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A. Subareas 1, 2 and 3

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

The landings data for 1969 for Canada were not available at the time this document was being prepared and any landings data used are preliminary and for Newfoundland only and are only approximately similar to the data which will be reported to ICNAF in May-June.

Subarea 1

A. Status of the Fisheries

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

II. Biological Studies

1. Atlantic salmon, *Salmo salar* L. In the Labrador Sea - West Greenland area (2 September-10 October) 627 salmon were caught and 385 tagged. Most of the work was done in Disko Bay (about 69°10'N, 52°30'W). The lower ratio of fish tagged to fish caught relative to the Port aux Basques salmon tagging experiment, discussed later, was probably due to a combination of factors, including unfavourable weather, greater amount of gear used (longer time to patrol the nets) and greater susceptibility of salmon to injury during this time of the year. Recaptures to 31 December 1969 totalled 14, of which 13 were from West Greenland and 1 from northeast Newfoundland. The latter is the fifth Canadian recapture of a Greenland-tagged salmon, and the first such recapture in the year of tagging; all others being in the following year.

Size and age distributions were derived from 616 salmon from the Godthaab shore net fishery in 1968, and 627 fish taken by research vessel drift nets in 1969. In each year fish which had completed 1 year of sea life accounted for 96% of the samples, the balance being fish of 2 sea years and previous spawners. Fish of smolt ages 2 and 3 accounted for 75% of the 1968 sample and 80% of the 1969 sample; salmon of smolt age 2 were more numerous in 1968.

Average size at capture of 1-sea-year salmon declined with increase in smolt age. Overall average sizes for 1-sea-year fish and for all fish were greater in 1969 than in 1968 (average fork length for all fish sampled was 64.1 cm in 1968 and 67.0 cm in 1969). This was also true for each smolt class within the 1-sea-year group.

So far, 242 salmon caught off West Greenland have been analysed electrophoretically and classified according to 3 independent protein systems where qualitative differences are known to occur between North American and European salmon. The usefulness of these systems and their hereditary basis were evaluated in co-operation with the Swedish Salmon Research Institute in the years 1965-67. Two of the systems are located in the blood serum and consist of (1) a migration difference for one of the transferrin bands and (2) qualitative differences in the band pattern of the slow $alpha_2$-globulins. These systems are visualized by employing different buffer systems. The third difference, which proved reliable in only about 20% of the cases, is a slight but significant difference in the liver esterase zymograms. Evidently the enzymatic activity in the liver is correlated with type of diet or other environmentally controlled variation which is absent in young salmon reared under laboratory control.

The results of this investigation indicate that North American salmon make up 43% of the salmon stocks off West Greenland (most of the material was collected over a 10-day period in Disko Bay). However, this figure may vary considerably due to seasonal and annual fluctuations in stock composition. No apparent schooling of fish from the two continents could be detected, the salmon being distributed at random in the nets. A sample of 17 salmon caught in the south Labrador Sea roughly halfway between Cape Farewell and Labrador contained 11 (65%) fish of European origin.

The results of this investigation are substantiated by examination of mean smolt ages from scale readings where it was found that the means were significantly different between salmon classified as American and European, respectively. Also, a sample of tagged American salmon caught in Greenland waters was similar to those classified as American fish according to protein analysis. The higher mean smolt age in American fish verifies earlier results.

Further support to the protein studies was obtained from a comparison of the mean length of the fish, that of European fish being significantly higher. It was indicated that abundance and intensity of infestation of certain internal parasites were significantly different between the two samples.

Studies to determine if parasites might be useful to separate stocks of salmon caught on the high seas continued in 1969. Work was confined to parasites which earlier studies had indicated might be useful as biological tags. Emphasis was placed on the geographic distribution and abundance of the larval nematode *Anisakis* sp. and the adult tapeworm *Eubothrium crassum*. Two other species which also showed some promise, the tapeworm larvae *Hepatoxylon trichiuri* and *Tentacularia coryphaenae*, were very rare in salmon in 1969 and were omitted from the studies. A total of 1,426 adult salmon from 10 sampling stations, collected in the fall of 1968 and throughout 1969, was examined in 1969.

Studies on apparent differences in fluorescence characteristics of *Anisakis* larvae from Canadian and European fish continued. Specimens from the west coast of Scotland and the North Sea exhibited characteristics previously attributed only to North American *Anisakis*. This finding is consistent with biochemical studies which have shown that *Anisakis* larvae in salmon from both sides of the Atlantic belong to the same species.

Biochemically identified North American salmon in Greenland, 1969, contained significantly less *Anisakis* larvae than did biochemically identified European salmon. The former contained an average of 4.5 larvae per host while the latter contained 7.1 larvae. Similarly, the incidence of *E. crassum* was higher in North American salmon (23.8%) than in European salmon (13.4%). The abundance of *Anisakis* larvae and *E. crassum* in biochemically identified North American salmon conformed with their abundance in salmon tagged in Canada and caught in Greenland in 1969. These studies support biochemical techniques for identifying North American and European Atlantic salmon on the high seas and indicate that these parasites warrant further investigation.

In 1969 the intensity of infestation of *Anisakis* in Canadian stocks varied from 2.75 per host (East shore, Bay of Fundy) to 7.75 per host (Pack's Harbour, Labrador). Similar variations were observed in the 1968 data. With documentation of the abundance of *Anisakis* in North American salmon stocks in Greenland, identification of stocks which have been to Greenland seems possible. Preliminary analyses indicate that salmon caught in the Miramichi and Chaleur Bay areas harbour *Anisakis* populations very similar to those in North American salmon caught in West Greenland. Preliminary conclusions on data from stocks in the Bay of Fundy and Newfoundland areas await results of age determinations.

In the two years 1968-69 there was no change in the mean abundance of *Anisakis* in mixed populations of salmon in West Greenland. In 1968 there were 5.96 per host; in 1969, 5.97 per host. However, considerable annual variation in the abundance of *E. crassum* in Greenland is evident (17-55% infested).

In 1969 ultraviolet light was used for the first time during routine examination of Atlantic salmon viscera for *Anisakis* larvae. The technique, which causes the nematodes to fluoresce brightly, was formerly used by other workers to find parasitic nematodes in fish muscles. It was compared with standard searching procedures for *Anisakis* and found to be superior. Practically all larvae were found within the first six minutes of searching with ultraviolet light but a maximum estimate of only 26% of the larvae present were found during the same period with visible light illumination. Qualitative differences in fluorescence characteristics of different species of nematodes greatly simplified preliminary identification of the parasites. Of the two species commonly found in Atlantic salmon, *Anisakis* sp. fluoresced a brilliant bluish-white but *Contracaecum aduncum* larvae and adults fluoresced pale to bright yellow.

III. Gear and Selectivity Studies

Surface gillnets of different mesh sizes were fished at West Greenland and at Port aux Basques in Subarea 3. These were mainly of Ulstron twine, but some monofilament nets of 152-mm mesh were also used in each area. Highest catch rates at Port aux Basques were obtained with 114-mm and 133-mm Ulstron nets (other mesh sizes were 152 and 165 mm) and the 152-mm monofilament nets (about 2.4 salmon per mile of net per hour fished during the period 22 May-10 June). At West Greenland the monofilament nets outfished the best Ulstron nets (127 mm) by a ratio of 2.2:1. During a 10-day period of fishing in Disko Bay, catches by monofilament nets averaged 3.7 salmon per mile of net per hour fished.

