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FISHERIES RESEARCH BOARD OF CANADA

Atlantic Biological Station

A Summary Report of the  
Maritime Groundfish Investigation

by

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Introduction

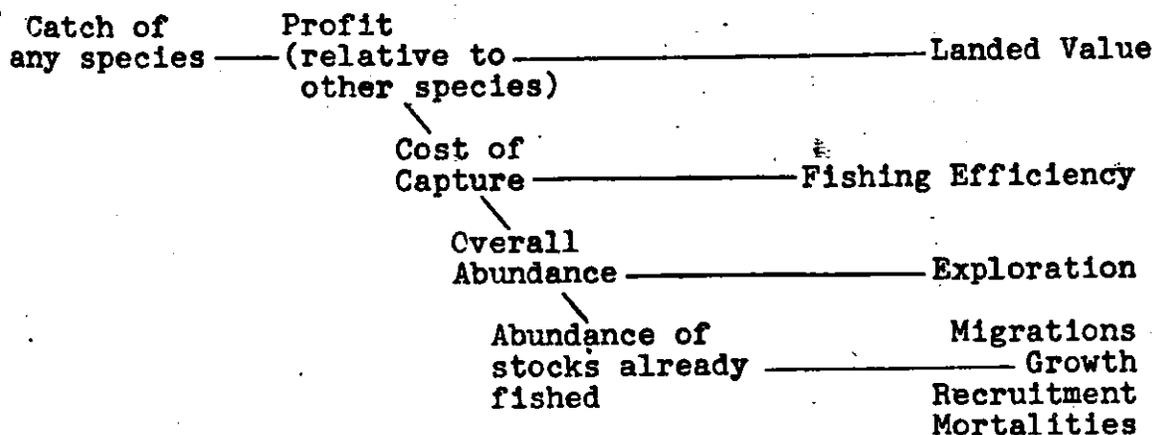
Nets and lines, when fished on the ocean floor, catch a great variety of species which in the aggregate we term "groundfish". In the Maritimes, cod, haddock and halibut have been traditionally popular and pollock, hake, cusk and catfish have been landed as bi-products. Redfish and four of the flounder species, plaice, witch, yellowtail and winter flounder, have become marketable in recent years.

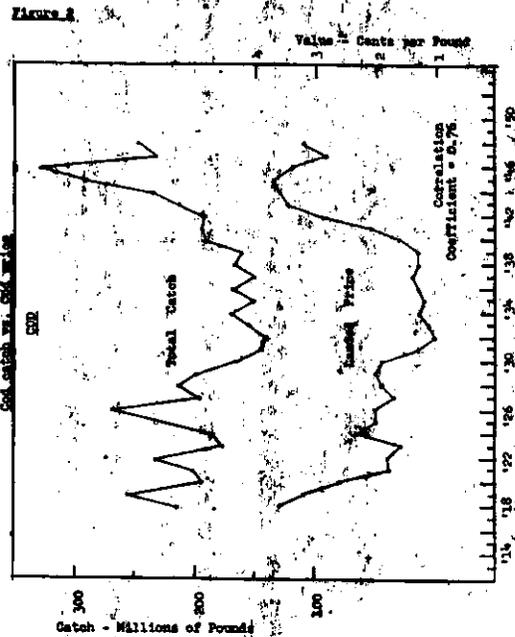
An excellent record of the annual catch of each of these species has been kept by the Department of Fisheries since 1917 and less complete records go back to 1880. These statistics which are broken down by Province, County and unit area are submitted monthly and annually. The inshore catch made by small boats is separated from that made offshore by vessels and otter trawlers and trawler catches in turn are listed separately. The inshore records are particularly valuable to the biologist since, for the most part, the catches are made in the neighbourhood of the point of landing. The locations of offshore catches, on the other hand, are not

recorded and may be taken anywhere from Browns bank, off western Nova Scotia, to Grand bank, south of Newfoundland. In order that the offshore statistics may be of greater value in the assessment of the status of the fishery, records of the location of offshore catches and the effort expended in making these catches are now collected by the Fisheries Research Board.

The annual catches of the more important groundfish species have fluctuated widely from year to year. (Figure 1). The cod catch was less than 150 million lb. in 1931 and 1932 and greater than 300 million lb. in 1910 and 1946. Annual catches of haddock have varied widely, from 25 to 70 million lb., during the past 50 years. Such statistics are of primary importance to the fisheries biologist.

Since the end of the 1939-45 war a groundfish investigation has been established by the Fisheries Research Board to analyse the observed fluctuations in catch and on the basis of various measurements to evaluate the potentialities for the future. The investigation follows several lines of attack, all of which are directed toward developing a wiser exploitation of groundfish resources. The relationship of the various factors measured in the analysis of catch fluctuations is shown below.





### Landed Value

The landed price of various groundfish species has had a important effect on the total catch. The relationship between price and total catch of cod is shown in Figure 2. It is apparent that both price and catch were high at the end of the first and second Great Wars and again during the late twenties. Price and catch were low, on the other hand, during the depression of the early thirties. It is obvious that increased market demand through improved quality is of the greatest importance in increasing the cod catch of the Maritimes.

Part of the problem of quality improvement in cod has fallen to the biologists. The cod of the Maritimes and those taken from inshore waters, in particular, are infected with a larval nematode of the genus Parrocaecium. An investigation by Dr. Scott has clarified the essential features of the life history of this nematode. It has been demonstrated that the harbour and grey seals, the hosts of the mature worms, constitute the most vulnerable link at which the life cycle of the worm may be broken. On the basis of this study, an experimental control of parasitization of cod, through reduction of the seal population, will be initiated by the Fisheries Research Board in the Bras D'Or lakes during 1950.

The catch of any particular species is believed to be dependent in part on the relative rather than actual landed value. For example, the catch of halibut has been more directly related to the relative price of halibut and cod than to the price of halibut alone.

