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I. Canadian Research Report, 1962

B. Subareas 4 and 5, Biology

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Canadian research of interest to ICNAF in Subareas 4 and 5 was carried out by the Biological Station of the Fisheries Research Board of Canada at St. Andrews, N. B.

Cod, Gadus morhua L. The species of greatest international interest in Subarea 4 is cod. During recent years otter trawling for cod has become relatively more important than other fishing methods, and total fishing effort applied to this species has increased. These changes have greatly reduced the availability of large cod. Studies of the Gulf of St. Lawrence cod fishery are providing background knowledge for wise management of the fishery.

Returns from cod tagged in October 1961 off Seven Islands on the north shore of the Gulf have thrown new light on divisions and migrations of cod stocks. About 10% (148 fish) of the tags were returned by the end of 1962. During autumn months of 1961 and 1962 most recaptures were taken in the tagging area. In winter, returns came from the Cabot Strait area, mainly off southwestern Newfoundland. In summer, tagged cod were recaptured in the western Gulf, south of Gaspé, and along the north shore of the Gulf. It is apparent that some cod migrate through three Divisions of the Gulf. Cod of the southwestern Gulf (4T) cannot be considered to be completely distinct from those of the northern (4S) and eastern Gulf (4R). Further taggings on both sides of the Laurentian Channel, off Gaspé and off Seven Islands, planned for the early summer of 1963, will add more information on Gulf cod populations.

Winter and spring research-vessel surveys in the western Gulf of St. Lawrence provided new information on seasonal changes in cod distribution. In winter, cod were mainly distributed in deep water (80-125 fath) along the western edge of the Laurentian Channel. Cod were found in increasing numbers from Gaspé south to Scatari Bank, off eastern Nova Scotia, and in decreasing numbers from Scatari to Misaine and Canso Banks. Cod sizes increased from north to south. The few cod caught in shallow water south of Gaspé were shorter than 15 cm. Those caught in deep water off Gaspé were 20 to 40 cm in length. The concentrations of cod in the Sydney Bight area off eastern Nova Scotia were of commercial size, 40 to 70 cm. The largest catches were taken from water temperatures of 1 to 3°C.

During the last half of April an A.T. Cameron survey showed that cod were moving north and into shoaler water. Large catches of commercial-size fish (mode 49 cm) were taken at Scatari from depths of 45 to 75 fathoms. Equally large catches (3,000 fish per half-hour tow with a 41 otter trawl) of smaller fish (modes at 25 and 40 cm) were taken at 75 to 100 fathoms off Bird Rocks. Catches south of Gaspé were small in quantity (less than 50 fish per tow) and the fish were small in size. Small cod do not migrate as far south as commercial-size fish, and they are the first to return north. In April, they were deeper than 50 fathoms, enroute to shoaler water where they are caught later in the spring.

Surface plankton tows taken during groundfish surveys in the southwestern Gulf of St. Lawrence from 1958 to 1962 were examined for cod eggs and larvae. Although the largest numbers of running

female cod were observed in otter-trawl surveys during the last half of June, the greatest numbers of cod eggs in plankton tows were taken in May. Earlier observations of mature female cod spawning throughout summer months to late October conformed with collections of cod eggs in surface plankton tows during every month from May to November.

Very few cod larvae were taken in the southwestern Gulf plankton tows. It is suspected that the eggs and larvae were carried away from the spawning area by the counter-clockwise circulation of surface water. Inefficiency of gear for catching cod larvae, and heavy mortalities of eggs and larvae are probably less important explanations for their scarcity.

An October small-mesh otter-trawl survey in 4T provided information on the outlook for the 1963 fishery. The 1957 year-class, which was dominant in 1961 and 1962 survey catches of cod, is expected to be the dominant year-class in 1963 commercial landings. The 1956 and 1955 year-classes appeared in higher-than-average numbers as 6- and 7-year-old fish in the 1962 survey. These should appear in 1963 landings as 7- and 8-year-old fish. For these reasons it is predicted that the mean length of cod landed from the southwestern Gulf of St. Lawrence in 1963 should increase from 51 to 53 cm. Landings per hour fished are expected to increase to about the 1959 level.

Use of $4\frac{1}{2}$ -inch-mesh otter trawls and a reduction in the minimum sizes of fish accepted by buyers have reduced the quantities of cod discarded at sea.