Monofilament nets appeared to produce more viable fish for tagging. Condition ratings assigned as fish were being tagged in each area were higher on the average for monofilament nets than for Ulstron nets. From the fish tagged at Port aux Basques from Ulstron nets, the return was 33%; the return from monofilament nets was 47%.

Subarea 2

A. Status of the Fisheries

I. Cod, *Gadus morhua* L.

The Newfoundland-Labrador inshore cod fishery was a failure, producing only 4,200 tons compared with 17,900 in 1968 and 27,700 in 1967. This was due to lack of fish and not to lack of effort. The mean length of cod sampled in the coastal fishery of 2J decreased in the July and August samplings from 59 and 58 cm in 1960-64 to 56 and 53 cm in 1965-69.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic Studies. The standard section off Seal Island in southern Labrador was occupied in early August for the first time since 1965. See the research document on hydrography of the Newfoundland area for details (Res.Doc.70/36).

II. Biological Studies

1. Cod. The inshore Labrador cod landings were sampled at 2 localities in 2H and 3 in 2J in July-August. Thirty-six hundred and sixty cod were measured and 940 otolithed. Biological studies on cod and collection of catch statistics in selected areas were continued.

2. Harp seal. *Pagophilus groenlandicus* (Erxleben). Ice was almost completely absent in early March in the normal whelping areas of harp seals off southern Labrador, northeastern Newfoundland and in the southern part of the Gulf of St. Lawrence. Seals in Subarea 2 whelped near George's Island in Hamilton Inlet. There is strong evidence that a large percentage of seals moved from Subarea 4 to Subarea 2 to find ice for whelping.

Subarea 3

A. Status of the Fisheries

I. Cod

Canadian landings in Subarea 3 were not available when this report was written and only general accounts of the status of the fisheries can be given.

On the northern part of the northeast coast of Newfoundland in 3K the cod fishery was a failure as it was in Labrador. Many cod from this area spawn on the outer slopes of Hamilton Inlet Bank with the Labrador cod.

In 3L the yields of cod from traps and handlines were generally high during the summer and resulting landings were higher than for several preceding years. As occurred in 1968, for the remainder of the season yields from line gears were low because stormy weather prevented regular fishing, and non-appearance of squid in the coastal areas caused a shortage of bait for the fisheries.

On the east coast generally through new construction an increasing proportion of the inshore fleet is becoming more mobile and versatile in operating, and increased amounts of other groundfish species (Greenland halibut, plaice, witch and wolffish) are being landed in the longline and gillnet fisheries.

In 3Ps the inshore fishery was about at the same level as in 1968.

II. Haddock, *Melanogrammus aeglefinus* L.

Newfoundland haddock landings at about 2,450 tons, probably mainly from 3P, almost doubled the previous year's catch but were still at a very low level.

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

Newfoundland redfish landings from Subareas 4 and 3 increased by about 4,000 tons to 32,000 tons. Most of this catch was from 4R.

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

Newfoundland landings of American plaice almost all from Subarea 3 increased by 15,000 tons to 67,000 tons. This was due to increased effort. On the Grand Bank catch per effort of Newfoundland trawlers engaged in the fishery for American plaice in terms of kilograms per hour's fishing fell from 851 kg in 1956 to 499 kg in 1968.

Yellowtail flounder landings rose from 4,400 to 6,000 tons and witch flounder landings fell slightly from 6,700 to 6,100 tons. An analysis of research vessel and commercial catches indicates an apparent increase in abundance of yellowtails on the Grand Bank since 1961-62. This is coincident with a reduction in the haddock population but the relation between the two is uncertain.

Greenland halibut landings, mainly from the deep bays of the east coast of Newfoundland and almost all from Subarea 3, fell from 13,400 to 12,000 tons as the rich fishing ground of Trinity Bay became relatively unproductive because of overfishing by gillnets.

A further decrease is evident in the average catch of Greenland halibut per gillnet in Trinity Bay from 41 kg in 1968 to 23 kg in 1969.

Also, there was a decrease in the average catch of Greenland halibut per gillnet in Bonavista Bay from 53 kg in 1968 to 21 kg in 1969.

The average length of Greenland halibut caught in commercial gillnets in Trinity Bay has decreased since 1966; the average for males caught decreased from 59.1 cm in 1966 to 56.2 cm in 1969; the average for females decreased from 62.2 cm to 59.8 cm in the same period.

Most of the Greenland halibut fishery during 1969 was carried out in Notre Dame Bay and vicinity.

V. Herring, *Clupea harengus* L.

Herring landings in Newfoundland almost all from Subarea 3 rose by about 28,000 tons to 168,000 tons. Most was taken in winter-spring and was the result of increased effort.

In the autumn of 1969, despite a substantial increase in the number of seiners, the herring fishery had a slow start both at Magdalen Islands in November and subsequently along the south coast of Newfoundland. Landings for July-December 1969 totalled 51,000 tons compared with 60,000 tons in October-December 1968. Unusually high water temperature conditions which prevailed throughout the fishing areas to the end of December undoubtedly inhibited the concentration of herring into schools and their movement into the fjords where they can be fished more readily by seiners than offshore.

VI. Atlantic salmon

Newfoundland landings of Atlantic salmon from the commercial fishery (total of Subareas 2, 3 and 4), at 1,440 tons were the same as those of 1968.

VII. Capelin, *Mallotus villosus* (Müller)

Newfoundland landings of capelin of 3,300 tons and mainly from Subarea 3 were at the same level as in 1968.

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

Squid were again extremely scarce as in 1968 with only 22 tons being recorded.

B. Special Research Studies

I. Environmental Studies

1. Hydrographic Studies. The five standard sections across the continental shelf and Labrador Current which, apart from the St. John's-Flemish Cap section had not been taken since 1965, were occupied again at the usual times in July-August using the Department of Fisheries and Forestry vessel, *Cape Freels*. The results of these sections are presented in a separate document (Res.Doc.70/36).

During the 1965-66 season 13 hydrographic stations were established about 5-10 nautical miles offshore along the south coast from Fortune Bay to Port aux Basques to observe the seasonal pattern of surface to bottom water temperatures and its relationship to the distribution and availability of herring along the coast. The stations were occupied in February and March 1966 and not again until the autumn of 1968. Subsequently the stations were occupied periodically between October and February by the *Investigator II*.

Normally, water temperatures in late November and early December range between 3 and 4°C in the upper 80 m, decreasing to about 1.5°C at 140 m and increasing to about 4°C at 220 m. By January temperatures range between 1.5 and 2°C from the surface to 140 m and increase to 4 to 5°C at 220 m.

During November and December water temperatures ranged from 5 to 6°C in the upper 90 m, decreased to 1.5 to 2.0°C at 140 m, and increased to the usual 4 to 5°C at 220 m. These unusually high late autumn and early winter water temperatures along the south coast probably caused the herring to remain outside the fjords and thus made it more difficult for seiners to locate and catch them.