Maritime catch vs. New England catch

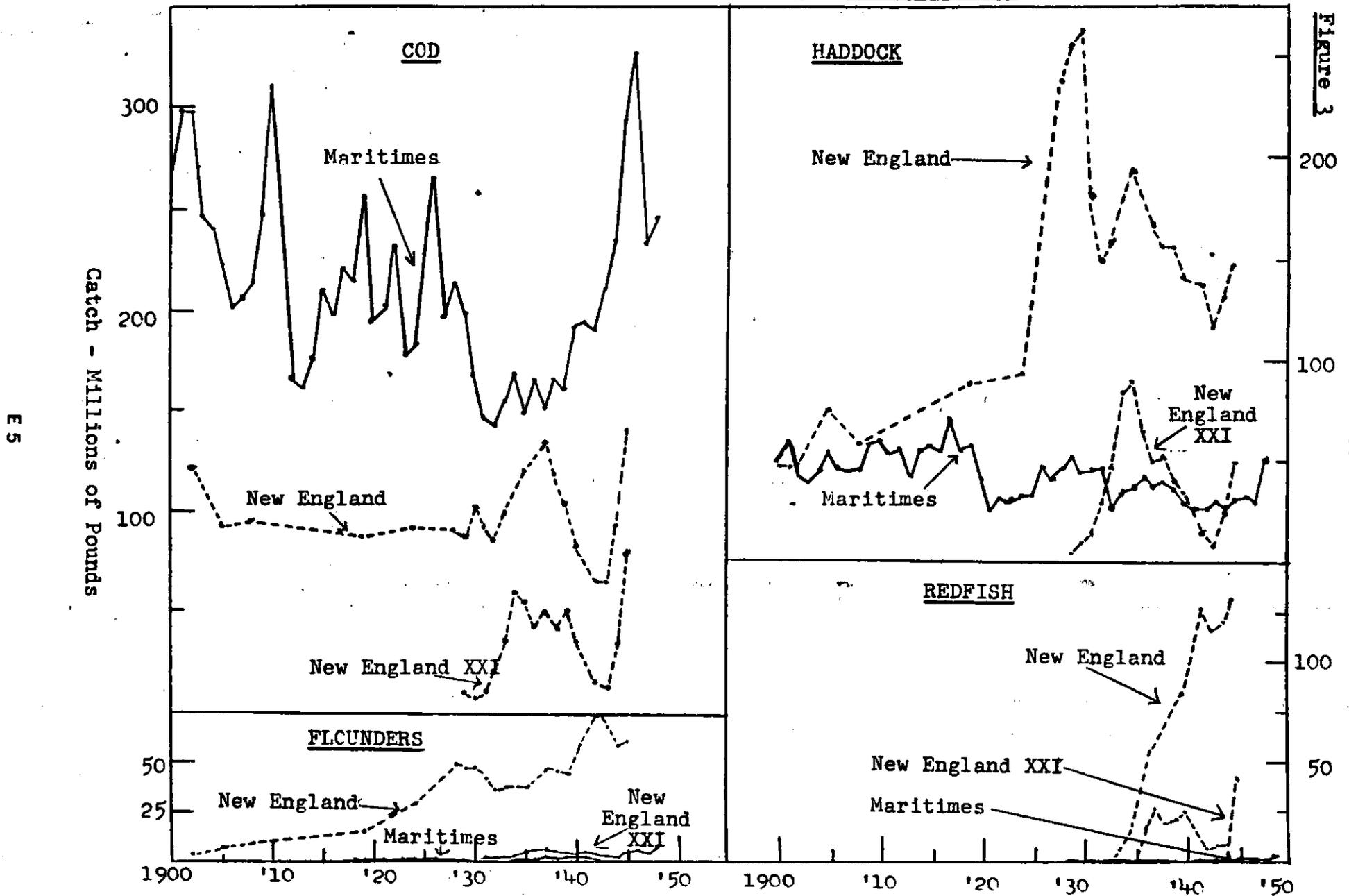


Figure 3

<u>Period</u>	<u>Average Halibut Catch millions lb. - Nova Scotia</u>	<u>Average ratio of Halibut price to Cod price</u>
1920-29	2.6	6.2
1930-39	3.1	7.1
1940-47	1.4	5.5
1948	2.3	6.1

During war years when the price and availability of cod were high, it was not as profitable to fish halibut as in pre-war years. Since the war the relative price of halibut has increased and cod have become less abundant. As a result, vessels have again fitted out for halibut fishing and the halibut catch has increased to more than 4 million lb. in 1949.

In the assessment of fluctuations in groundfish catch, landed value is an important factor to be measured. As long as catch can be increased through increased market demand and increased price, there will be little concern over limitation of supply.

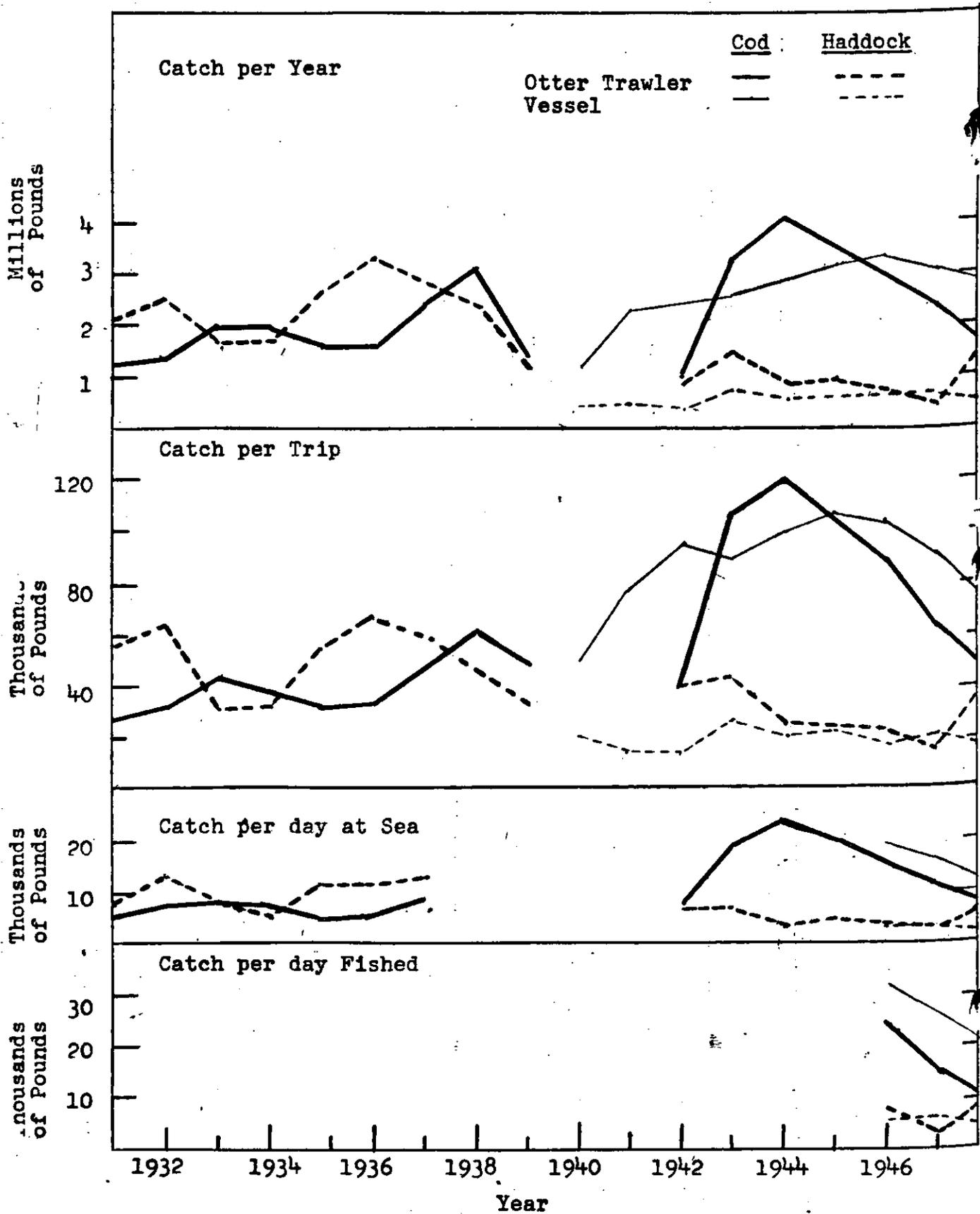
### Fishing Efficiency

The introduction of new fishing methods has an important effect on catch. Canadian fishermen have depended largely on traditional line-fishing methods and as a result have lagged behind other countries in the exploitation of groundfish resources. Only through the use of efficient fishing methods can Canada maintain her competitive position in world markets.

It is of interest to contrast the groundfish catches of the Maritimes and the New England states (Figure 3). In the twenties there was a major shift from line fishing to otter trawling in the New England states and as a result the catches of haddock, flounders and finally redfish have increased sharply. The total

Figure 4

Vessel catch vs. Trawler catch



groundfish catch increased from about 200 million lb. in 1920 to about 400 million lb. in 1940 while the groundfish catch of the Maritimes decreased from about 250 million lb. to about 230 million lb. during the same period. An important proportion of the increased New England landings was taken from the Nova Scotia banks (Area XXI). The contrast of New England and Maritime catches is of importance in pointing out the opportunities for development of increased variety and increased catch in our groundfish industry.

By measuring catches made with various fishing methods, the Board is attempting to assess the efficiency of each method and the potentialities of effecting an increased total catch through improved fishing efficiency.