The cod of the western Gulf of St. Lawrence are fished intensively by otter trawlers, and fishing mortality is as high as that for any important cod population. Gulf cod are particularly vulnerable during winter months when they are concentrated in deep water off eastern Nova Scotia. It is mainly during this season that Gulf cod are fished by European trawlers. Ice cover in late winter off eastern Nova Scotia frequently blocks fishing operations and offers some protection to concentrations of Gulf cod. Such was the case in April 1962.

Haddock, Melanogrammus aeglefinus (L.). Another intensively fished species which is protected by an ICNAF $4\frac{1}{2}$ -inch mesh regulation is the haddock. Studies of commercial landings, observations at sea on commercial trawlers, and surveys with research vessels have provided new information on the status of haddock stocks in Subarea 4.

Haddock are found in warmer water than cod. They are less abundant than cod in the Gulf of St. Lawrence and more abundant than cod on Nova Scotia banks. During winter surveys from 1959 to 1962, haddock were taken at 125 fathoms along the western edge of the Laurentian Channel (4T), off eastern Nova Scotia (2-4°C); at 55 to 80 fathoms in the gully between Sable Island, Banquereau and Middle Ground (4V), and at 45 to 70 fathoms in the Western-Emerald Bank (4W) area (4-6°C). Catches increased from east to west.

Surface plankton tows from the A.T. Cameron in March and April of 1959, 1961 and 1962 provided information on the distribution of gadoid eggs in the Sable Island-Emerald Bank region of the Nova Scotian shelf (4W). In all three years the greatest abundance of eggs was found over Western and Emerald Banks. The distribution of eggs corresponded closely with the winter distribution of haddock as observed in otter-trawl surveys. Small annual variations in the distribution of eggs reflect differences in distribution of spawning fish and differences in the drift of eggs in surface waters. The proximity of centres of egg abundance to the edge of the Scotian Shelf suggests that we should expect annual differences in the numbers of haddock settling on and off the banks, and thus a mechanism for variation in year-class strength.

Research-vessel surveys of haddock in 1961 and 1962 showed strong 1956, 1957 and 1959 year-classes. Both 1958 and 1960 year-classes are weak. The 1956 year-class was dominant in 1961 and 1962 landings from Division 4W. The 1957 year-class contributed large numbers of fish to commercial catches in 1962, but with a modal length of 43 cm many were discarded at sea. Observations at sea on a commercial trawler on Nova Scotia banks in July showed that substantial numbers of haddock are still discarded at sea. Discarded fish were 35 to 40 cm long.

In 1963, the 1957 year-class will be dominant in haddock landings from Division 4W. With poor recruitment from the 1958 year-class, reduced catches of small scrod haddock are expected. A series of relatively poor year-classes among the fish of pre-commercial size will result in reduced catches of haddock from the Sable Island-Emerald Bank area (4W). No compensation for anticipated poor haddock fishing in Subarea 3 can be expected from Subarea 4 during the next few years.

Pollock, Pollachius virens (L.). A species of increasing commercial importance in Division 4X, the pollock, has been studied since 1960. Largest catches are made at temperatures above 1°C at depths down to 100 fathoms. As noted in cod and haddock, pollock migrate south in winter, and north for summer months. Spawning takes place in the southern Gulf of Maine and probably also on the Scotian Shelf in winter. By summer, 0-class pollock are found inshore. The 1-year-old pollock disappear from the sublittoral zone in early August when 20 to 25 cm in length. The 2-year-old pollock may be found in deeper water near shore or on offshore banks. Large offshore pollock show a marked gradient in size composition across the Bay of Fundy, with large fish (65-85 cm) on the northern side, medium-size fish (60-75 cm) around Grand Manan, and small fish (45-60 cm) on the southern side, off western Nova Scotia. Schooling by size-groups is an important feature of pollock behaviour.

Bay of Fundy pollock have a growth rate similar to that of pollock off western Norway, and more rapid than those of Faroese and Barents Sea pollock. Growth is rapid to maturity at about 6 years and slow thereafter. Plankton, particularly the euphausiid Meganctiphanes norvegica, is the main food of Bay of Fundy pollock. Fish is relatively more important in the diet of pollock on the Scotian Shelf.

The segregation of pollock by sizes implies that relatively few small pollock would be released by applying a minimum mesh size to otter trawling for pollock.

Halibut, Hippoglossus hippoglossus (L.). Halibut studies are concerned with the effects of incidental catches of small fish by otter trawlers, and of large fish discarded by European fishermen, on the longline fishery for large halibut.

In March, 707 halibut were tagged in the gully region between Sable Island and Banquereau (4V). Early returns indicate movement up the gully onto Middle Ground (4W).