In conjunction with the geologists a north-south oceanographic section across the Newfoundland Basin and running south into the Sargasso

Sea was occupied using the Bathysonde. This line was chosen because it crossed several different water masses which will enable correlation to be made between the water masses and data on plankton distribution in the water and sediments collected by geologists.

2. Plankton Studies. Plankton surveys were carried out in Cabot Strait, on St. Pierre Bank and along the south coast of Newfoundland as part of a program aimed at establishing where the various components of our coastal zooplankton originate.

4. Other Environmental Studies. The general navigational charting program of AOL along the east coast of Newfoundland was continued. The Sir Charles Hamilton Sound Survey was completed in 1969. Charting of the eastern approaches to Fogo Island was continued.

II. Biological Studies

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

In the inshore cod of 3L, recruitment to the fisheries has been fairly regular for the past few years although there are some regional differences in the contribution of the year-classes. Traps first catch the faster-growing 4-year-olds. These (1965 year-class) were strongly represented in trap catches at St. John's but were not numerous in other areas. Most of the cod caught by traps in areas studied were of the 1964 year-class, which was dominant in handline catches and present as smaller fish in the longline catches. Longline and gillnet catches were dominated by fish of the 1961 and 1962 year-classes.

Increased catches in traps during 1969 are attributed in part to growth of fish of the 1964 year-class, large quantities of which were discarded as undersized in 1968.

A cruise of the *A.T. Cameron* to the Avalon Channel-northern Grand Bank, 20-29 October (using a No. 41-Yankee otter-trawl with a 24.1 m headline) investigated the abundance of cod in this area before the survivors of the inshore fishery were forced by cooling coastal waters to retreat to neighbouring offshore deepwater areas. Sets were made on lines of fishing stations in depths generally ranging from 75 to 230 m, and extending from the northern edge of the 90-m plateau of the Grand Bank, across the Avalon Channel and over the northern edge of the bank. No concentrations of cod were found at any depths. The only catches over 230 kg per 30-minute haul were one of 270 kg in 200 m (-1.1°C) and another of 380 kg in 255 m (-0.3°C) on the slopes off Trinity Bay. No age-group was particularly strong.

During March a cruise of the *A.T. Cameron* was made to St. Pierre Bank to determine the abundance of young cod. Average catches were 220 and 266 fish per 30-minute drag on two lines on the northern part and 281 and 118 fish per 30-minute drag on two lines on the southern part. The 1967 year-class was not abundant.

In two cruises of the *A.T. Cameron* to the eastern part of the Grand Bank (ICNAF Division 3N) in May and June, cod of the 1966 year-class (3-year-olds), with peaks at 39-44 cm in the length frequencies, dominated the catches. Best catches per 30-minute drag were obtained in 230 m (1,455 fish, 1,700 kg) on the earlier cruise and in 180 m (3,187 fish, 1,900 kg) on the later cruise. Catches of 2-year-old fish were small.

During a cruise to Divisions 3N and 30 in November, catches of all sizes of cod were extremely low. In Division 3N in a total of 11 sets on two lines, the best catch was 248 fish (150 kg) per 30-minute drag in 275 m, and in Division 30 the best catch was 17 fish (23 kg) per 30-minute drag in 75 m in a total of 12 sets. Cod with peaks in the length frequency at 33-35 and 42-44 cm (2- and 3-year-olds) dominated the catches. Catches of 1- and 2-year-olds were small indicating that the 1967 and 1968 year-classes are probably not good.

Mesh assessments on cod from ICNAF Division 2J using data from 1964-68 indicated long-term gains of only 6% or less to the otter-trawl landings and 8% or less to the total landings unless M was as low as 0.10, which is unlikely. If M were as high as 0.30, long-term losses would have occurred at 152-mm mesh size for total landings and at both

140-mm and 152-mm mesh for otter-trawl landings. Immediate losses to otter-trawl landings ranged from 7 to 37%.

An assessment of changes in cod landings which would have occurred off eastern Newfoundland (ICNAF Divisions 3K and 3L) during the period 1964-68, if increases in the mesh size of otter-trawl codends had been made, has been completed. The current codend mesh size in use is 114 mm. If the mesh size had been increased, there would have been immediate losses to the otter-trawl fishery, but long-term changes would have been beneficial to all sections of the fishery, including the otter-trawl fishery. If the instantaneous natural mortality had been as high as 0.30, the optimum mesh size for the otter-trawl fishery would have been 140 mm, but for the fishery as a whole, the optimum size would have been 152 mm. If the instantaneous natural mortality had been 0.20 or lower, the optimum mesh size for all sections of the fishery, including the otter-trawl fishery, would have been 152 mm.

For Divisions 3N and 30, long-term gains in landings with increases from 110-mm to 140- and to 152-mm mesh were predicted for both 1959-62 and 1963-66. Immediate losses were 10-13%.

For Division 3Ps significant long-term gains to the total landings during 1964-68 were predicted even at 152-mm mesh (9-30%) whereas for otter-trawl landings significant gains would only have been realized if M had been between 0.20 and 0.30. Immediate losses ranged from 5 to 24%.

2. Haddock. During November, haddock were found to be extremely scarce on the southwestern slope of the Grand Bank. In 12 thirty-minute otter-trawl sets of the *A.T. Cameron* only 54 haddock were caught, all of them being large commercial size. Indications are that survival from the 1967 and 1968 year-classes is extremely low and no commercial fishery is possible for the near future at least.

Haddock of the 1966 year-class, with length-frequency peaks at 34-35 cm and 40-41 cm, on two lines on the southern part of St. Pierre Bank, comprised almost the entire research vessel catch of haddock in March. The 1966 year-class was much less abundant on the northern part of the bank, catches being

36 and 87 fish per 30-minute drag on two separate lines as compared with 209 and 376 fish per 30-minute drag on two lines on the southern part. The 1967 and 1968 year-classes seem to be almost complete failures.

3. Redfish. An echo-sounder survey accompanied by baited handline fishing revealed large numbers of redfish, *Sebastes mentella*, almost continuously distributed from a position approximately midway between Labrador and Greenland to the Labrador continental shelf. An attempt at using vertical longlines with herring and capelin for bait (a total of 8 lines extending from the surface to 550 m over water greater than 2,700 m in depth) was not successful and only one redfish was taken at a depth of about 275 m. However, handlines baited with herring, capelin or myctophid lanternfishes proved very successful at catching the redfish and on one occasion 5 redfish were taken on the 6 hooks of the line. These redfish were usually within the 140-275 m depth zone and continued to appear at these depths on the echo sounder and to be caught at these depths even when the ship was over the shelf at a depth of 550 m quite close to the position where previously we had fished a No. 41.5 otter trawl on the bottom.

In an *A.T. Cameron* trip from Newfoundland to Greenland and back in September and October an echo-sounder survey was carried out to examine the extent of the pelagic population of redfish. The echo sounder was run practically continuously over both the outward and inward tracks and showed recordings exactly similar to those obtained in the August trip to the Labrador Sea when the recordings were confirmed as redfish by handline fishing on at least seven different occasions. In addition, on one occasion on the outward trip to Greenland, handline fishing confirmed the recordings as redfish.