By means of detailed records of each offshore fishing trip, the Fisheries Research Board now obtains valuable information on abundance and fishing efficiency. A back log of trip reports collected by the Department of Fisheries has been useful in building up the long-term picture of offshore fishing.

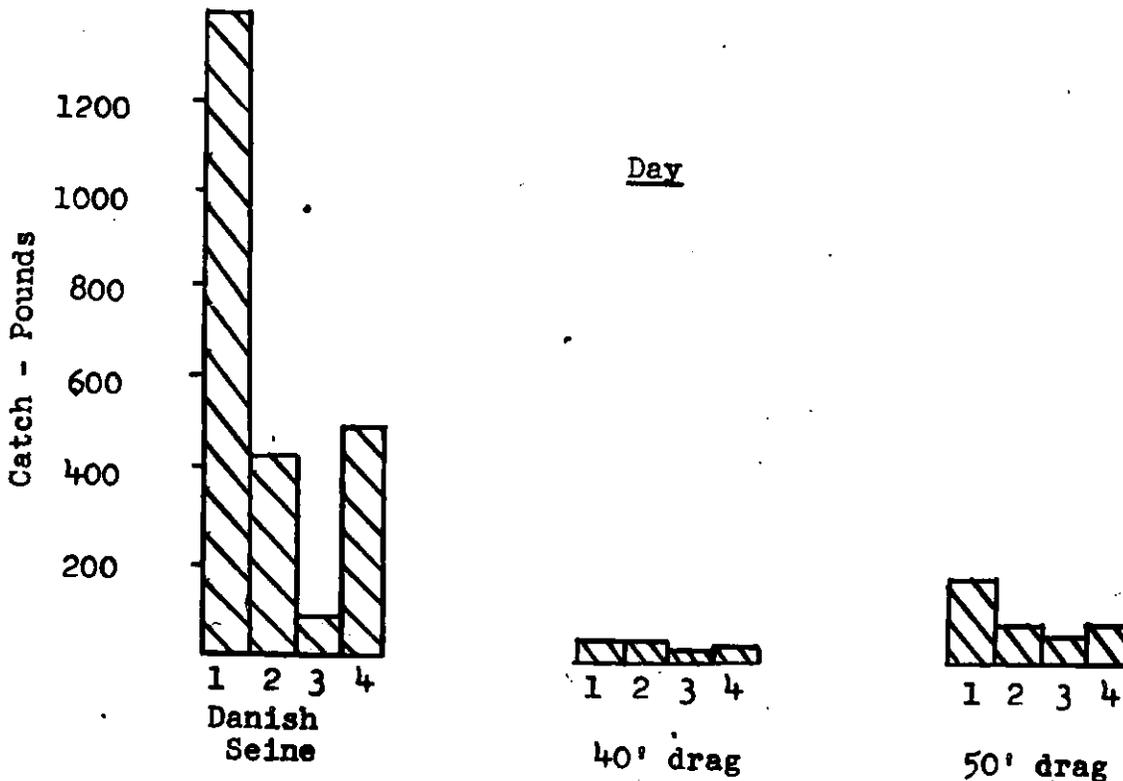
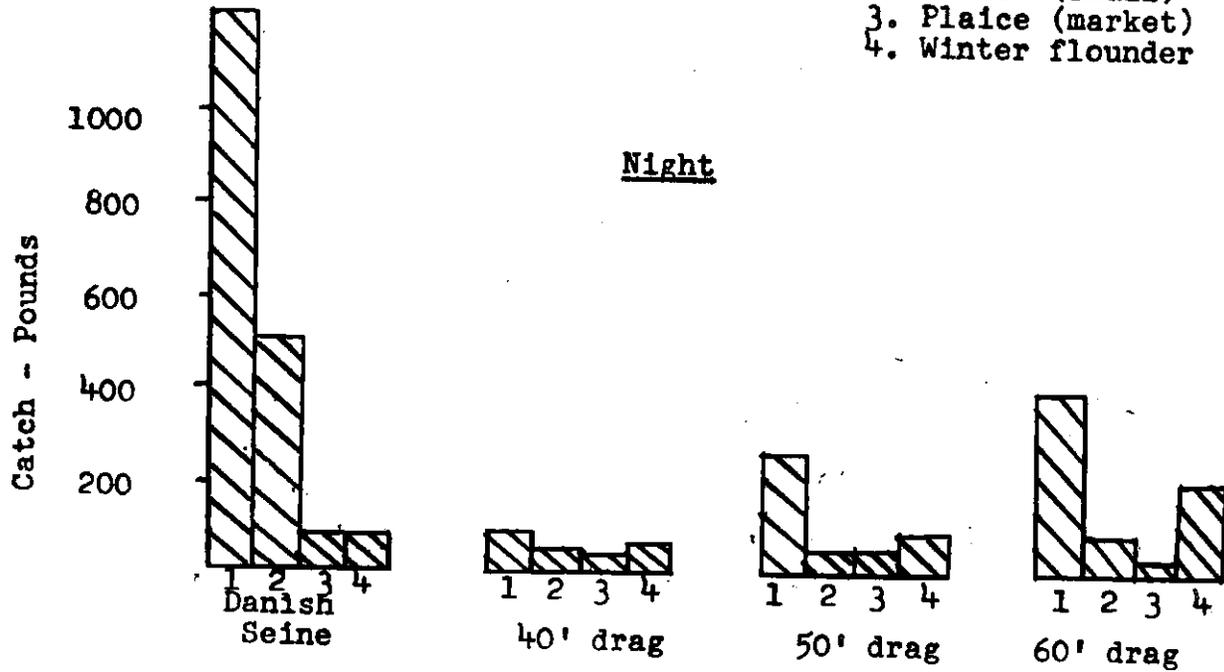
The average catches of the four largest vessels\* and four largest otter trawlers carrying out continuous fresh fishing operations are plotted in Figure 4. The data are of interest in a study of the comparative efficiency of vessels and otter trawlers in the capture of cod and haddock. It may be noted that the relative catches of otter trawlers and vessels differ from year to year. When haddock were abundant in the thirties otter trawling proved to be an effective fishing method but

\*The term vessels as used in this paper refers to line-trawl or dory schooners.

Figure 5

Comparison of average haul  
Danish seine and flounder drags

- 1. Witch
- 2. Plaice (small)
- 3. Plaice (market)
- 4. Winter flounder



when cod were abundant during war years line-fishing vessels, in general, made better total catches. In some years fish are abundant on the smooth grounds on the tops of the fishing banks while in others the fish are more readily available on the deeper and rougher parts of the banks. Since otter trawling is restricted to the smoother fishing grounds and line fishing is less restricted by bottom type, otter trawl catches are more variable than those of vessels. It is clear then that, in comparison with otter trawling, dory fishing is an efficient fishing method on grounds adjacent to the Maritimes. The lower capital cost and lower operating expenses in vessel fishing, together with the high efficiency of this method, particularly in fishing salt cod, suggests that vessels will not be replaced quickly by otter trawlers. Dory fishing is a rigorous life and the survival of vessel fishing hinges on the problem of finding dory fishermen rather than the relative efficiency of the method.

