded to include the effects of temperature and feeding. Mean fat values ranged from 1.6 to 24.3% of

the wet weight. Lowest values were obtained from small herring (10-15 cm) in Div.4X during the spring. Highest values were from large herring (30-35 cm) in Div.4T during late summer and early autumn.

Basic principles of herring ageing techniques were examined. The results showed clearly that definition of spring and autumn spawned fish by means of otolith nucleus type (opaque or hyaline) is suspect. A by-product of this study was the inference that most problems of ageing older herring can be resolved by using both scales and otoliths from the same fish.

13. Mackerel. Investigations were continued by sampling commercial landings and by tagging. Mean lengths, ages, and weights from 1,764 individuals suggest three distinct groups of mackerel along the Nova Scotia coast (4V-W-X) during the summer. Spawning occurred from late June through July in the Gulf of St. Lawrence and in St. Margaret's Bay. The 1960 year-class predominated in early sampling, but the 1965 year-class became most important subsequently. Altogether, 1,607 tagged fish were released in two localities. Recoveries ranged from 1.2 to 9.2% and indicated an early season migration into the Gulf of St. Lawrence, and an irregular wandering thereafter.

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

15. Tuna. During the summer, 201 giant bluefin (182-273 kg) were tagged and released in St. Margaret's Bay. In addition, 309 individuals of various species (swordfish, tunas, and sharks) were tagged and released in offshore areas between Cape Hatteras and the Flemish Cap. In the Gulf of Guinea, 436 tunas (chiefly yellowfin and skipjack) were tagged and released. Twelve of the above tags were recovered plus eight from taggings in previous years. Included in the results were two giant bluefin tagged in Nova Scotian waters and recaptured off Massachusetts, providing the first direct evidence of a relationship between the stocks of these two areas.

16. Atlantic salmon. From 42,000 smolts tagged in 1965, 134 (only two as 2-sea-year fish) have been recorded from Greenland waters and 821 in Canadian waters (481 as grilse and 340 as 2-sea-year fish).

From 38,000 tagged in 1966, 76 were reported from Greenland by March 1968 and 286 were reported as grilse from home waters.

In 1967, the Fisheries Research Board liberated 63,000 tagged smolts in Maritime rivers and the Dept. of Fisheries about 50,000.

Studies of Atlantic salmon from the Little Codroy River, Newfoundland, indicate that, on the average, about 3.5% of the smolts survived. About 65% of the returning adults were taken by the commercial fishery, and the remainder, which represent about 1% of the migrating smolts, returned to the natal river.

III. Gear and Selectivity Studies

A combination of theoretical studies and fishing experiments has indicated that the catch of fish on the Scotian Shelf depends at least as much on changes in "availability" as on changes in abundance. Echo-sounding equipment, designed to measure the availability, was constructed at the Marine Ecology Laboratory. An operating field test indicated that the equipment is working according to expectation. The program is designed to provide information necessary in developing a fisheries information and forecasting service.

IV. Miscellaneous Studies

Studies of unfished populations hold many keys to the understanding of effects of fishing, but unfished natural stocks are almost unknown in temperate waters. The American plaice population of St. Margaret's Bay, which, from our studies in 1966-67, seems completely isolated from stocks outside the Bay, is therefore an almost priceless rarity. Measurements of population parameters show it to be unusually slow-growing, with low rate of reproduction and possibly a food-limited biomass density. Observations are continuing with the aim of testing hypotheses of productivity control.

Subarea 5

A. Status of the Fisheries

I. Cod

Landings of cod from this subarea were over 10,000 metric tons in 1965 and over 15,000 tons in 1966. However, landings in 1967 are expected to be lower than in 1966.

II. Haddock

Landings of haddock were 15,048 tons in 1965 and 18,960 tons in 1966. Landings in 1967 are expected to be lower than in 1966.

