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Canadian Researches, 1957

I. Subareas 2 and 3

By W. Templeman

Subarea 2

Redfish were examined from various depths east of Hamilton Inlet Bank. At 158 fathoms, of 12 redfish 9 were Sebastes marinus marinus (L.), one doubtful, and 2 Sebastes marinus mentella Travin. At 170-172 fathoms 3 very large redfish were marinus type and 17 smaller redfish were mentella type, at 182-186 fathoms all 49 redfish were mentella. At 200, 250 and 300 fathoms all were mentella. Redfish were most abundant at 250-300 fathoms.

In the hydrographic section off Seal Islands, Labrador, (Fig. 1) taken on August 6 to 7, 1957, offshore temperatures in the deep water of the continental slope east of the Hamilton Inlet Bank were above 4°C. This hydrographic section has been taken yearly since 1950 and the 1957 cruise was the first occasion when temperatures as high as 4°C. have been found in the deep offshore water of the area. In 1950 these offshore deep-water temperatures were 3.6 to 3.9°C.; in 1951, 3.3 to 3.5°C.; in 1952, 3.4°C.; in 1953, 3.5°C.; in 1954, 3.5 to 3.7°C.; in 1955, 3.3 to 3.6°C.; in 1956, 3.6 to 3.9°C.; and in 1957, 3.9 to 4.7°C. Salinities and inshore temperatures were generally similar to those encountered during the past few years. Some water below -1.5°C. was present near shore. This was absent in 1956 but present in 1955 and 1954. The lowest temperature encountered in 1957 was -1.67°C. and in 1956 -1.41°C.

Subarea 3

Data were collected on location of catches and catch per unit of effort of the offshore groundfish fleet. A beginning was made at gathering catch per unit of effort data in several localities for different fishing gears of the inshore cod fleet. Offshore commercial landings of groundfish were well sampled for size and age and similarly the inshore catches were sampled at Burin, St. John's and Bonavista.

Haddock, Melanogrammus aeglefinus (L.). During the May and June haddock otter-trawling surveys by the Investigator II the haddock had spread northward from their winter concentrations in the deeper water of the southwest slope of the Grand Bank to occupy most of the southern half of the bank and thus were not very abundant in any one area. On the Grand Bank as a whole fair quantities of haddock appeared to be present. The 1949 year-class still made up a very significant part of the catch and the 1952 year-class, with some additions from the 1953 year-class and from year-classes older than 1949, made up the remainder of the haddock of commercial size. The 1950, 1951 and 1954 year-classes were completely insignificant; there was evidence of a modestly large 1955 year-class and of moderate survival of the 1956 year-class.

In the St. Pierre Bank bottom survey no significant quantities of the once very large 1949 year-class or of other haddock of commercial size were obtained. There was evidence that the survival of the 1955 year-class was only small and no evidence was found of

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significant survival of other year-classes from 1950 to 1954. There has been no immigration to St. Pierre Bank of the successful 1952 and 1953 Grand Bank haddock broods. There was some indication of good survival of the 1956 year-class in deep water at the western edge of St. Pierre Bank but this year-class cannot be properly assessed before it is two years old. Assuming no immigration from the Grand Bank there is at present no evidence that there will be a haddock population available for sustained commercial fishing on St. Pierre Bank for the next three years.

A study of the sound-producing muscles of the swim-bladder of the haddock has been proceeding since 1953 and is now completed. The volume of these muscles in mature male haddock at spawning time in May-June is nearly twice as great as in October-November, whereas in the mature females and in immature males and females these so-called "drumming" muscles are much smaller and there is no seasonal difference in size. Presumably these drumming muscles are used for sound production in male haddock, mainly during the spawning season, and these organs may provide a rallying sound for spawning schools. It is possible that, with suitable equipment, the sounds of these male haddock at spawning time could be an aid to identifying schools of adult haddock. These drumming muscles can be used also in sexing sexually-mature, gutted haddock, but this is not a great problem in Newfoundland where most of the haddock are landed round.

Redfish, Sebastes marinus mentella Travin and Sebastes marinus marinus (L.). The Investigator II carried out deep-water explorations for redfish between 100-150 and 400 fathoms northeast of the Grand Bank and south of Green Bank. In each of these areas a few marinus-type redfish were found at the shallower depths while almost all the redfish, including all at the greatest depths were of the deep-water mentella type. The greatest redfish abundance was at 200 fathoms northeast of the Grand Bank and at 170-200 fathoms south of Green Bank. Occasional redfish were recorded to 380 fathoms. From a small commercial catch of 3000 pounds of redfish during a cod trip by the otter trawler Blue Spray in the southern part of the Halibut Channel between St. Pierre Bank and Green Bank in 88-90 fathoms, 543 redfish were examined, of which 14% were of the marinus type and the remainder of the mentella type.