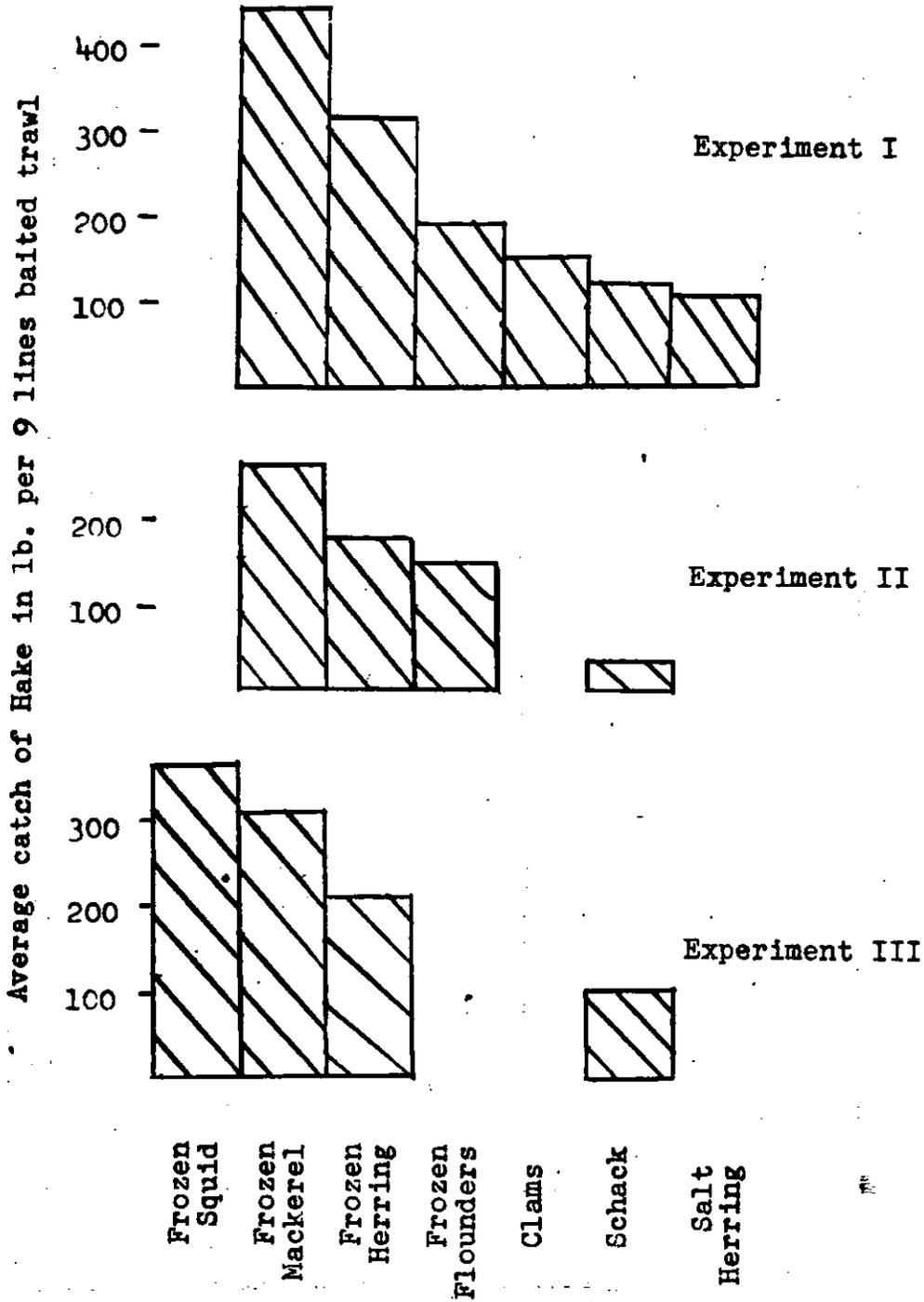
A major part of the groundfish investigation is concerned with the measurement of catches made with methods which are new to the Maritimes.

The west coast long-lining method was studied by the construction and operation of the long-liner M.V. "J.J. Cowie" (49 gross tons) and the purchase of four small gurdies which were operated by inshore fishermen in various parts of the Maritimes. The experiments showed that the use of a gurdy reduced effort and permitted the handling of more gear and thus more fish. Power hauling was shown to be particularly useful in hauling heavy gear and large fish from deep water. This

Figure 6

Bait Experiment for Hake

Souris, P.E.I. - July-September, 1949



work stimulated the development of power hauling of line trawls by inshore fishermen in the Maritimes and power haulers of various types are now common in south-western Nova Scotia.

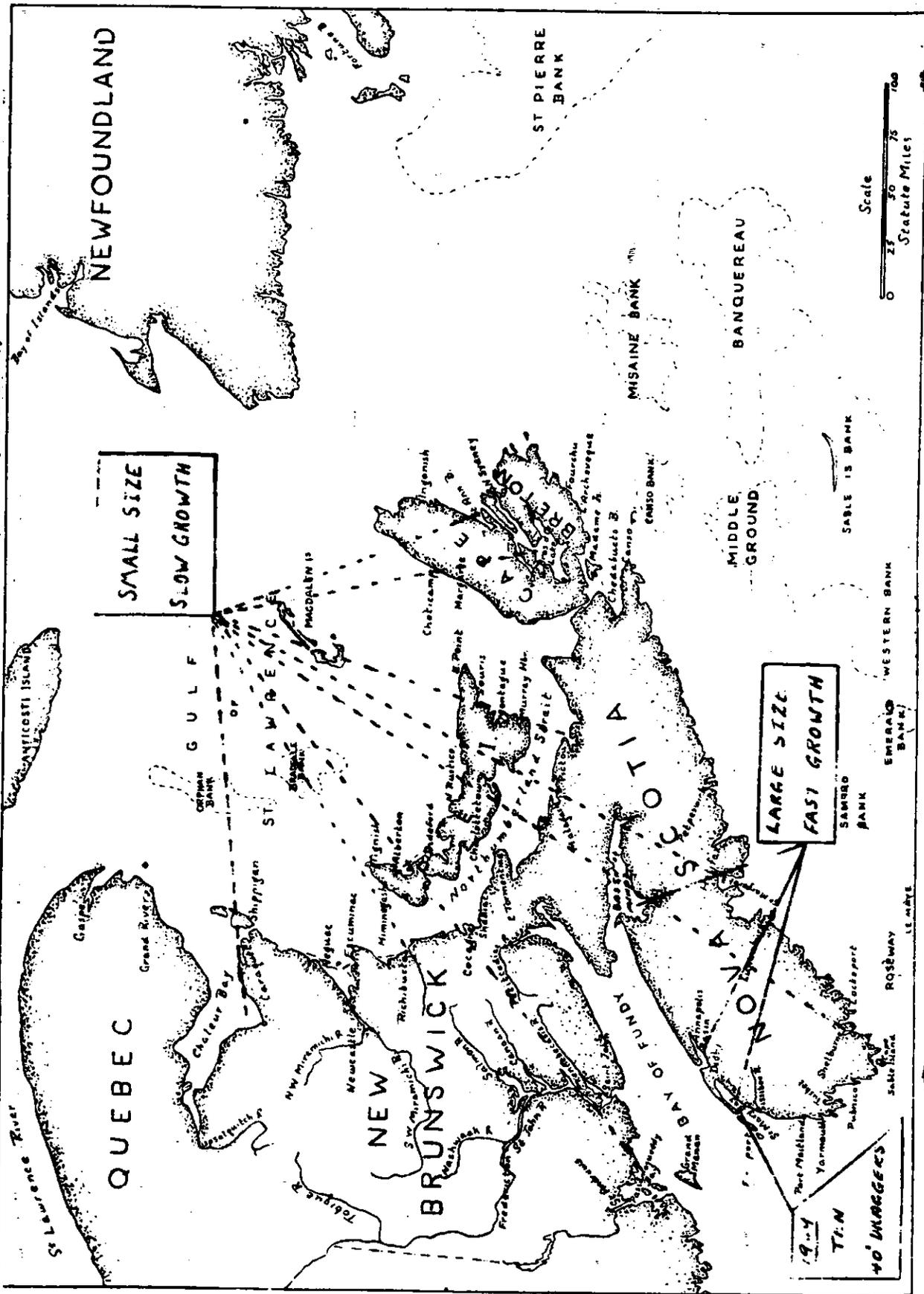
During the past two years, the M.V. "J.J. Cowie" has been used for Danish seining experiments. A comparison of average hauls made with the Danish seine and 40, 50 and 60 ft. flounder drags in Chedabucto bay is shown in Figure 5. The method is clearly efficient for the capture of flounders. However, it must be remembered that the value of Danish seines is strictly limited since the use of this gear is restricted to smooth bottom and such grounds are not common in the Maritimes. The Danish seine equipment has now been transferred to a commercial vessel at Canso, N.S., in order that a commercial trial may be carried out in the area in which the "Cowie" had the greatest success.