These results indicate that in areas off Labrador and on the northeast Newfoundland Shelf the pelagic population is not spacially discrete from those redfish which inhabit the edge of the coastal banks and which are the basis for the commercial redfish fishery. With redfish undertaking the vertical movements that they are known to make both diurnally and seasonally, it is difficult to escape the conclusion that the pelagic stocks are mixing with the bank-dwelling stock. The extent of this mixing and the possibility of replacement of the slope stock by individuals from the pelagic stock assumes importance.

4. American plaice. Comparison of the growth curves for 1953-56 and 1965-68 of American plaice landed by commercial trawls indicates, on the average, an increase in the size at age of about 5-6 cm for the northern half of the Grand Bank and 8-9 cm for the more southerly areas of the bank. These increases would seem to indicate negative correlation between the rate of growth and the population size or density. The catch per effort by Newfoundland trawlers of American plaice on the Grand Bank in 1968 was only about 60% that of 1956, indicating a considerable decrease in the standing stock of American plaice. Additionally, there probably has been a reduction in the size of the cod population along the seaward slope of the bank because of the big increase in the total effort for that area. Plaice and cod both feed on capelin and sand launce at certain periods of the year so that a reduction in both the numbers of plaice and cod reduces competition for these two items of food.

5. Greenland halibut. A gillnet survey using 155-mm, 178-mm and 203-mm monofilament gillnets was conducted in Fortune and Hermitage bays and Bay D'Espoir during September 1969. No catches of commercial amounts were obtained in any of the three bays, the largest catch being 130 kg from 9 gillnets in a depth of 480-490 m and bottom temperature of 0.60°C in Fortune Bay.

Two hundred and thirty-eight Greenland halibut were tagged in White Bay during October 1969. One return from Notre Dame Bay indicated that this fish had migrated about 75 nautical miles in a period of 2 months.

6. Herring. Investigations to elucidate the size, distribution and migratory pattern of the herring stocks which contribute to the autumn and winter purse-seine fishery were intensified in 1969. Efforts were continued to improve the collection of information on area of capture through log book records and port interviews of seiner captains. Sampling of seiner landings was carried out at Harbour Breton and Isle aux Morts. About 8,000 specimens were examined for length, weight, sex, maturity, nematodes and meristics, and the otoliths taken for age determinations. Length, sex and maturity were recorded for an additional 3,000 herring.

Age determinations are as yet incomplete, but length composition data for 1968-69 from the area between Port aux Basques and Hermitage Bay reveal that the mode was at 33 cm compared with 32 cm for the 1967-68 season. Over 95% of the herring were within the 30-36 cm size range. As in earlier years the composition of samples by maturity stages indicates a mixture of spring and autumn spawners, the latter comprising about two-thirds of the catches. Immature herring were rare in the samples.

The monthly distribution of catches along the south coast of Newfoundland indicate that herring arrive from the westward in late November and within a few days are distributed widely in the fjords between Burgeo and Bay D'Espoir. After January the fishery gradually shifts westward and the last catches for the season are usually made off the southwest corner of Newfoundland in April. About 3-4 weeks prior to the appearance of herring in south coast waters, there is a fairly intense fishery at Magdalen Islands and Bird Rocks. Also, about 1-2 weeks after the herring disappear from the south coast in April, a short spring fishery occurs at the Magdalen Islands again, and this is followed by a substantial summer fishery in the southwestern part of the Gulf of St. Lawrence.

In September 1968 and again in October 1969 the *Investigator II* carried out larval surveys using Isaacs-Kidd midwater trawl along the south coast between Fortune Bay and Port aux Basques, extending up to 25 nautical miles offshore. While capelin larvae were numerous in the catches, very few herring larvae were caught, indicating that late summer and early autumn spawning in the area is insignificant, if it exists at all. Thus the south coastal waters cannot be considered a major spawning area for the great numbers of autumn-spawning herring which subsequently over-winter in the fjords there.

During 1969 moderate herring spawning occurred in Fortune Bay (south coast) and in St. Paul's Bay (west coast) in May; an extensive spawning occurred in St. George's Bay on the west coast at intervals from late April to early June. There was a report of autumn spawning in St. John Bay on the northwest coast. The occurrence of some maturing herring in samples taken in mid-August in southern Labrador coastal waters and near Conche in northeastern Newfoundland indicates that either some late summer or autumn spawning occurs in the northeastern Newfoundland or southern Labrador areas, or the ripening herring were migrants from the Gulf of St. Lawrence where autumn spawning is known to occur.

A quantitative study of spring spawning aimed at estimating the size of the spawning stock from egg deposition was planned for 1969. On the basis of previous spawnings in the area, and accessibility, St. Mary's Bay was selected as a preliminary study area. However, herring were very scarce in comparison with previous years. This is attributed to the heavy mortality of herring in Placentia Bay in the winter and spring as a result of phosphorus poisoning. The occurrence of "red" herring in St. Mary's Bay early in the spring indicated a migration of the stock from Placentia Bay to St. Mary's Bay. As a result of the decreased abundance of herring only a relatively small amount of spawning occurred in late May and early June and this was restricted to Colinet Arm. A series of bottom grabs with a Petersen dredge revealed that spawning took place over rocky bottom in depths of from 4 to 9 m; small quantities of eggs were washed up on the shore. Spawning occurred at bottom temperatures between 3 and 5°C.

7. Capelin. Beach spawning of capelin at Middle Cove near St. John's was characterized by an early start (14 June) and a premature end (27 June). This is attributed to high and rapidly rising surface temperatures near the beach which were 6°C on 11 June and in excess of 9.5°C on 27 June. Spawning was observed again on 5 July when surface temperatures at the beach had dropped to 8.9°C, and sporadic spawning was reported up to 11 July when the surface temperatures had reached 10°C. Temperatures of the exposed egg-bearing sand were also very high and by 27 June had reached 18°C at a depth of 15 cm. These high temperatures undoubtedly caused a rapid hatching of the capelin eggs in and on the sand as capelin larvae were caught on 27 June, less than two weeks after the first spawning. The first catch of capelin larvae in 1968 was made 4 weeks after the first spawning. Capelin eggs were observed in the sand at Middle Cove up to 5 August and the last catch of recently hatched capelin larvae, i.e. larvae with yolk sacs, in this cove was on 14 August. Surface temperatures were then 13°C.

As part of a research project initiated in 1967 the research vessel *A.T. Cameron* carried out an annual survey of the Southeast Shoal of the Grand Bank from 19 June to 2 July to determine the distribution, abundance and spawning characteristics of capelin in the area.