Other researches in redfish biology have been continued on age and growth, the reproductive cycle, and on a study of body proportions and meristic characters of redfish from various areas and depths. The occasional occurrence of red flesh in redfish was investigated and the pigment responsible was found to be astaxanthin.

Cod, Gadus callarias L. Cod investigations were chiefly on size, age, growth and year-class abundance. Sampling has been improved. A study of pre-commercial year-classes of cod was begun through the gathering of data on their abundance and the collection of material for growth studies.

Flatfishes. Age and growth studies have been continued on the American plaice, Hippoglossoides platessoides (Fabr.), and on the witch flounder, Glyptocephalus cynoglossus (L.).

Male American plaice from both St. Mary's Bay and Southern Grand Bank areas mature secually at 5 to 11 years and females from 11 to 17 years, but, at comparable ages, for both males and females the Southern Grand Bank plaice are much larger.

Male plaice are much slower growing than females, reaching 40 cm. in length in St. Mary's Bay in 19 to 20 years compared with 15 years for the females.

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On both the Southern Gran Bank and St. Pierre Bank the 1951 and 1952 year-classes of American plaice were dominant. This is interesting because both of these year-classes of haddock were failures on St. Pierre Bank, and on the Southern Grand Bank haddock survival was good for the 1952 year-class but very poor for the 1951 year-class. Plaice spawn earlier than haddock and thus their eggs and larvae encounter lower surface temperatures and different upper-water currents. Plaice also have a much more wide-spread distribution in the Newfoundland area than haddock and are much more unlikely than haddock to lose a complete year's brood over depths too great for them to survive at the bottom-seeking stage.

Hydrography. Five regular hydrographic sections usually extending from shore and across the banks to the 500-metre depth beyond the edge of the continental shelf were taken during July and August. These sections extended from off Cape Bonavista to the southern slope of the Grand Bank. Once or twice each month temperatures and salinities were taken at a station 5 miles off Cape Spear in 176 metres. Daily surface temperatures were obtained in St. John's Harbour.

In the section off Cape Bonavista there was an abundant supply of water over 4°C. in the deep water at the edge of the continental shelf. As in Labrador this is very unusual and has not previously occurred in our records at this station where the deep-water temperatures at the continental slope are generally below 4°C., similar to those we have described for the deep-water continental slope area east of Hamilton Inlet Bank. There was a considerably greater volume of water below 2°C. in 1957 than in 1956. Otherwise, temperatures in this section were little different from those of 1956 except that the 0°C. isotherm lay closer to the surface in 1957.

In the St. John's-Grand Bank-Flemish Cap section (Fig. 2) some water below -1.5°C. was present near shore. Here the lowest temperature was -1.57°C. whereas in 1956 the lowest temperature in the same area was -1.34°C. In agreement also with the very low air temperatures of the 1957 winter in the Newfoundland area, bottom water temperatures on this northern section of the Grand Bank were all between -0.8°C. and -1.1°C. whereas in 1956 bottom temperatures of 0.2°C. were to be found in this area. Temperatures east of the Grand Bank and around Flemish Cap were little different from those of 1956. The large supply of water over 4°C. which existed at the edge of the continental slope from Labrador to the northern slope of the Grand Bank did not occur in this section. The salinities of the upper layers in the shoreward part of the section were slightly lower than in 1956.

Bottom temperatures on the southern Grand Bank in the section across the Southeast Shoal were unusually low and lower than in 1956. Bottom temperatures in the shallowest water near and on the Southeast Shoal were 0.8 and 0.1°C. in 1957 compared with 3.4 and 4.7°C. in 1956.

In the section close to and paralleling the southwest slope of the Grand Bank water below -1°C. filled most of the Haddock Channel between Green Bank and Grand Bank whereas in 1956 only a trace, and in 1955 no water with this low temperature was present in this channel. Otherwise the bottom temperatures at the edge of the southwestern slope of the bank in this section were very similar to those in 1956.

More warm water and water of a higher temperature than in 1956 or in 1955 was present in 1957 in the 275-metre section paralleling the southwest slope of the Grand Bank. In this section there was less water below 0°C. and considerably less water below 2°C. in 1957 than in 1956. The lowest temperatures in the Labrador Current water which occurs in the eastern part of this section were -0.7 in 1957 and -0.9 in 1956.