III. Scallop

Landings of scallops from Georges Bank of about 42,000 tons (5,040,000 kg meats) increased slightly over the 1966 catch of 41,000 tons. Most effort was concentrated on the northeastern edge of the Bank.

The number of vessels in the offshore fleet decreased from about 60 to 54, of which 48 fished regularly. There was no effort south of the Convention Area on the Virginia beds which produced 50% of the 1966 offshore fleet catch.

IV. Herring

Landings of herring were approximately 6,400 tons. Small herring, "sardines", from Div.5Y accounted for most of the catch, athough substantial catches of adults in Div.5Z were recorded for the first time.

V. Swordfish

Swordfish landings at 1,500 tons were about 500 tons less than in 1966. However, landings from Statistical Area 6 increased to about 570 tons (ca. 325 tons in 1966). Total landings in the two regions at 2,000 tons were about 250 tons below those reported for 1966.

VI. Tuna

There was no Canadian tuna fishery in Subarea 5. Incidental catches of several species of tuna by swordfishermen are included in the report for Subarea 4.

B. Special Research Studies

I. Biological Studies

1. Scallop. Scallop catch statistics continued to be collected from offshore fleet log records and catches were assigned to 10-min squares for Georges Bank. Collaboration and exchange of Georges Bank scallop data with the US Bureau of Commercial Fisheries continues.

2. Herring. Two samples of herring (200 fish) were obtained from the northern edge of Georges Bank in October, one from a purse seine and the other from a mid-water trawl catch. The length range of the former was 28.9 to 36.3 cm (mean 31.6 cm) and of the latter, 22.8 to 35.0 cm (mean 31.4 cm). Herring from these samples were not aged.

3. Swordfish. Research on swordfish was concerned with abundance estimates, distribution, size and age composition, food and feeding habits, sex, maturity, and migrations. Average number and total weight of fish caught per trip were substantially higher, but the mean size decreased about 7% to 125.5 lb (57 kg). The distribution of catches indicates a gradual expansion of the fishery offshore within the boundaries of the Gulf Stream. There were no recoveries of tagged swordfish during 1967.

Studies of food and feeding habits were completed and results presented for publication.