Bait experiments were conducted by Mr. McCracken during the summer of 1949 at Souris, P.E.I., in order to measure the relative efficiency of various baits. The results of these experiments are summarized in Figure 6. Squid and mackerel, although expensive, yielded a greater net profit than the cheaper baits which were available locally.

Gill-netting experiments are planned for 1950.

The development of a variety of fishing methods is essential if we are to more fully exploit our groundfish resources and indeed if we are to maintain a competitive position with our neighbours. Many of the groundfish species with small mouths (redfish, witch, yellowtail and winter flounder) are not available

EXPLORATORY WINTER FLEETNET DRAGGING



to line fishermen and other methods of capture must be developed for these species. The biologist, through an understanding of fish populations, can contribute much toward better exploitation of these species and the measurement of catches made with various fishing methods will lead to this end.

### Exploration

An important division of catch measurement work is exploration for new concentrations of fish. The fishing banks along our east coast are intensively fished adjacent to the New England states but very lightly fished east of Newfoundland. Even on the New England grounds, the biologists in charge of the U.S. research vessel "Albatross III" have, during the past year, advised the industry of the location of fish concentrations as they have been discovered. On the grounds adjacent to Newfoundland many poorly exploited populations are being discovered by the Newfoundland Biological Station. The potentialities of the grounds adjacent to the Maritimes are not as yet well known. United States fishermen have contributed much to the exploration of Nova Scotia banks, particularly in the discovery of concentrations of redfish. A concentration of witch was discovered by American fishermen in deep water north of Banquereau during the winter of 1949 and Gloucester fishermen in particular reaped the harvest. The Maritime Industry has shown little interest in these fish concentrations to date.

Exploratory inshore dragging conducted by the Fisheries Research Board during the summers of 1947-49 with the 40 ft. M.B. "Pandalus" has resulted in the development of commercial

dragging in western Nova Scotia (Figure 7). This has been a completely new departure for the industry. Winter flounders were taken in large numbers from waters shoaler than 20 fm. along the whole coast line from Passamaquoddy bay, N.B., around Nova Scotia, to Chaleur bay. A series of 15 min. hauls with a 40 ft. flounder drag were made in each of the areas sampled. Most of the flounders taken were of small average size and slow growth rate. However, in St. Mary's bay, Annapolis basin and Minas basin the winter flounders were large and growth rate was shown to be rapid. During 1948, the M.V. "K.L.-63" was granted an experimental dragging licence for St. Mary's bay and from April to October she landed 343 thousand lb. of flounders. In 1949 boats smaller than 40 ft. in length were granted dragging licences for St. Mary's bay. Open boats were rigged in various ways, some with double-drum winches and gallows frames and others with adapted lobsterpot haulers and ropes for hauling the net. The local fishermen were strongly opposed to dragging until they discovered, through experience, that an additional source of income was available to them. One of the small draggers planned to continue with flounder dragging in the winter of 1949 in preference to conversion to lobster fishing, his normal winter-time occupation. Commercial flounder dragging is following a similar development in Annapolis and Minas basins.

Exploration for halibut with the M.V. "J.J. Cowie" in 1946 demonstrated the possibility of a larger fishery in the Anticosti region by fishing more gear in deeper water (100 fm.) over a longer season.

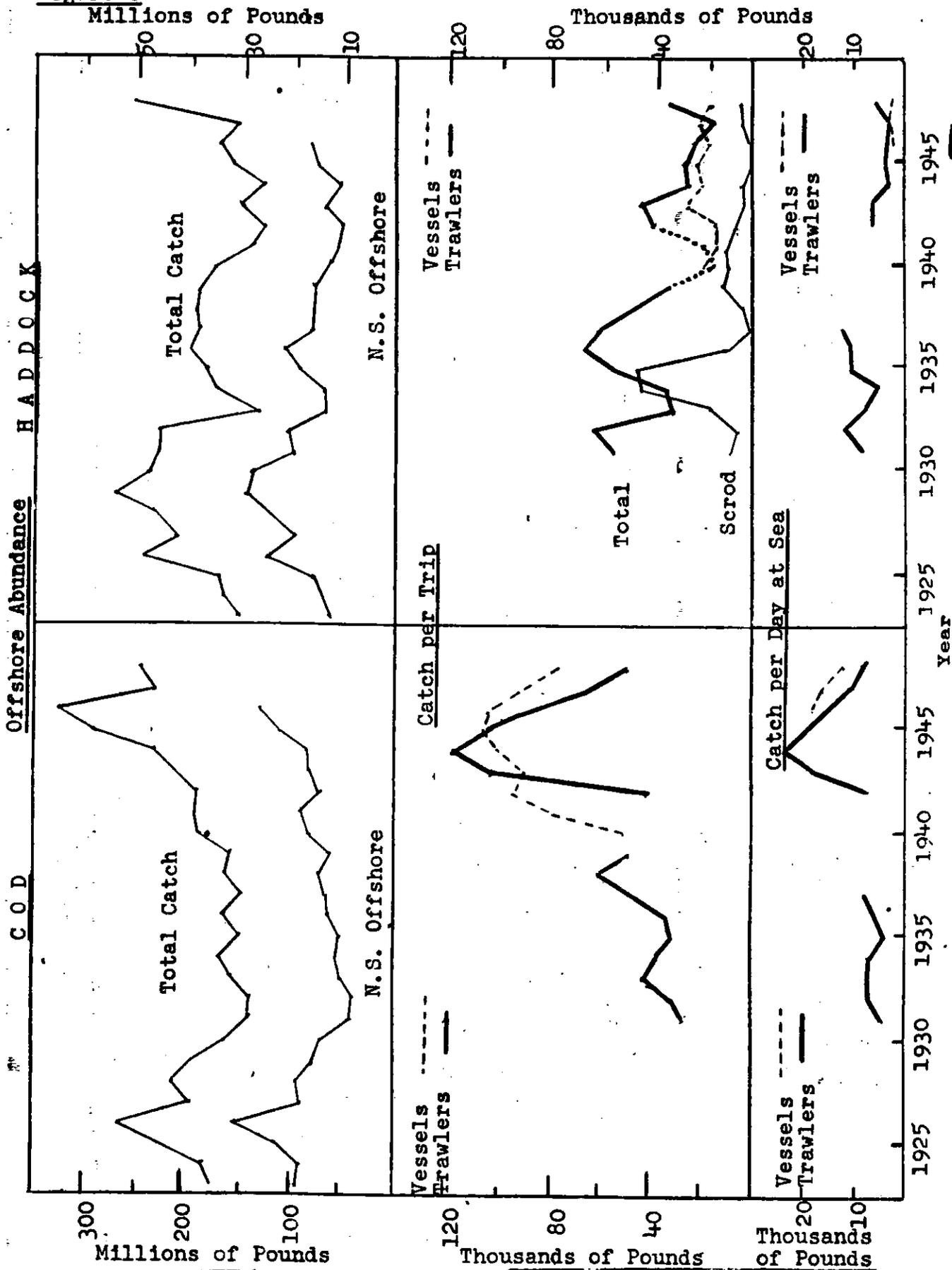
To date, exploration in the Maritimes by the Fisheries Research Board has been limited to inshore waters. It is hoped that an offshore research vessel will be obtained in order that this work may be extended. Continued exploration in deeper water should point the way to development of a fishery for redfish, plaice and witch. The recent development of a fleet of 20 New Brunswick draggers, some of which have taken a million pounds in one season from the Gulf of St. Lawrence, is indicative of the potentialities for development of the groundfish industry in this area. The measurement of fish catches made in exploratory fishing whether by the Board, the Department of Fisheries or the Industry, is essential to the development of the groundfish industry.