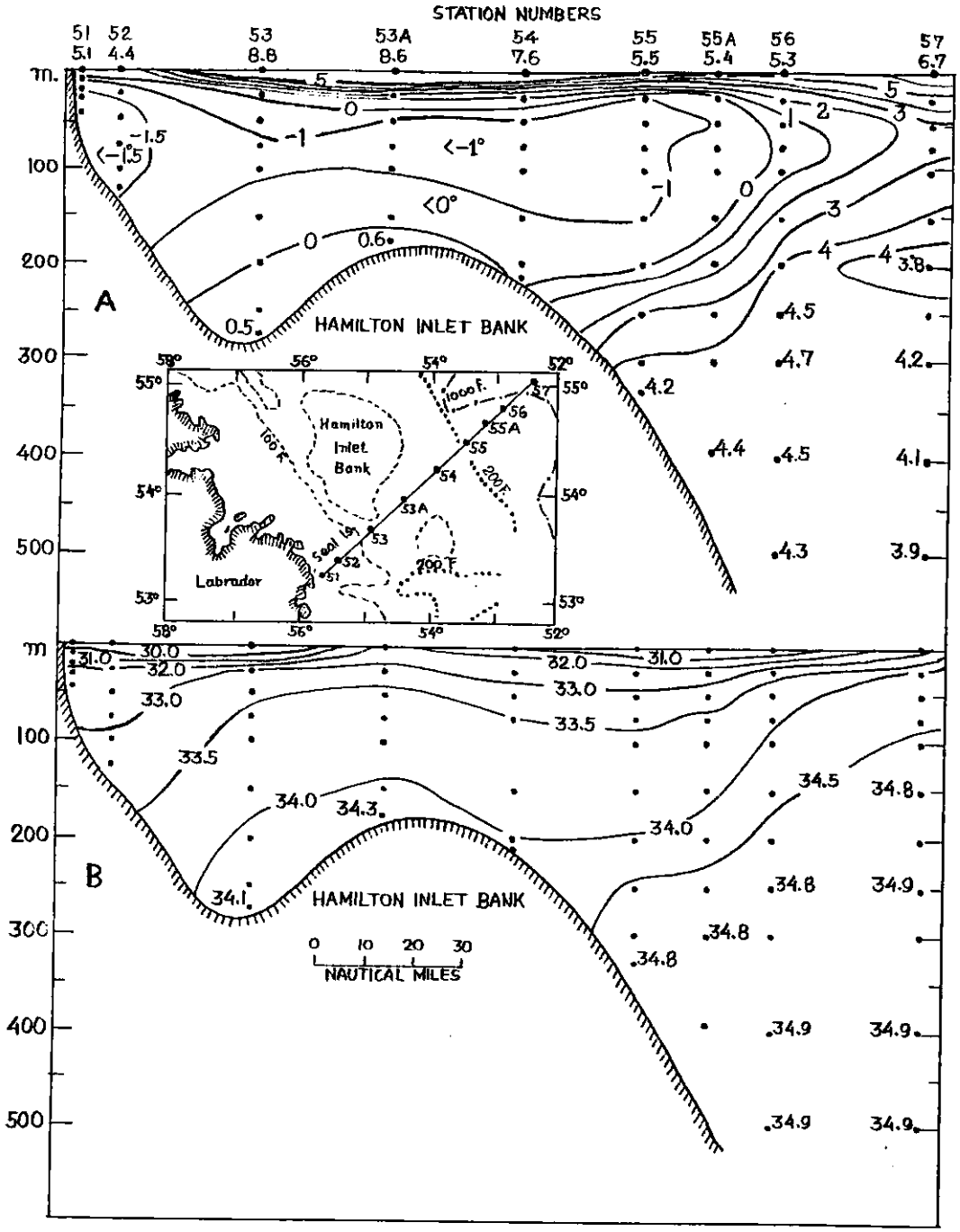

Figure 1. Hydrographic section off Seal Islands, Labrador, August 6-7, 1957. A - Temperature °C.; B - Salinity °/oo.