Previous annual cruises to the Southeast Shoal in 1967, 1968 had been unsuccessful in that bottom-spawning had been completed by the time the cruises began. However, in 1969 large bottom concentrations of spawning capelin were detected by echo sounder mainly on the southern, western and northwestern parts of the shoal and catches up to 2800 kg were obtained. These catches consisted mainly (80-98%) of spent or partly spent male capelin with fat contents ranging from 2.6 to 1.3% and were obtained in bottom depths ranging from 44 to 55 m. Bottom temperatures in the spawning localities ranged from 3.1 to 4.5°C, although on the northeastern and eastern portions of the shoal where no spawning concentrations were located bottom temperatures as low as 0.2°C were recorded. Spawning had begun before 20 June as was evidenced by the capture of live spent capelin on that date a considerable distance north of the shoal. Although dead capelin were quite numerous on the Southeast Shoal by 1 July, the capture of male capelin with developing spawning ridges and female capelin with maturing eggs in late June indicated that spawning would probably continue until mid-July. Capelin larvae were not present in any of the plankton hauls that were made in the Southeast Shoal area indicating that hatching had not yet begun.

8. Atlantic salmon. At Port aux Basques (2 May-10 June) 270 salmon were caught by drift nets and 247 (91.5%) were tagged. The high proportion tagged was made possible by continuously patrolling the nets in a small boat. Returns to 31 December 1969 totalled 90 (36.4%); this is almost triple the rate of return from a similar experiment in the same area in 1937. The returns were distributed as follows: West and southwest Newfoundland, 24%; Miramichi river and drift net fisheries, 39%; Chaleur Bay, 12%; Quebec North Shore, 17%; Gaspe Peninsula and Anticosti, 5%; Nova Scotia, 3%. About 20% of the returns were from angling.

In 1968, 3,009 smolts in Salmonier River, St. Mary's Bay, Newfoundland, were tagged with an internal anchor tag inserted into the body cavity. This is the last of a series of experiments designed to develop an easily applied smolt tag. The returns as grilse in 1969 were 29 or 0.96%. Of these 16 were angled in Salmonier River and 13 were caught in the commercial fishery (11 in salmon gillnets and 2 in codtraps). The recaptures were quite local being distributed from Trinity Bay (southern part of Newfoundland east coast) to Placentia Bay (immediately west of St. Mary's Bay). Not one was taken in a river other than Salmonier and only six were reported from outside the St. Mary's Bay area.

9. Pink salmon, *Oncorhynchus gorbuscha* (Walbaum). Returns of pink salmon in 1969 were the progeny of the 5,334 pink salmon which had been allowed to spawn naturally in North Harbour River in 1967. The egg deposition from these fish was estimated at 4,400,000.

The run of pink salmon into North Harbour River in 1969 extended from 20 July to 2 October with the peak on 8 September, a week or more later than other years. There were 992 pinks counted at the fence and 124 below the fence giving a total of 1,116 in 1969 as compared with 1,353 in 1968 and 5,334 in 1967. Most of the spawning took place between 15 and 20 September, and was distributed over 5.8 km of the main river and 0.8 km of a tributary, Cataract Brook. There were 584 females in the spawning run giving an estimated egg deposition of 0.9 million. After spawning, 580 redds were counted.

In addition to the returns to the parent stream of North Harbour River, 425 were reported from 11 other rivers, 2 were taken in the sport fishery in salt water, and 1,060 were caught in the commercial fishery giving a total return of 2,603 fish in 1969 as compared with 2,426 in 1968 and 8,500 in 1967. Of all the known returns in 1969 only 56% were in the St. Mary's Bay area whereas the percentages in this area were 91 in 1968 and 78 in 1967. Better homing was expected of the adults in the 1969 spawning run because they were the offspring of parents that spawned naturally in North Harbour River in 1967.

From egg samples placed in plastic cases in the gravel of the main river, the time of eyeing and hatching and survival rates were determined. The time of eyeing was 25 October in 1968 and 15 October in 1969. The hatching period was 9-20 December in 1968 and 5-9 December in 1969. Rate of survival was 80%, 24 April 1969 and 87%, 8 April 1968. (Comparable rates

for Atlantic salmon in this river were much lower, namely 51% and 47% respectively.)

The downstream migration of fry in 1969 started 17 April, reached a peak 29-30 April, and ended 12 May. By the mark-and-recapture method the estimated number at the mouth of the river was found to be 860,000 which is 76% of the estimated egg deposition in 1968. In 1968 nine females spawned in the controlled flow egg channel and in 1969 the number of fry leaving the channel was 11,000 by actual count which is 78% of the estimated egg deposition. The three methods of determining survival rates gave remarkably similar results, namely 76%, 78%, and 80%.

The seaward migration of fry was followed by visual observations in the river and in St. Mary's Bay. They were seen in the river from 18 April to 6 May and in St. Mary's Bay from 10 June to 10 July. There were 22 sightings and the estimated number seen was around 30,000. All of the fry seen were within 0.3 to 15 m from the shore and from the surface to a depth of 2.5 m. The greatest distance from the mouth of the river where fry were seen was 35 km on the west side of the bay.

B. Subareas 4 and 5

by J. S. Scott

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, the Arctic Biological Station (Ste. Anne de Bellevue) 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 (Grande-Rivière) 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. Preliminary statistics of landings used in reporting on the status of

the fisheries were in part obtained and compiled by the Canadian Department of Fisheries and Forestry. 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

Mainland landings were down about 6 percent from 1968, but constituted about 38 percent of the total weight of groundfish landed. Landings from the Gulf of St. Lawrence and Cape Breton areas (Div. 4R, 4S, 4T, and 4Vn) continued the upward trend since 1967; those from Nova Scotia Banks and Georges Bank (Div. 4Vs, 4W, 4X, and 5Z), which had increased in 1968, were down slightly below the 1967 level. These changes can be partly attributed to a diversion of effort from the Nova Scotia Banks to the northern Gulf of St. Lawrence (Div. 4R and 4S), particularly by otter trawlers of 150 gross tons and upward. Sizes and ages of cod from Division 4T changed slightly in 1969. The 1964 year-class, now 5 years old, was still dominant, confirming predictions that it was above average size.

II. Haddock

Total landings declined about 14 percent from 1968 levels and about 23 percent from 1967 levels. Poor recruitment in recent years has been a contributing factor in the decline. The last good year-class in 1963, together with the 1962 year-class, has sustained the fishery since 1967, but with diminishing returns. More than 95 percent of the haddock landings on the Canadian mainland are from Divisions 4W, 4X, and Subarea 5. The lower abundance of haddock in these areas tended to divert the larger, more mobile units to other

*The preliminary figures for 1969 in this report are based on actual landings by the mobile fleet (vessels over 25 gross tons) and estimated inshore landings.

areas and other species, thus further decreasing haddock landings.

III. Flatfish

Total landings (plaice, witch, yellowtail, winter flounder, and Greenland halibut) were up 6 percent from 1968 and only slightly below the 1967 landings. Increases and decreases in the various Divisions appear to reflect changes in effort rather than changes in abundance.

Atlantic halibut landings at 1,374 metric tons declined 26 percent from 1968 and 33 percent from the 1967 landings of 2,060 metric tons.

IV. Pollock

Pollock are caught mainly in Divisions 4W and 4X and Subarea 5. Landings have remained relatively stable over the past 4 years at approximately 16,000 to 18,000 tons per year.