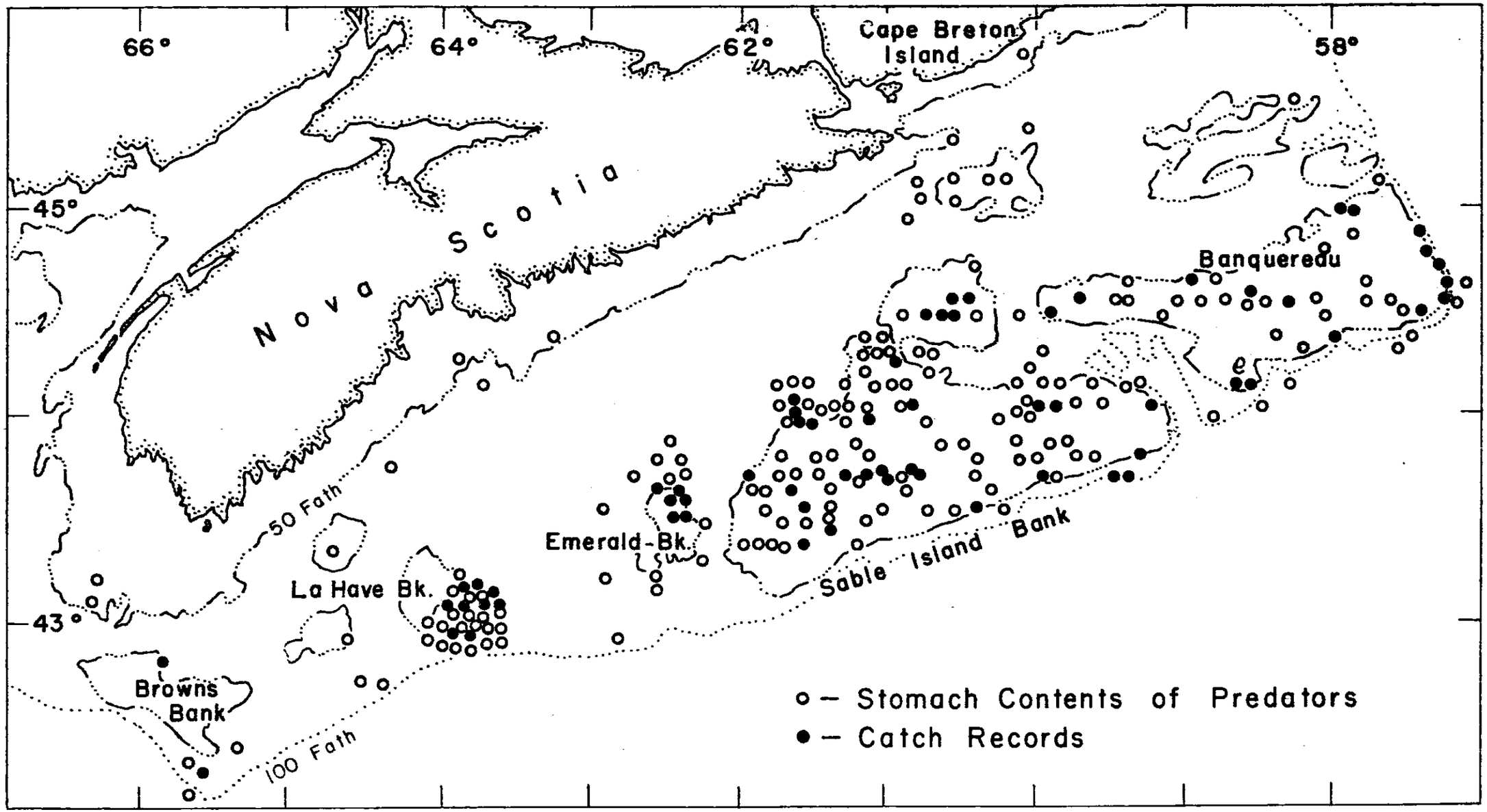

Fig. 1. Records of sand launce on the Nova Scotian banks (FRB research cruises 1956-67).

Subareas 2 and 3

A. Status of the Fisheries

Harp and Hood Seals

Canadian catches of harp seals were 31,000 young and 11,000 older animals or 42,000 in all; of hood seals, 655 young and 585 old, or 1,240 in all.

B. Special Research Studies

II. Harp and Hood Seals

(1) Age and ovary samples were collected from shore fisheries near St. Anthony, Newfoundland, and, through fishery officers, from a Canadian sealing vessel. Material was also analysed from a Norwegian sealing vessel (see Seal Panel Contribution No.1).

(2) Analysis of returns from capture-recapture marking (tagging) experiment in Subareas 2 and 3 was completed.

(3) Intermixing of one-year-old seals between Subareas 3 and 4 was studied from tag recoveries (see Seal Panel Contribution No.1).

(4) The survival rate of hood seals in Subareas 2 and 3 was studied from age samples collected before and after a lapse of 12 years (see Res.Doc.67/83).

Subarea 4

A. Status of the Fisheries

Harp and Hood Seals

Canadian catches in Subarea 4 were 96,000 harp seals taken by ships, aircraft and landsmen, of which 91,000 were young-of-the-year and 5,000 were older animals. Hood seals are fully protected by Canada in Subarea 4, but four were taken by landsmen at the northern border (see Res.Doc.67/86, Addendum).

B. Special Research Studies

II. Harp and Hood Seals

(1) Age-class survival and reproductive rate were monitored as indices of state of the stock.

(2) An aerial photographic survey was made of a herd of harp seals occurring in the northern Gulf of St. Lawrence.

(3) Study was made of behaviour of adult female harp seals with young.

(4) Juvenile hood seals were marked (tagged) (see Seal Panel Contribution No.1)