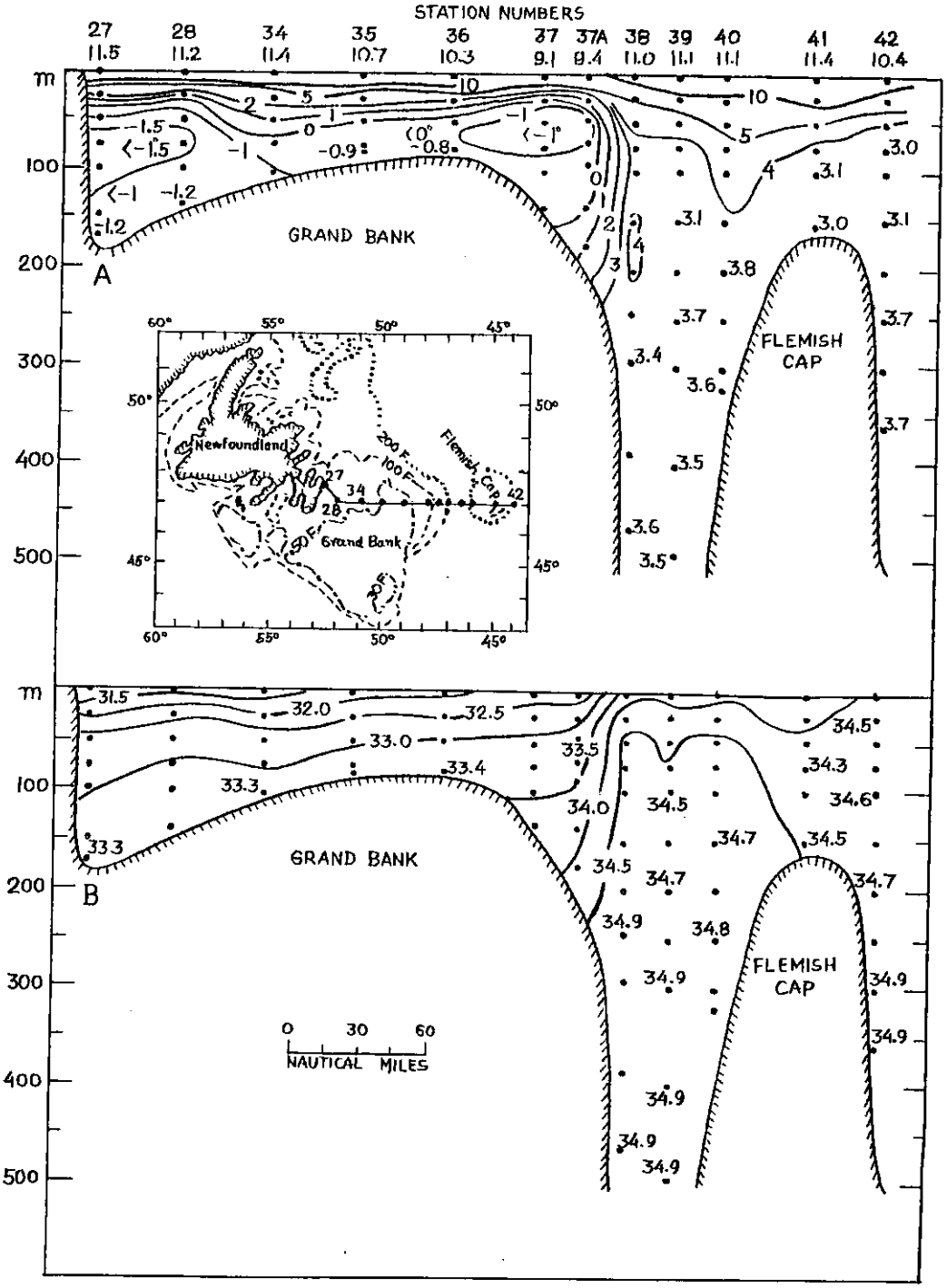

Figure 2. Hydrographic section, St. John's-Grand Bank-Flemish Cap, July 29-August 1, 1957; A - Temperature °C.; B - Salinity °/oo.

II. Subarea 4

By W.R. Martin

Canadian research in the offshore waters of Subarea 4 is carried out by the Fisheries Research Board of Canada and the Quebec Department of Fisheries. The Board's Station at St. John's, Newfoundland, did redfish work in Subdivision 4R. The Quebec group studied redfish in Subdivision 4S and cod in the northern part of Subdivision 4T. The Board's Station at St. Andrews, New Brunswick, investigated cod and haddock in Subdivisions 4T to 4X, and the Atlantic Oceanographic Group at St. Andrews continued hydrographic work throughout the subarea. This report summarizes the various Canadian researches in Subarea 4 which are considered to be of interest to the Commission.