Collections of halibut stomachs and gonads are made at sea on research vessels and by fishermen on commercial longliners. The main spawning takes place between December and February. Young halibut, up to about 75 cm fork length, feed mainly on crustaceans but also on molluscs, echinoderms and annelids. Halibut feed on fish at sizes as small as 35 cm, and fish becomes the main item of diet in halibut over 75 cm. By changing diet the halibut is able to maintain a rapid growth rate and reach a large ultimate size.

American plaice, Hippoglossoides platessoides (Fabr.). The flounder species of greatest commercial interest in Subarea 4 is the American plaice. The plaice has been studied in the southwestern Gulf of St. Lawrence (4T), where this species is second only to cod in total landings. Intensive otter trawling and high discards at sea of small plaice are reducing the availability of large plaice to the commercial fishery.

Tagging studies since 1958 have provided information on stocks, migrations and fishing mortalities of 4T plaice. None of the plaice tagged in 4T were recaptured outside this Division. Within this Magdalen Shallows area, two groups of plaice have been distinguished, one from the northern Miscou-Magdalen sector and the other from the southern Cape Breton sector.

Recaptures of tagged plaice in fall and winter months were few in number, because of greatly reduced fishing effort. However, all recaptures, even though limited in number, conformed with evidence from survey studies in demonstrating an offshore migration of plaice to deep water of the Laurentian Channel in winter. Nearly all fall recaptures of fish tagged in Chaleur Bay came from outside the Bay. Fall recaptures of plaice tagged west of the Magdalen Islands were almost all taken offshore towards the Laurentian Channel (60-100 fath). The three winter recaptures were from deep water along the western edge of the Laurentian Channel. The majority of summer recaptures from all areas were from the release areas, supporting survey evidence of a return spring migration inshore to shoal-water grounds.

High tag returns gave estimates of high total mortalities of marketable sizes of plaice (0.6-0.7).

Minimum mesh sizes in otter trawls and Danish seines would have to be considerably larger than $4\frac{1}{2}$ inches to release the large quantities of small unmarketable plaice which are currently discarded at sea as dead or dying fish.

Herring, Clupea harengus L. There is little doubt that the herring stocks in the southern part of the ICNAF area are under-exploited. Canadian and international catches of herring have been increasing. An important part of the catch is taken at the mouth of the Bay of Fundy (4X) as small "sardine"-size fish. However, the expanding fishery is for large herring, principally off western Nova Scotia (4X) and on Georges Bank (5Z). Otter trawls and purse seines have become relatively more important than the traditional weir and gill-net gears.

Canadian herring research is directed toward providing a sound basis for efficient utilization of the resource. Research programs in 1962 were concerned mainly with: factors affecting the abundance and availability of small herring in the Bay of Fundy (4X); the recovery of Gulf of St. Lawrence (4T) herring from epizootic effects on stocks; a survey of herring spawning areas in Chaleur Bay (4T); and a study of the migrations of herring in the Bay of Fundy and in the Gulf of St. Lawrence. In addition, two exploratory fishing cruises were carried out in the Browns (4X) and Georges Banks (5Z) areas of the Gulf of Maine.

The distribution of herring catches in the Bay of Fundy has shown wide variation in recent years with no major change in total landings. In 1958 and 1961 most of the catch (up to 80%) was taken on the southern side of the Bay and this has been associated with an "open"-type surface circulation in these years. In 1959, 1960 and 1962 most of the catch was taken on the northern side of the Bay when surface circulation was of the "closed" type.

The commercial herring sampled in 1962 on the southern side of the Bay of Fundy (25-32 cm) were about twice as long as those sampled on the northern side (12-14 cm).

Studies of the production and dispersal of herring larvae were carried out on a monthly basis throughout the year at the mouth of the Bay of Fundy. Larval collections were considerably smaller (about half as many per tow) than in 1961. However, for the first time in more than 25 years of collecting, some newly-hatched (5-7 mm) larvae were found in the northern, Passamaquoddy region during the spring (May).

Beginning in the late spring and early summer of 1954 a heavy and widespread mortality of herring occurred in the Gulf of St. Lawrence (4T). The dying and dead fish were infected with the fungus Ichthyosporidium hoferi, a pathogen which causes a systemic infection focused in the heart and lateral line musculature of herring and which, in an acute phase, results in the death of the fish. Mortalities reached a peak in June 1954 and continued to 1956. Conservative estimates place the destruction of herring in the Gulf of St. Lawrence at 50% of the mature fish present in the area at the time. Landing statistics, 112 million pounds in 1954 and 77 million pounds in 1957 with no change in effort, support this conclusion. Biological studies of the herring before and after the epidemic showed a decrease in the mean age and number of year-classes, and an increase in growth rate and relative abundance of the autumn-hatched herring. Changes in spawning habits, seasons, and in distribution and movements were also noted.