#### Abundance

Fluctuations in catch are in part the reflection of variations in abundance of fish stocks. In the measurement of fish catches we are therefore concerned with the vital statistics of the stocks and the various factors which control abundance. Such measurements enable us to recognize the conditions necessary for optimum sustained yield. They form the basis for assessing the relation of changes in fishing intensity and changes in the minimum size at which fish are taken to the catch. Such knowledge permits prediction of and planning for the fishery of the future.

Groundfish abundance is sufficiently great and fishing intensity sufficiently low that the more direct measurements of population size such as tagging are impractical. Changes in

Figure 8



the relative size of groundfish populations have been measured indirectly by means of catch-per-unit-effort data. Although the relationship may not be linear the measurements are valuable in the interpretation of catch fluctuations.

Trip reports for otter trawlers have been collected by the Department of Fisheries since 1931 and reports of individual vessel landings have been submitted since 1939. These data, which have been made available to the Board, have been useful in building up the long-term picture of changes in abundance. Although data on effort and location of capture were not collected until 1946, measurements of catch-per-trip and catch-per-day-at-sea are available from Department records. The four largest steam trawlers and four largest vessels which have carried out continuous year-round fresh-fishing operations were selected as an index of changes in abundance. The averages have been plotted in Figure 8.

The abundance of cod increased during war years but since the war the abundance has decreased to the pre-war level. Cod catch per-day-at-sea of the selected otter trawlers increased from an average of about 7 thousand lb. in the thirties to more than 20 thousand lb. at the end of the war. The offshore catch increased from about 55 to 130 million lb. during this period. It may be noted that the otter trawl cod catches exceeded those of the selected vessels in 1943-44 at the peak of cod abundance on Nova Scotia banks. This may be due to a general spreading of cod over smooth and rough bottom when they are abundant or when hydrographic conditions permit such distribution. When abundance is reduced or when hydrographic conditions are

suitable cod appear to be more readily available on rougher bottom and thus more readily caught by vessels than by otter trawlers. There is a good deal of evidence to suggest that both factors affect the relative efficiency of vessels and otter trawlers.

In contrast to cod, the abundance of haddock was low during war years. The market demand and landed price were sufficiently high to induce fishermen to search for haddock but they were found to be much less abundant than cod. In the thirties, on the other hand, otter trawlers caught more haddock than cod. The years of maximum abundance, 1932 and 1936, correspond with years in which the offshore catch exceeded 20 million lb. The increased abundance and increased catch in 1948 were in part due to the discovery of good haddock fishing on St. Pierre bank and in part due to increased abundance on Nova Scotia grounds.

The abundance of scrod haddock as well as total haddock is shown in Figure 8. The high scrod catch in 1934-35 was associated with a high total haddock catch in 1935-38. A lesser scrod peak in 1939-41 was associated with an increased total catch in 1942-43. This relation of scrod abundance to total haddock abundance indicates large fluctuations in reproduction and survival of young haddock. Production of young has been low since 1935 and as a result haddock abundance and total catch on Nova Scotia banks have been low for the past ten years.

Short-term biological investigations by Needler and Thompson provided data which contribute to our understanding of fluctuations

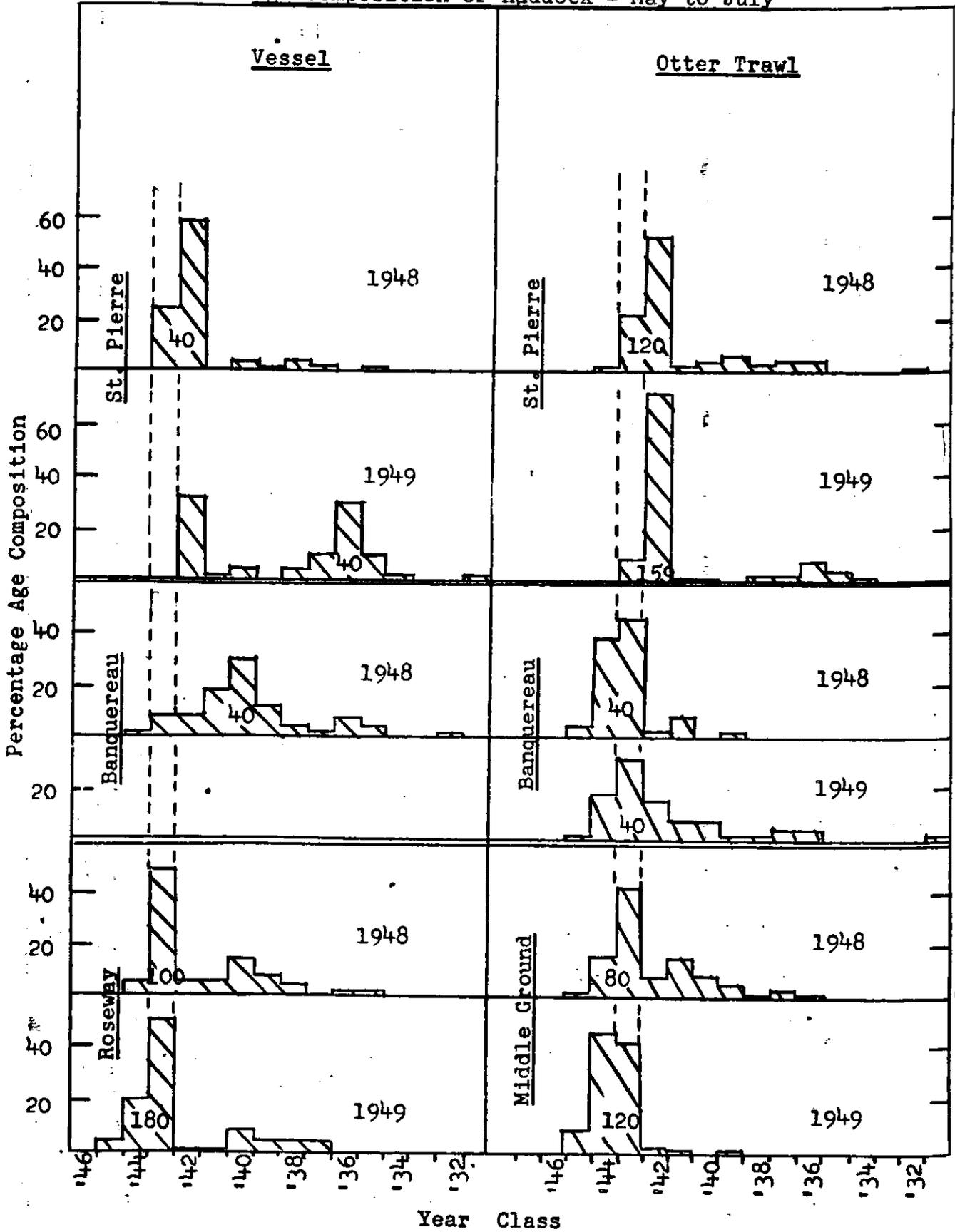
in the haddock catch. On Nova Scotia banks, year-classes immediately prior to 1915 and those of 1920-25 and 1928-29 have been shown to be abundant with those of 1914, 1920 and 1929 particularly outstanding. Age analyses show that each year-class contributes most to the catch when five to six years old. The years in which increased catch might be expected as a result of abundant year-classes correspond closely with years in which the Maritime catch was observed to be high.