V. Redfish

The rising trend in redfish landings, begun in 1963, continued into 1969. Increases were registered in all areas and divisions except 4Vs. Approximately 85 percent of the Canadian mainland landings were taken in the Gulf of St. Lawrence (Div. 4R, 4S, and 4T).

VI. Other groundfish

Other groundfish include hake, cusk, wolffish, skate, angler, and any of the common groundfish species not recorded by species name. Together they comprise about 5 percent of the total landings. Cusk and hake are of importance to the inshore fisheries in several locations but generally are taken as incidental catches and do not vary much from year to year.

VII. Sea scallop, *Placopecten magellanicus* Gmelin

Total landings of scallops dropped by about 20 percent from the 1968 figure to 9,900 metric tons whole weight (1,200,000 kg meats). The inshore fishery accounted for

79 percent of the catch, the largest fraction coming from 4T. 4T produced 5,320 tons; 4X 2,267; and 4V and 4W together produced 198 tons. Landings by the offshore fleet from 4X (Browns Bank and Lurcher) decreased slightly from 1,300 metric tons in 1968 to 1,200 tons in 1969. However, a new area was fished in 1969 in 4W (Western Bank) and produced 923 tons, 44 percent of all offshore landings from Subarea 4.

VIII. Herring

Landings in Subarea 4 (excluding Div. 4R) amounted to 319,000 tons, a decrease of 58,000 tons (15%) from the record landings of 1968. In Division 4T landings (143,000 tons) were nearly 50 percent greater than they were in 1968. This increase was more than offset by smaller landings in Division 4X where landings decreased from 280,000 tons in 1968 to 170,000 tons in 1969. In Division 4W (6,200 tons) landings were higher than in 1968, and in Division 4V (225 tons) they were lower.

IX. Swordfish

Canadian landings for all ICNAF areas amounted to 4,300 tons in 1969. This is only slightly (3%) less than the amount landed in 1968 but continues the downward trend which started immediately after the first full year (1963) of longlining for swordfish. Data processing is incomplete but the proportion of the catch taken in Subareas 5 and 6 was approximately the same (50% each) as in 1968. The combined catch for Subareas 3 and 4 is also unchanged but, in contrast to the previous year, most of it came from Subarea 3. There was no appreciable change in either fishing effort or size composition during 1969. However, the high proportion of small swordfish in landings from some areas is cause for concern about the future of this fishery.

X. Mackerel, *Scomber scombrus* L.

Mackerel landings in Subarea 4 (excluding Div. 4R) amounted to 12,800 tons, an increase of 2,000 tons (19%)

over 1968 landings. Landings along the southwestern part of the Atlantic coast of Nova Scotia (Div. 4W and 4X) were substantially (75%) higher than they were in 1968 and there was a smaller but significant increase in Division 4V from 1,770 tons in 1968 to 2,080 tons in 1969. In the Gulf of St. Lawrence (Div. 4T and 4S) however, landings decreased from 5,000 tons in 1968 to 3,700 tons in 1969. The difference in landings for the two years may be more a reflection of a change in fishing effort, particularly in relation to the herring fisheries, than a change in availability of mackerel.

XI. Tuna

Total Canadian landings of tuna in 1969 amounted to 1,300 tons of which 900 tons were mixed yellowfin and skipjack from the eastern Pacific and the Gulf of Guinea. The remainder (400 tons) was made up of several species (unidentified) landed incidentally by swordfish fishermen and small quantities of giant bluefin taken by traps in St. Margaret's Bay (Div. 4X). No details are available.

XII. Sharks

Incidental landings of porbeagles (*Lamna nasus*), mako (*Isurus oxyrinchus*), and hammerheads (*Sphyrna* sp.) amounted to 7.5 tons as compared to 11 tons in 1968.

XIII. Atlantic salmon

Total catch (commercial plus angling), exclusive of Div. 4R, declined to 670 metric tons, compared to 804 tons from the same areas in 1968. Commercial catches decreased by 10 to 20 percent in Divs. 4S-W and by 60 percent in 4X (catch 31 tons) where special restrictive measures were applied to the principal fishery. The angling catch (167 tons) was 25 percent higher than in 1968. Grilse comprised 60 percent of numbers caught by angling.

B. Special Research Studies

1. Environmental studies

1. Hydrographic studies. Investigations of seasonal changes in surface axial and cross channel tidal streams and their relationships to internal tides were continued. Data were collected from seven strings of three current meters each, moored at 10 km intervals along the axis of the St. Lawrence estuary (4T) at the end of April and again in late September and early October. Studies of salinity and temperature distribution and evolution of heat budget were carried out in Chaleur Bay.

Gyre studies in the southwestern part of the Gulf of St. Lawrence included a two-week survey in the Gaspe-Bradellé drogues to determine surface circulation features.

The ice forecast survey (Div. 4R, 4S, 4T) consisting of standard oceanographic stations was undertaken in November.

The Scotian Shelf (Div. 4X, 4W) oceanographic and moored buoy program, initiated in 1967, was discontinued early in 1969. The Halifax Section was monitored five times.

Detailed study of St. Margaret's Bay--division 4X--continued in 1969.

Studies of circulation of surface-bottom waters over the continental shelf from Bay of Fundy-Gulf of Maine to Newfoundland and Labrador continued. An exceptionally strong surface southwesterly drift (7-9 miles per day), intensified by strong easterly winds, was evident in Gulf of Maine in winter 1969. It had subsided by spring. Accumulated data from the lower Laurentian Channel indicate a northerly bottom drift along the western slopes of St. Pierre Bank (3P).

Surface temperatures along the Canadian Atlantic coast were generally warmer than in 1968 and above the long-term averages at all seasons. In the deep waters of the Gulf of Maine, the intrusion of relatively warm and highly saline waters, which started in late winter of 1968, persisted until the beginning of 1969 but had regressed by spring. The temperature of the warm, deep layer in Cabot Strait increased from about 4.3 C in 1966 to 5.4 C in 1969.

Runoff conditions and flushing times in the Miramichi estuary (4T) were studied in connection with pollution and salmon movement.

2. Plankton Studies. Zooplankton surveys were carried out on the Scotian Shelf, Cabot Strait and off the South Coast of Newfoundland to determine where the various components of the coastal plankton originate.

A special effort was made to determine herring spawning areas along the Scotian Shelf.

3. Miscellaneous. The Navigational Charting program in the eastern half of the Gulf of St. Lawrence (Div. 4R, 4T) was completed in 1969.

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

II. Biological Studies

1. Cod. Survey cruises for eggs and larvae (4T) were continued in connection with recruitment studies.

Study of population changes in cod stocks in southern Gulf of St. Lawrence (4T) continued. Sampling of commercial landings showed average sizes slightly larger than in 1968, with 4- and 5-year-olds dominant. Tagging confirmed that fish move seasonally from Magdalen Shallows (summer) to Laurentian Channel (winter).

2. Haddock. Results of research cruises in 4X and 4W indicate that recruitment to the fishery remained low and that the 1968 year-class is poor. Tagging in

eastern Bay of Fundy (4X) indicates that there is a small stock of resident fish there but that the summer fishery in this area is based mainly on fish which migrate to Browns Bank area for winter and spring months.