Statistics and sampling of commercial landings are reported separately. During post-war years the numbers of offshore otter trawlers and longliners have steadily increased. This has increased the work involved in relating landings to area of capture and fishing effort. Sampling of commercial landings included approximately 15 thousand cod and 14 thousand haddock measurements, and age determinations for about one fifth of these. Another 14 thousand cod were measured on commercial draggers in order to determine the proportion and sizes of cod discarded at sea.

Haddock, Melanogrammus aeglefinus (L.). The haddock program has been carried out in co-operation with the United States laboratory at Woods Hole. In 1957 this research included tagging, exchange of statistics and wharf sampling data, and development of the otolith method of age determination for all Subarea 4 haddock.

In March and April, haddock were caught by otter trawl from depths of 45 to 80 fathoms in the LaHave-Browns region of Subdivision 4X by the M.V. J.J. Cowie, and 1123 of these were tagged. In November and December, 1085 haddock were tagged at the mouth of the Bay of Fundy in Subdivision 4X. Most of these were tagged from the same research vessel in Passamaquoddy Bay and Grand Manan Channel over depths of 20 to 60 fathoms. Early returns are consistent with results of earlier taggings which show a southern movement of haddock to offshore grounds in winter, and a northern movement to inshore grounds in summer months. The success of tagging experiments is shown by the high returns from earlier taggings. Over 40% of the disk-tagged haddock released off Locekport, N.S., (Subdivision 4X) were recovered by the end of 1957. Recaptures in 1957 were still 6% of the possible number of tagged fish remaining in the water at the end of 1956, without any allowance for natural mortality since tagging.

Haddock statistics and sampling data for Subdivision 4X were sent to Woods Hole for analysis. United States statistics and sampling data for Subdivision 4V and 4W were examined at St. Andrews. A large 1952 year-class was largely responsible for increased landings of haddock from Subdivision 4W in 1956, and this year-class continued to be dominant in 1957 catches from Subarea 4. Growth of this year-class appeared to be normal for the Western Bank region of Subdivision 4W.

As a result of an earlier conclusion that otoliths were more satisfactory than scales for age determination of Subarea 4 haddock, all age analyses are now based on otolith readings.

Cod, Gadus callarias L. Cod research, in 1957, was concentrated in Subdivision 4T. Investigations included tagging, parasite incidence, growth experiments, models of the fishery, effects of mesh regulation, mesh selection, and a new census program.

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In late July and early August, 1202 cod were tagged at the Magdalen Islands at depths of 12 to 26 fathoms. Most of these cod were caught by handline from the M.V. J.J. Cowie. First-year recaptures showed a seasonal pattern of migrations similar to that observed earlier for cod tagged farther north off Shippegan Island. Summer recaptures were mainly taken near the Magdalen Islands. Winter recaptures were taken farther south in deeper water, outside the Gulf of St. Lawrence. Percentage recaptures have been smaller than the high returns from earlier taggings (Table I).

Studies of parasite incidence contribute to definition of cod populations. The proportion of cod infected with Porrocaecum decipiens (Krabbe), Lernaeocera branchialis (L.), and Clavella uncinata (O.F. Muller) varied with the size of fish and with the area of capture.

Returns of fish lengths with recaptured tags from 1955 and 1956 cod tagging experiments have provided direct measurements of growth. Results from the 1955 tagging show that the average growth increased from 0.6 cm in July to 3.7 cm in November of the year of tagging, from 5.3 to 7.7 cm during the summer of 1956, and from 9.3 to 11.3 cm in the summer of 1957. There was considerable growth during winter months. The results from the 1956 tagging showed similar changes, but it was evident that there was more growth from 1955 to 1956 than from 1956 to 1957. This difference between years was also observed from otolith studies of commercial samples.

Data on growth, mortalities, fishing intensity, and size at first capture have been used to construct models of the Subdivision 4T cod fishery. The models provide information on fishing conditions required to make best use of the resource. On the basis of present models it is predicted that the sustained yield can be increased by increasing fish size at first capture with a minimum mesh size of at least $5\frac{1}{2}$ inches, and by limiting the total amount of fishing effort to a level approaching the present intensity. The evidence was presented to the Commission in 1957.

As a first step in management of Subarea 4 groundfish the $4\frac{1}{2}$-inch minimum mesh size recommended by the Commission for cod and haddock dragging entered into force for all countries on January 1, 1958. This $4\frac{1}{2}$-inch mesh became effective for Canada in March, 1957. The year, accordingly, was one of transition from small- to large-mesh nets, and there was a good opportunity to compare the effects of different mesh sizes on the quantities landed and the sizes of fish caught.