Recent studies of 4T herring have shown some evidence of return to pre-epidemic conditions. Average catches have increased about 20% in the Chaleur Bay area and nearly threefold in the Magdalen Island region. Additional evidence of recovery is seen in a gradual return to spring-hatched domination of the stock, and in increased mean age and number of year-classes.

A herring spawning survey was carried out in 1962 in Chaleur Bay by means of free (Scuba) diving techniques supplemented by sampling with a Petersen grab. The total spawning area surveyed was 375,000 square metres in extent. Eggs were attached to seaweeds and fishing gear but not to bare sand, gravel or rocks, and varied in density from about 1.4 to 21 million per square metre.

The estimated number of eggs on the spawning bed was 354×10^{10} and the number of spawners 185×10^6 . When related to landings, mortality in the immediate vicinity was calculated to be not more than 4%. Hatching commenced May 24, about 3 weeks after the beginning of spawning, and such concentrations of 5- to 7-mm-long larvae occurred that they were observed visually as "clouds" in the water.

In 1962 a total of 25,466 herring were tagged at the mouth of the Bay of Fundy and in the southwestern Gulf of St. Lawrence. Three types of tags were used, one "celluloid" cheek tag and two back tags--a spaghetti and a nylon-covered elastic thread. About 1% of the tags released in the Passamaquoddy area were recovered, practically all from the same general area. Less than 1% of the southern Bay of Fundy tags were recaptured in 1962, mostly from the same area but with some from the northern side of the Bay of Fundy. About 1% of the Magdalen-tagged herring were recaptured in 1962, all off the Magdalen Islands. Less than $\frac{1}{2}$ % of the herring tagged at Caraquet (northern 4T) were retaken in 1962, mostly in the tagging area, but with some southerly movement. The three types of tags yielded similar returns.

Exploratory fishing cruises in September 1962 showed herring to be abundant on Georges Bank and scarce on Browns Bank.

The few herring caught on Browns Bank in September averaged 21.4 cm long while the numerous herring on the northern edge of Georges Bank in the same month ranged from 28.5 to 30.6 cm in length. Some of the schools consisted of fish almost ripe and a few were in a "running" condition.

Sea scallop, Placopecten magellanicus Gmelin. Canadian sea scallop landings increased again in 1962 to a record 6.4 thousand tons of shucked meats (53 thousand tons whole weight). The bulk of this catch (94%; 6 thousand tons) was landed by the offshore fleet which fished almost exclusively on Georges Bank (5Z). A few trips were made to Port au Port, Newfoundland (4R), and Lurcher Shoals (4X) at the mouth of the Bay of Fundy. Landings from these areas amounted to less than half of 1% of those from Georges Bank. The increased landings by the offshore fleet resulted from increased effort (39 boats cfd. 28 in 1961). Crew sizes remained the same as in 1961 or even decreased slightly.

Two trips were made to Georges Bank on commercial boats to sample catches, study mortalities, measure sizes discarded and make biological observations. In 1962 Canadian scallopers fished continuously in order to keep crews busy. Deck loading, which was the accepted practice in 1960 and the first part of 1961, was uncommon in 1962 because the catch per unit effort decreased. Boats not only dragged continuously but fished over a greater area of the Bank (30 unit areas cfd. 19 in 1961). The minimum size retained for shucking dropped slightly in 1962, the 50% retention size being at a shell height of 90 to 95 mm. In the early part of 1962, six boats used 4-inch rings, but by the end of the year all except one reverted to the 3-inch ring.

The catch per unit effort, as measured by observers on commercial boats, has declined markedly over the past 3 years. Expressed as catch of market size scallops in bushels, per drag, per tow, per minute, it has decreased from 1.93 in 1960 to 0.58 in 1961 to 0.4 in 1962.

Results of gear studies, conducted in 1961 and reported at the Annual Meeting in June, showed that increasing the ring size on offshore drags to 4 inches will produce neither the sharp selection nor sufficient release of small scallops to increase yield by delaying age at first capture. In 1962 a program was begun to examine the present gear and determine whether it can be made more selective and more efficient or if a new design is necessary to achieve these ends. Work was done in the southern Gulf of St. Lawrence from the M.V. Harengus. Scuba divers were employed in this study. Preliminary results indicate the present style drag is very efficient at catching market size scallops when they are sparsely distributed on smooth bottom.