During the high abundance of scrod and large haddock in 1934-38, New England trawlers caught 50 to 90 million lb. annually on Nova Scotia banks. Again in 1945 New England trawlers took 50 million lb. of haddock from Nova Scotia banks. It is apparent then that although abundance, as measured by catch-per-unit-effort, has been low during recent years and the Maritime catch similarly at a low level, the total catch taken by Maritime and New England fishermen from Nova Scotia banks has been higher during the past 20 years than it was previously. However, the effort expended in obtaining a comparable total catch has been greatly increased since 1938.

Interspecific competition between cod and haddock may be of importance in determining the relative abundance of each. Cod may have been sufficiently abundant during war years to restrict the production of haddock. Such a relationship is purely speculative. It has been shown by Herrington for Georges bank that an abundance of adult haddock has been correlated with a reduced production of young haddock. Since cod are more cannibalistic than haddock, it is not unreasonable that population densities of cod and haddock may be related in a

Figure 9

Age Composition of Haddock - May to July



similar way.

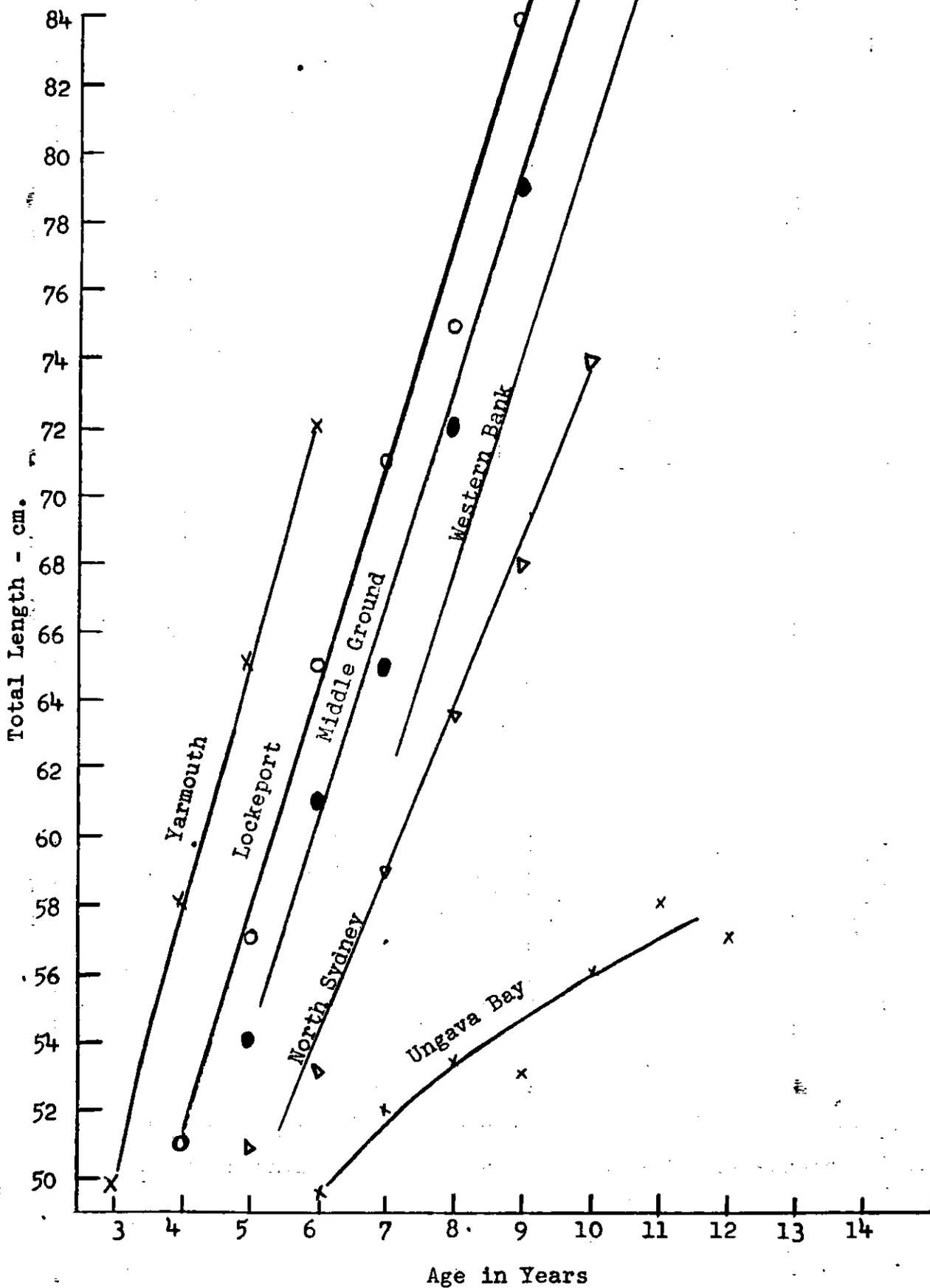
Since 1945, detailed records of sizes and ages as well as abundance of the more important groundfish species have been collected by the groundfish investigation for waters of the Maritimes. In 1948, for example, 4,900 cod otoliths, 3,200 haddock otoliths and smaller numbers of otoliths from pollock, hake, plaice, yellowtail, witch, winter flounder and redfish were read. Otoliths were taken from about one-fifth of the fish measured. These data are useful for the measurement of migrations, growth, recruitment and combined fishing and natural mortalities. Although our groundfish stocks are believed to be under-fished, the long-term collection of vital statistics of each species will enable us to determine more precisely the factors involved in abundance fluctuations. Reduced catches, increased fishing effort and competition invariably result in apprehension on the part of fishermen concerning the ruination of the fishery. Measurements of migration, growth, recruitment and mortalities will enable us to distinguish between under- and over-fishing and recommend remedial measures to assure wiser use of the fishery.

### Migrations

Investigations by McKenzie, Needler, Thompson, Vladykov and others have established the major groupings of cod and haddock populations. Present studies of growth, age composition and codworm incidence are useful in defining the populations within each major group. The difference in age composition of haddock taken from St. Pierre bank and Banquereau, on either side of the

Figure 10

Variation in rate of growth of Cod



Laurentian channel, adds credence to the distinctness of these populations (Figure 9). Differences in growth, vertebral counts and movements of tagged fish have been described by other writers. The occurrence of cod worms in the majority of cod taken from the Gulf of St. Lawrence distinguishes these fish from cod taken from the banks off Nova Scotia where cod-worm incidence is generally less than ten per cent. Such definition of populations forms the basis for interpreting the vital statistics of the groundfish in any given area.