The relative efficiencies of small- and large-mesh draggers have been compared from statistics of landings per trip by various size classes of New Brunswick draggers. The comparisons give no evidence of decreased landings for draggers which increased their mesh size in 1957.

There is convincing evidence that many fish are released through the larger meshes. The proportion and sizes of cod discarded at sea in Subdivision 4T were examined on 10 commercial dragger trips. As an example, three small-mesh (3-inch) trips to Bonaventure Island grounds were compared with three large-mesh ($4\frac{3}{4}$-inch) trips in 1957. Discards were reduced from 31% to 12% by numbers, and from 10% to 5% by weight on large-mesh trips.

Sizes of cod caught by 3- and $4\frac{3}{4}$-inch mesh codends are compared with sizes landed by fishermen in Figure 1. It is noted that even in the larger-meshed nets the proportion of cod caught and discarded is still significant. Examination of the data indicates that a minimum mesh size of about $5\frac{1}{2}$ inches would be required to eliminate waste.

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New information was obtained on equivalent mesh sizes for twines other than manila. The selective properties of two twines, No. 400/3 ply twisted nylon and braided parachute cord nylon were compared with manila during covered codend studies of cod and plaice in Subdivision 4T. The results confirmed earlier conclusions that nylon meshes release larger fish than manila meshes of the same size. This justifies special provisions in the Canadian regulations for nylon twine. The results are being incorporated in a gear selection review for the Commission.

A systematic census of cod and plaice (Hippoglossoides platessoides (Fabr.)) populations in Subdivision 4T was started in 1957 to determine recruitment, and to assess the effects of environmental factors on abundance, distribution, and movements of these fish. In May to October, 245 tows were made, 16,210 cod and 21,554 plaice were measured, and detailed observations of age, sex, maturity, parasites, and food were recorded for 3,136 cod and 771 plaice. The results should lead to short-term predictions of the relative abundance of stocks available to the fishery. Preliminary results show four well defined size groups of cod. These groups changed in length during the summer, indicating growth of 3 to 6 cm. Small cod moved into Chaleur Bay at the end of June and offshore again in August.

Redfish, Sebastes marinus (L.). Two subspecies of redfish have been found in the central part of the Convention Area. No marinus -type redfish were found in an exploratory otter trawling cruise in Subdivision 4R between 100 and 180 fathoms off Port Saunders and Cape St. George; all were mentella. On a later cruise farther south off Cape Anguille, between 100 and 250 fathoms, of 1900 redfish only two at 120 fathoms were marinus type, the remainder being of the mentella variety.

Exploratory dragging for redfish was carried out along the south coast of Anticosti Island in Subdivision 4S, at depths of 100 to 200 fathoms. Good catches were usually taken between 140 and 150 fathoms. Over 90% of the redfish sampled were large, over 30 cm in length.

Hydrography. For the second consecutive year a winter hydrographic survey was made in the Gulf of St. Lawrence. Ice conditions were heavy in 1957 as compared to those of 1956. The production of the cold-water layer in the Gulf seems to be related to the cooling of the upper layers during the winter as well as to the oceanographic conditions of the deeper layers.

A survey of the Bay of Fundy, Scotian Shelf, and the Gulf of St. Lawrence areas was carried out in June. The hydrographic section off Halifax is described in Figure 2. In June, the cold-water layer was more developed in 1957 than in 1955. The inshore banks were presumably covered with water of sub-zero temperature. The Scotian Gulf was filled with warm water, above 8°C., and the bottom temperature on Emerald Bank varied between 5.5 and 7.5°C.

Analysis of oceanographic conditions in the Strait of Belle Isle-Esquiman Channel area indicates the development of an eddy in Esquiman Channel as a result of the dominant westward flow in the Strait and of the bottom configuration. Analysis of the properties of the deep waters in the Laurentian Channel indicates warming of the deep layer from the 1920's to the 1950's. The upward trend of temperature was accompanied by an increase in the volume of the deep layer.

Analysis of surface water along the coast revealed that the cooling observed during the previous three years was followed in 1957 by a slight warming in the Bay of Fundy area and the southwestern Gulf of St. Lawrence. The Halifax area showed a decrease from the previous year.

In June drift bottles were released over the Scotian Shelf for studies of mass transport.

Table I. Subarea 4 cod tagging experiments 1953-57.