3. Silver Hake. Monitoring of incidence and intensity of gill disease in 4V, 4W, 4X continued. The intensity remained very low in both adults and in the juveniles which formed the bulk of the catches.

4. Northern Sand Launce. Morphometric differences have been determined in groups of launce from different areas. Their relationships to environmental factors are being studied.

5. Argentine. Sampling for fecundity studies was completed.

6. Mesopelagic Fishes. Collecting was terminated and the results were analysed. Age, growth and vertical distribution of the dominant species, *Benthosema glaciale*, were studied. A diurnal vertical migration from centres of distribution at 250 fathoms by day to 25-50 fathoms at night was indicated.

7. Flatfish. A study of niche diversity in grey sole (witch flounder) in the Scotian Shelf was completed. The species occupies three diverse ecological niches during its development: (1) egg and pelagic larval phase of up to one year; (2) deepwater phase--metamorphosing fish settle as juveniles in 100-250 fathoms; (3) shallow water phase--young adults move onto the banks.

Monitoring of intensity and incidence of liver disease and parasite infestation in yellowtail flounder continued.

8. Food Resource and Digestion Rates. Studies of food resource division continued in Passamaquoddy Bay and were extended to include comparison with Arctic assemblages at Dease Strait, N.W.T.

Experiments on rates of gastric emptying in young cod indicated that the rate increases with acclimation temperature to about 15 C but is subsequently reduced. Rate of emptying is proportional to volume of food in the stomach. Continuing study of seasonal changes in gross energy content of major natural fish foods indicates material from Passamaquoddy Bay is not as rich as that from St. Margaret's Bay. Ecology of common species of Cumacea, Mysidacea and shrimps in relation to predation by commercial fishes was studied and observations on primary productivity were made in Chaleur Bay.

9. Groundfish surveys. The first of an intended series of annual, statistically designed survey cruises in 4W was completed. It is hoped to extend the surveys to cover the whole of the Scotian Shelf (4Vs, 4W, 4X) with the objective of providing data on which to base recruitment predictions, particularly for haddock, and abundance estimates.

10. Sea scallop. Studies were continued (4T) on drag efficiency and survival of discards. Scuba observations revealed an 11 percent catch of all scallops in the drag path and a 4 percent mortality of uncaught scallops. Mortalities due to deck exposure in 1969 were much lower than studies in 1968 had indicated.

A photographic survey of scallop beds in the Bay of Fundy (4X) in August 1969 confirmed the general scarcity of scallops noted by commercial fishermen. A research submersible (Shelf Diver) working in the same area in September estimated that population densities were less than 0.1 scallop per sq m over the commercial grounds.

11. Herring. The development of large-scale fisheries for adult herring in the Bay of Fundy (Div. 4X) began to show effects on the stocks in 1969. There was a marked reduction in the availability of adults during the summer-autumn season, possibly a result of the very high fishing intensities of recent years. There was also a reduction in the availability of 'sardines' but equally poor

fishing seasons have been recorded in recent years, and evidence is not conclusive that recruitment to the 'sardine' year-class has been affected.

Racial studies continued in the Gulf of St. Lawrence (4T). The strong year-classes of 1959 and 1960 in Division 4T were again dominant in 1969 samples although to a lesser degree than in previous years. The 1964 and 1965 year-classes were both strong and are replacing the older year-classes in the fishery.

Studies of morphometric and meristic characters including vertebral numbers, gill-rakers, fin-rays, otolith types, and ℓ_1's indicate the discreteness of two main spawning groups of herring in the southern Gulf of St. Lawrence (Div. 4T).

A series of plankton cruises was carried out to study the distribution and abundance of larval herring in Divisions 4X and 5Z. Centres of larval abundance occurred only in the Bay of Fundy and near the northern edge of Georges Bank, and only during the late autumn and early winter months. The results support the view that autumn spawnings off southwest Nova Scotia and on Georges Bank are the main sources of recruitment to herring stocks in this region.

Attempts to survey a herring spawning bed from a submersible demonstrated the potential value and practicality of the method but no spawning concentrations in the area of search were found.

12. Mackerel investigations were restricted to sampling for size composition from commercial catches in the Bay of Fundy (Div. 4X). Mackerel caught on the west side of the Bay are considerably smaller (mean length 267 mm) than those caught on the east side (mean length 320 mm).

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

14. Tuna. The behaviour of large bluefin tuna was studied in St. Margaret's Bay (Div. 4X) during July, using sonic tags that were also capable of telemetering water and fish temperatures. Four fish were tracked for a total of 30 hours and 200 km. They all left the Bay within 6 hours of release but did not seem to be unduly disturbed by the tagging operation and appeared to have fed soon after release.

15. Atlantic Salmon. Serological and electrophoretic studies were undertaken to determine whether genetically different populations of Atlantic salmon occurred in the North American Atlantic rivers. Electrophoretograms of blood transferrins indicate that there are some distinct populations.

Returns from tagged hatchery-reared smolts of selected grilse versus 2-sea-winter parentage have shown 70 percent or more of the progeny maturing at the same age as their parents.

Over 132,000 hatchery-reared and 32,000 wild smolts were tagged and liberated in stock-evaluation and utilization studies. In addition 3,500 mature salmon were tagged and subsequently liberated as they passed through fisheries and research installations or after use as fresh brood-stock for hatcheries.

Among recoveries from 49,000 tagged, wild smolts liberated between 1964 and 1967 about 40 percent were recorded as grilse in Canada, 8 percent from Greenland fisheries, 40 percent from Canadian fisheries and 2 percent as home-river spawning escapement. Similar proportions were recovered from 49,000 tagged, hatchery-reared smolts of late-run parentage.

Recoveries from 39,000 tagged, hatchery-reared smolts of early-run parentage were over 60 percent as grilse, 7 percent in Greenland, 42 percent in Canadian fisheries and under 1 percent as spawning escapement.

In the above studies about 1/4 of the grilse were recorded as spawning escapement.

Returns from a 1968 liberation of 28,000 tagged, wild smolts indicate a survival rate of about 3.8 percent after 1 1/2 years, about twice the average rate of return for a 2-year period (about 1,000 returns as grilse in Canada plus 50 from Greenland).

Studies, by sonic tracking, of adult salmon entering rivers indicate much slower progress in estuarine areas with substantial industrialization and shipping activity as compared to undeveloped areas.

III. Gear and Selectivity Studies.

Acoustic echo counting equipment constructed at the Marine Ecology Laboratory, has continued to undergo field calibration trials and progress has been made in the development of survey and analyses techniques to determine fish school patterns. Direct comparisons of otter trawl catches with simultaneous fish counts were made in 4T. Comparative experiments in use of lights for fishing were continued at the Station de Biologie marine, Grande-Rivière, Qué.

IV. Miscellaneous Studies

At the Atlantic Oceanographic Laboratory a diving "Batfish" has been designed for towing from a moving ship and capable of undulating between pre-set depths. The fish is made from glass fibre reinforced plastic and is extremely rugged. To date only temperature and pressure sensors have been fitted, but it is planned to add conductivity and a plankton counter. Recording from the sensors is made aboard ship.