The laboratory program, investigating aspects of the basic biology of the sea scallop, was continued in 1962 with major emphasis again devoted to a study of the larval stages. Larvae were obtained from six spawnings and reared under different temperatures and fed various foods. Larvae from one spawning were kept 58 days and measured 275 X 288 microns. They developed a foot and appeared ready to settle but did not.

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Fig. 1 for
1. Canadian Research Report, 1962 B. Subareas 4 and 5, Biology by W.R. Martin.

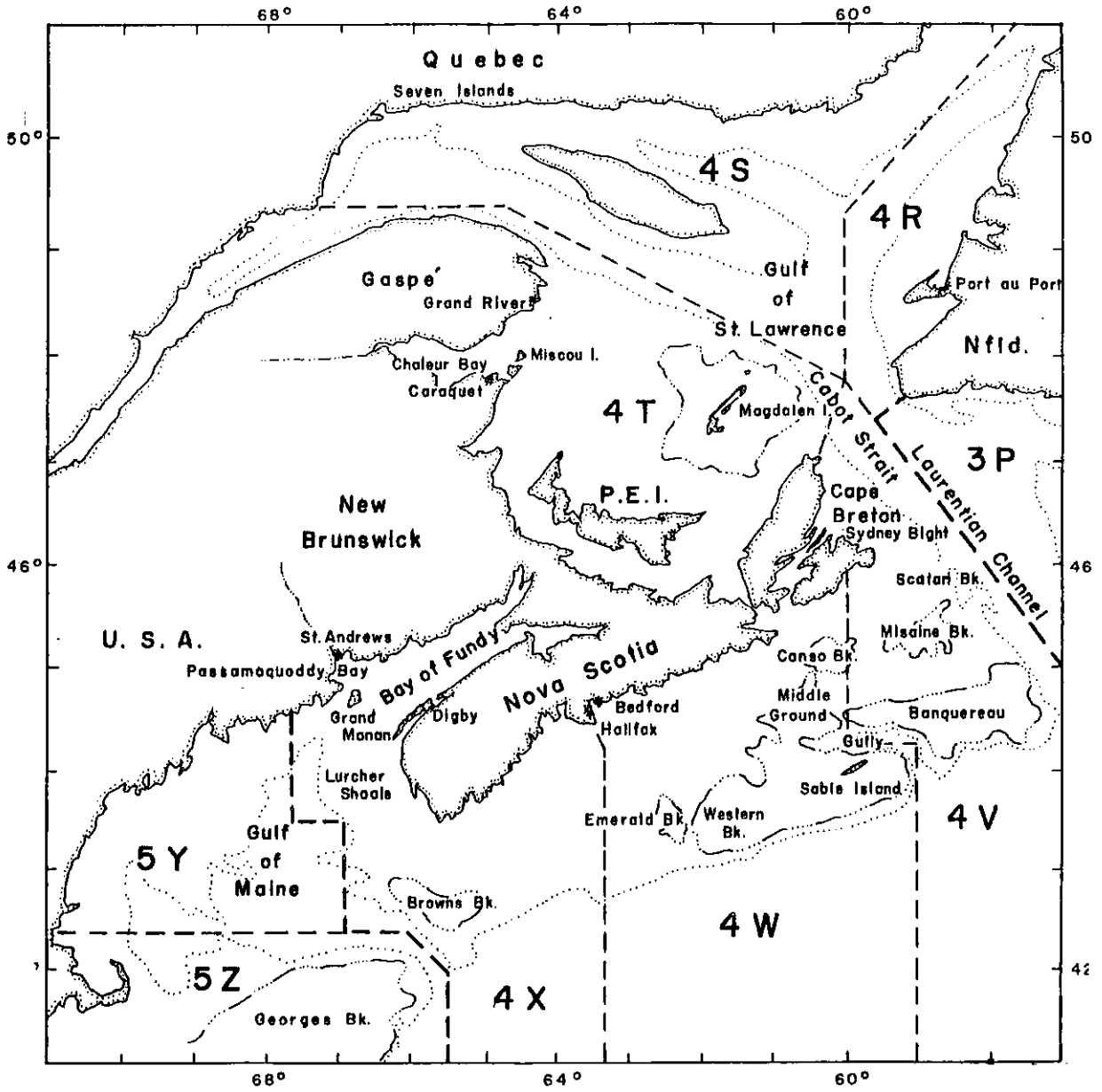


Fig. 1. Map showing locations of names mentioned in the text.