Year tagged	Place	Type of tag	Method of capture	No. tagged	Percentage recaptured: Calendar yr. of tagging	2nd yr.	3rd yr.	4th yr.	5th yr.	Total recoveries
1953	Lockeport 4X	Disk	Handline	608	34	27	5	3	2	62
1954	Louisbourg 4V	Disk	Handline	492	21	21	17	5	-	51
1954	Canso 4W	Disk	Handline	299	25	29	20	3	-	59
1955	Northern N.B. 4T	Disk	Handline	2650	7	14	8	-	-	27
1956	Northern N.B. 4T	Disk	Handline	482	9	24	-	-	-	30
1956	Northern N.B. 4T	Disk	Otter Trawl	922	7	9	-	-	-	16
1956	Cape Breton 4T	Disk	Otter trawl	733	10	6	-	-	-	16
1957	Magdalens 4T	Disk	Handline and otter trawl	602	2	-	-	-	-	
1953	Lockeport 4X	Hydrostatic	Handline	933	24	13	0.7	0.2	0.2	35
1954	Louisbourg 4V	Hydrostatic	Handline	318	13	14	7	2	-	32
1954	Canso 4W	Hydrostatic	Handline	175	26	14	3	-	-	38
1955	Northern N.B. 4T	Hydrostatic	Handline	1208	7	10	7	-	-	22
1956	Northern N.B. 4T	Hydrostatic (wire)	Otter trawl	150	10	7	-	-	-	17
1956	Northern N.B. 4T	Hydrostatic (nylon)	Otter trawl	448	8	10	-	-	-	18
1957	Magdalens 4T	Hydrostatic	Handline and otter trawl	600	3	-	-	-	-	

(Annual percentages are based on the maximum possible number of tags in the water at the beginning of the year. No allowance has been made for probable natural mortalities.)

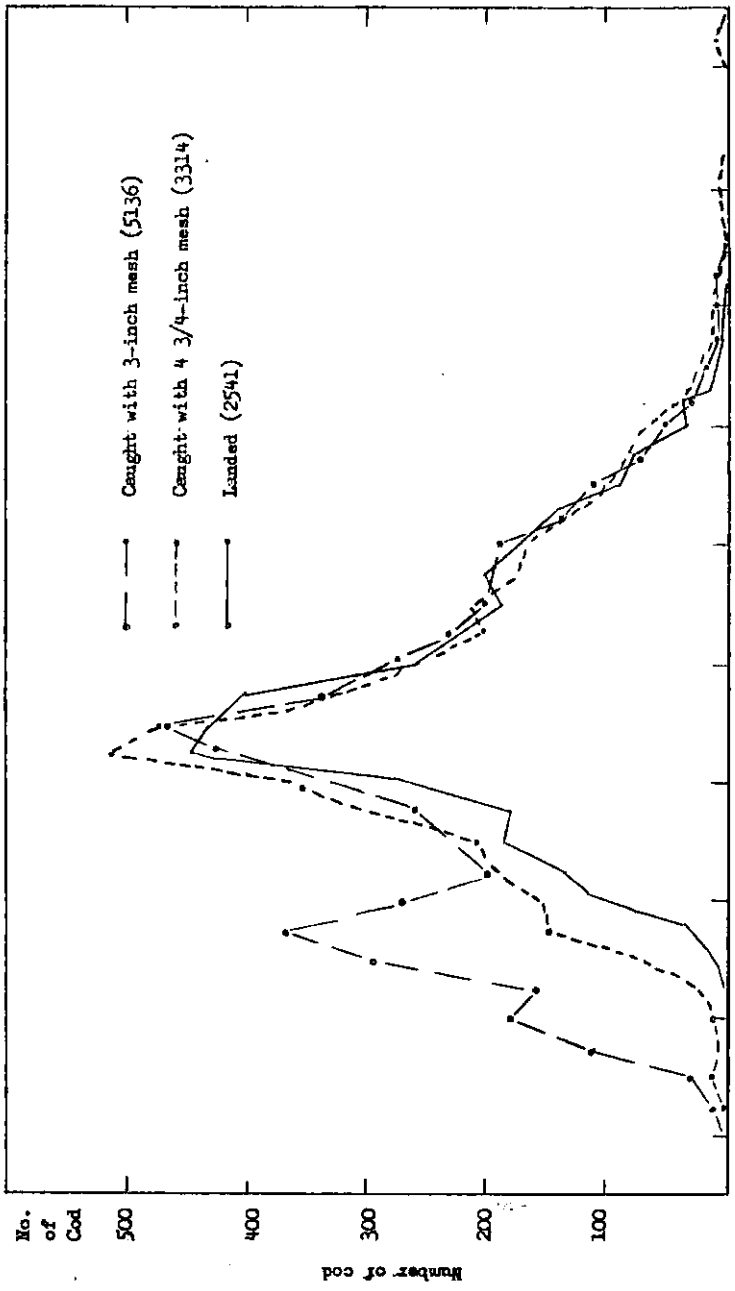

Figure 1. Size compositions of cod caught in 1957 on Bonaventure Island grounds by small- (3-inch) and large- (4 3/4-inch) mesh draggers compared with sizes landed by fishermen.