Subarea 5

A. Status of the Fisheries*

I. Cod

Canadian mainland landings from Subarea 5 were down by 34 percent from 1968, continuing the decline in recent years. The actual landings are as follows:

Year	1966	1967	1968	1969
Landings (metric tons)	15,127	8,529	9,195	6,047

II. Haddock

Landings on the Canadian mainland from Subarea 5 were less than half of the landings in 1968. Landings since 1966 are as follows:

Year	1966	1967	1968	1969
Landings (metric tons)	18,960	13,629	9,445	4,045

Poor recruitment since 1963 is the main factor in the decline in haddock landings from Subarea 5.

III. Sea Scallop

Landings of scallops from Georges Bank (5Z) showed a decrease from the 1968 catch by 4,000 metric tons; only 36,000 tons whole weight (4,380,000 kg meats) were landed in 1969, despite an addition of 5 boats to the offshore fleet. As in 1967 and 1968, most effort was on the northeastern edges of the bank. Only two trips were made to Statistical Subarea 6 for a catch of 18 tons whole weight.

IV. Herring

The herring fishery in Subarea 5 was significantly smaller than in the two previous seasons. Landings amounting to little more than 3,000 tons were recorded from the southern part of Division 5Y.

*The preliminary figures for 1969 in this report are based on actual landings by the mobile fleet (vessels over 25 gross tons) and estimated inshore landings.

V. Swordfish

Swordfish landings for the whole ICNAF area are included in the report for Subarea 4. Area-of-catch data are still incomplete but there appears to have been no major changes from previous years although Subarea 3 made a proportionately greater contribution to landings than Subarea 4 on the basis of 1968 figures. Subareas 5 and 6 account for approximately 50 percent of the total annual catch (4,300 tons in 1969).

VI. Tuna

Swordfish fishermen catch and land small quantities of tuna. Several species (bluefin, bigeye, albacore, and yellowfin) are included but are not identified. Total Canadian landings of tuna for the ICNAF area 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 and Subarea 6 scallop data with the U.S. Bureau of Commercial Fisheries continues.

2. Herring research was restricted to studies of larval abundance and distribution reported under Subarea 4 and to examination of a few samples from commercial catches on Jeffreys Bank (Div. 5Y) and Georges Bank (Div. 5Z).

3. Swordfish. The mean size of swordfish continued to decline and is now 62 kg (round weight) as compared with 103 kg in 1963, the first full year of the longline fishery. This cannot be explained solely by the expansion of effort into areas yielding larger numbers of smaller fish and the possibility of overfishing must not be overlooked.

The rate of growth of swordfish appears to be rapid with fish reaching a weight of about 4 kg in September of their first full year of life (assuming April-August spawning) and about 15, 39, 69, and 113 kg respectively in the following four years. Tagging returns, although only three in number, indicate that subsequent growth is equally rapid.

An examination of the gills and gastro-intestinal tracts of 18 swordfish showed numerous nematodes (*Contracaecum incurvum*) and a few giant digenetic trematodes, *Hirudinella marina*. In the rectum, there was a high incidence of the cestode *Fistulicola plicatus*. On the gills, *Tristoma coccineum* and *T. integrum* occurred. The difference in relative incidence of *T. coccineum* and *T. integrum* on swordfish from the Mediterranean and the Atlantic and the presence of a distinct species of *Tristoma* on Hawaiian swordfish suggest that these monogenetic trematodes may be useful as biological tags to distinguish populations of swordfish.

4. *Miscellaneous*. Recaptures of tagged blue sharks suggest an anticlockwise seasonal migration with fish wintering in the Gulf Stream. Some fish move east during the spring and then north and west along the edge of the continental shelf between the Grand Banks and Georges Bank during the summer and early autumn. Other sharks apparently move straight into the continental shelf areas south of Cape Cod in the summer and probably perform a similar but much reduced migratory pattern.

APPENDIX I

Subarea 4

A. Status of the Fisheries

Harp and Hood Seals

The major feature of the 1969 sealing season was an almost complete absence of ice in the normal whelping areas for harp seals in the southern Gulf of St. Lawrence (Subarea 4) in early March. The seals therefore whelped close inshore on avialable ice in Northumberland Strait and around the shore of Prince Edward Island (Subarea 4). There is strong evidence (see Special Research Studies) that a large percentage of seals moved from Subarea 4 to Subarea 2 in order to find ice for whelping. The distribution of catches reflects this movement.

Age samples obtained during 1969 show excellent survival of the 1968 age-class of harp seals, from which a catch of 156,000 young harp seals was made by all agencies and in both Subareas in 1968, as compared with catches of about twice this figure in the immediately preceding two years. This low catch probably lies close to or slightly below sustainable yield. The low catch was achieved by means of late starting dates in both Subareas.

B. Special Research Studies

Harp and Hood Seals

CANADIAN ATLANTIC SEAL CATCH

	Harp Seals			Hood Seals			
Year	Young	Older	Total	Young	Older	Total	Grand Total
1968							
Gulf	59,735	6,102	65,837	-	-	122	65,959
Front	32,907	5,692	38,599	12	13	25	38,624
Total	92,642	11,794	104,436	-	-	147	104,583
1969							
Gulf	46,901	4,787	51,688	112	-	112	51,800
Front	111,984	7,726	119,710	439	349	788	120,498
Total	158,885	12,513	171,398	551	349	900	172,298

(1) During March 1969 nearly open water in the Gulf of St. Lawrence for the first time in 17 years (since 1953) gave a unique opportunity to study the behaviour of harp seals faced with the near-absence of ice for whelping. The estimate of seals whelping around Prince Edward Island was about 50,000 of which 32,000 were taken at the fishery. The usual number whelping in this area is estimated at 100,000 to 150,000. Careful study showed no evidence of any massive drownings of young. It is very probable therefore that the majority of animals moved to the Labrador coast to whelp.

(2) Many young seals surviving the fishery in the Gulf fell prey to oil pollution. Samples identified the oil as bunker "C" probably discharged into Northumberland Strait on January 30, 1969. It was already heavy and broken into underwater globs, and young seals, but not old seals, became heavily fouled. Young were tagged by Arctic Biological Station staff, and subsequent tag recoveries show that heavily fouled young seals hunted in the Strait of Belle Isle during April had probably picked up the oil at the southern site. While the majority of fouled seals were alive, some dead seals were reported both around Cabot Strait and in Belle Isle Strait. Further mortality will be studied from a comparison of tag recovery rates with previous years.

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VII. Sea scallop, *Placopecten magellanicus* Gmelin

Total landings of scallops increased from the 1968 figure of 12,400 metric tons to 14,245 metric tons whole weight (1,716,000 kg meats). By far the largest fraction of inshore landings came from Div.4T.

Div.4T produced 8,605 metric tons; Div.4X produced 4,119 metric tons; Div.4V and 4W together produced 1,036 metric tons. A new area in Div.4W was fished in 1969 (Western Bank) and produced 923 metric tons.

10 C