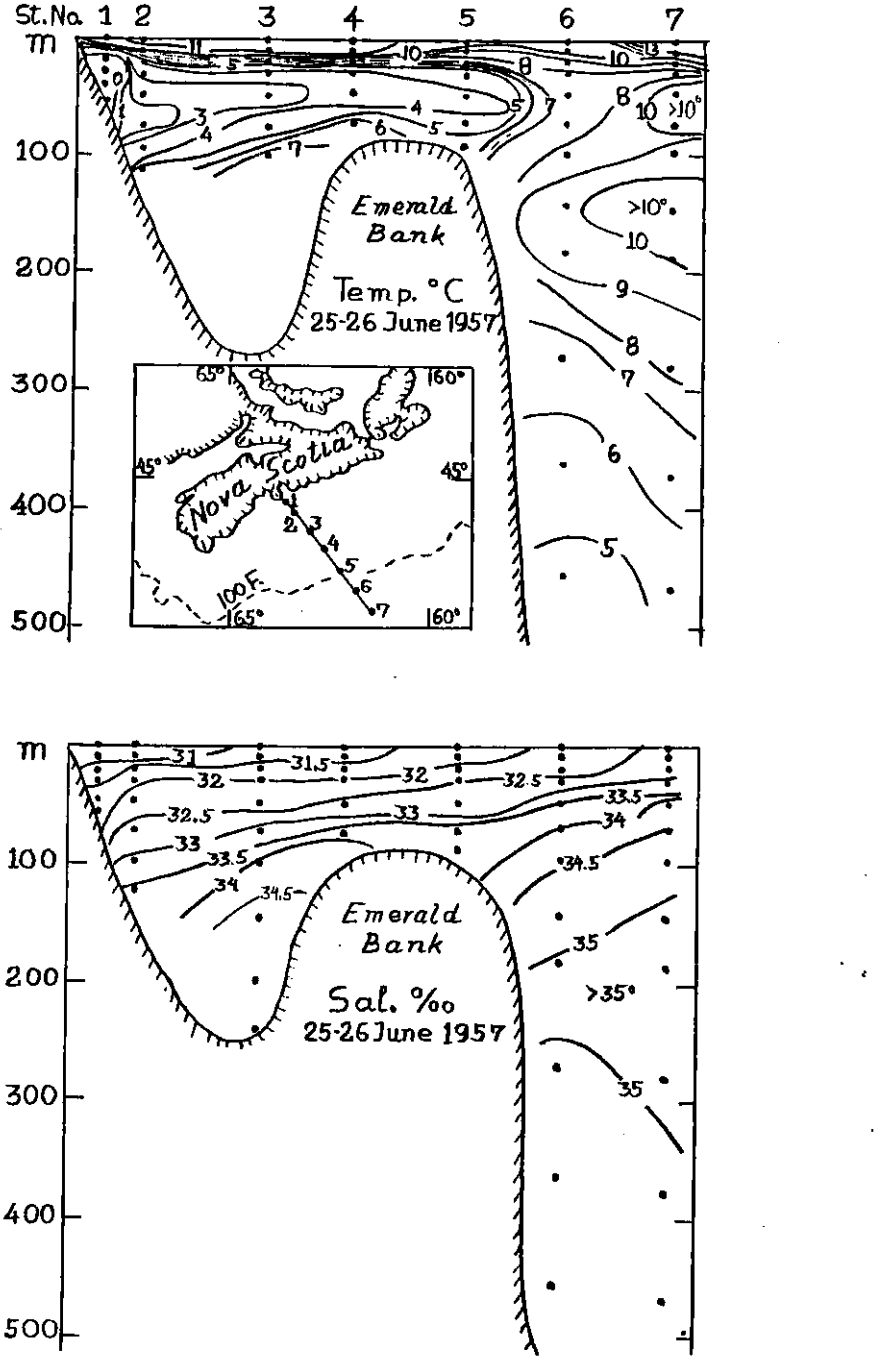

Figure 2. Hydrographic section across the Scotian Shelf off Halifax. 25-26 June, 1957.