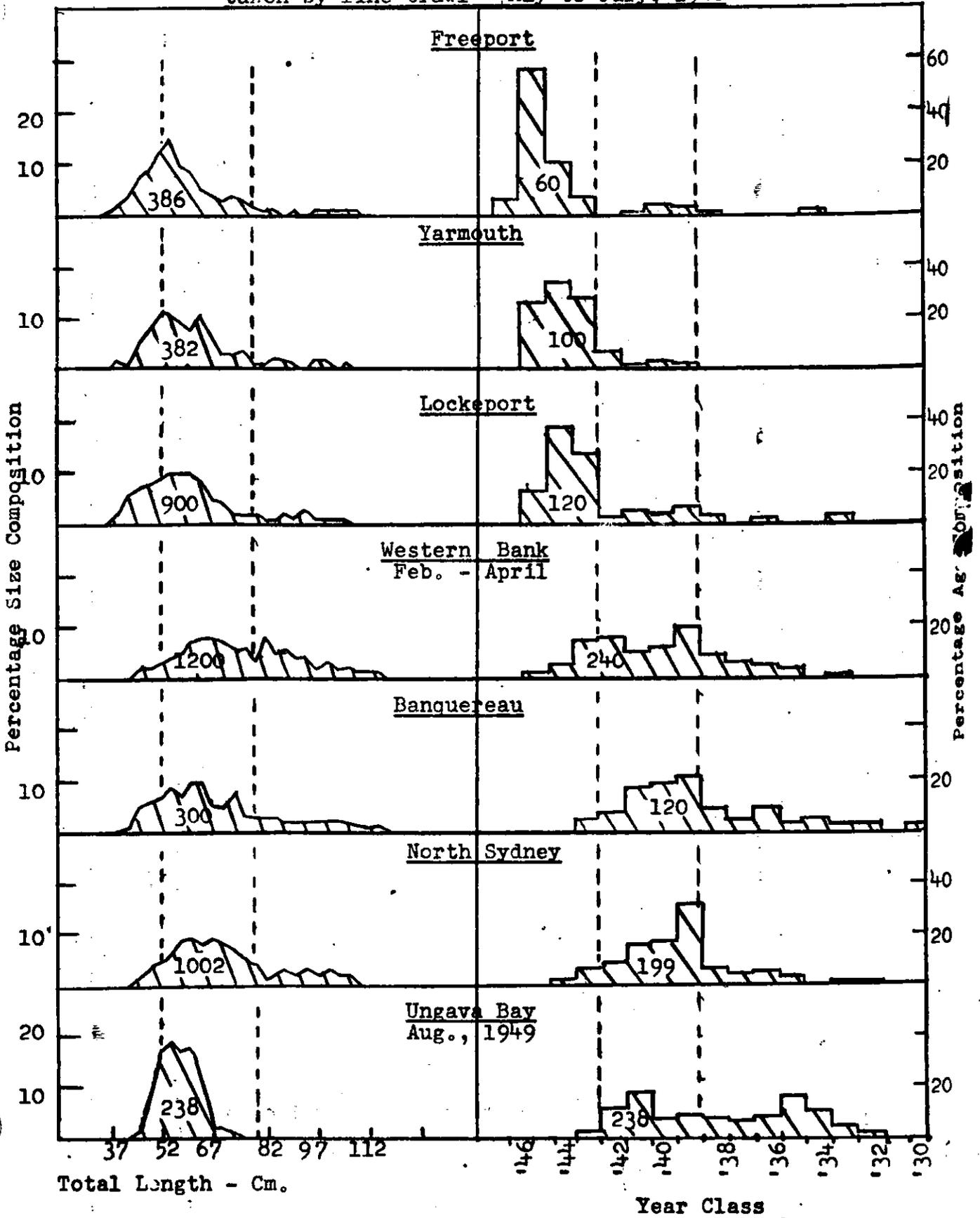
### Growth

Growth of groundfish populations differs widely from one part of the Maritimes to another. Growth rate of cod, for example, decreases between western Nova Scotia and Ungava bay (Figure 10) and this has a great effect on the size and age composition of the landed catch (Figure 11). In Ungava bay growth is so slow that an average length of 60 cm. is reached only after 13 years of growth. Although cod taken off western Nova Scotia are of comparable size with those from Ungava they grow much more rapidly and the greater part of the fish landed are less than six years of age. Cod from intermediate areas grow at an intermediate rate but to a much greater size than either at Ungava or off western Nova Scotia.

### Recruitment

The age at which cod and haddock enter the fishery varies in accordance with the area fished and the fishing method. The differences between areas are shown for cod in Figure 11. Cod

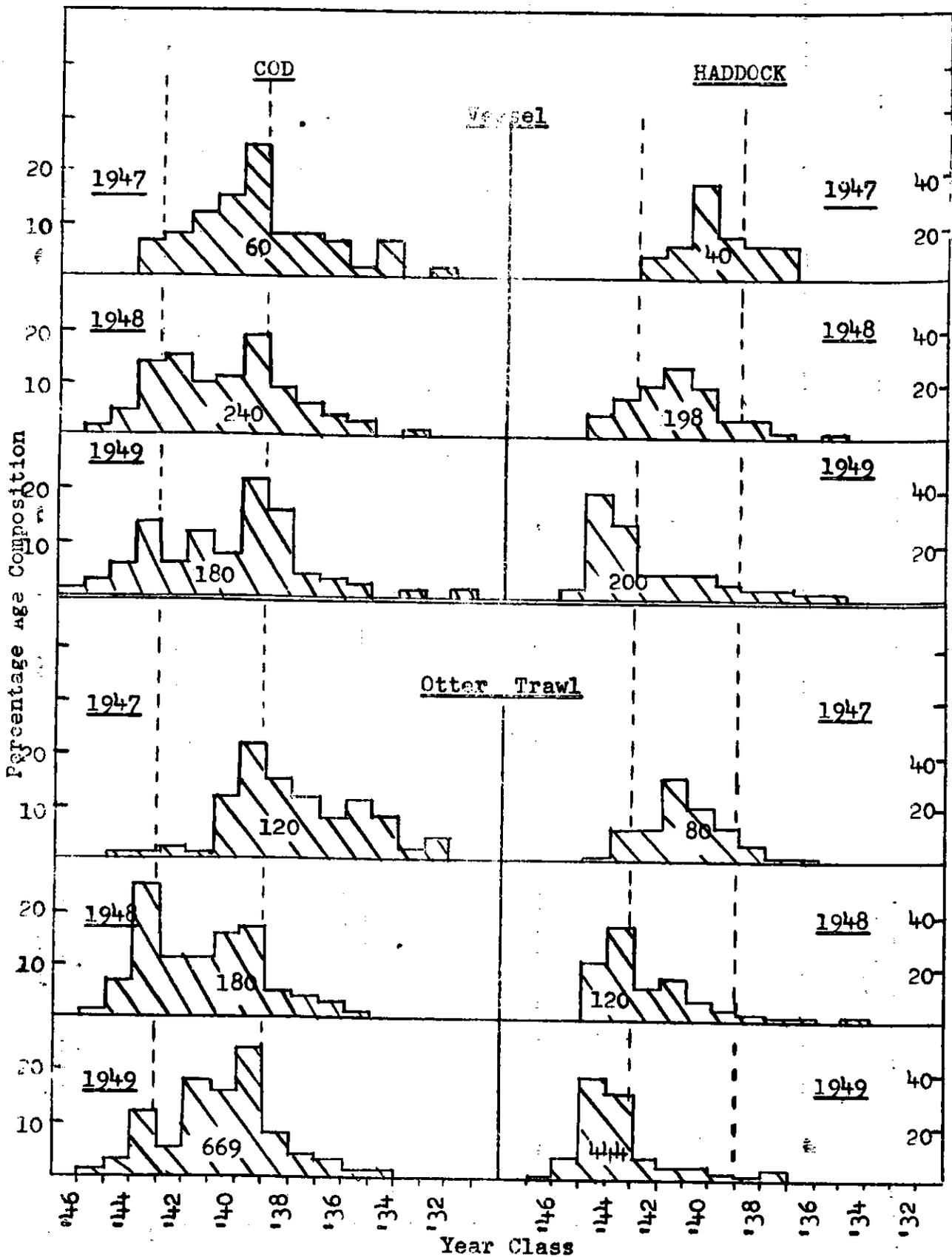
**Figure 11**  
Variation in Size and Age Composition of Cod  
taken by line trawl - May to July, 1948



enter the line fishery in large numbers at the age of three years in western Nova Scotia, five years on offshore Nova Scotia banks and seven years at Ungava bay. Haddock enter the line fishery in large numbers at the age of five years on offshore Nova Scotia banks. Both cod and haddock are taken at a smaller size by otter trawlers than by vessels (Figure 9 and 12). The difference is more pronounced for haddock than for cod as a result of two factors: (1) cod have larger mouths than haddock and are thus able to take a baited hook at a smaller size and (2) since cod appear to be segregated by sizes on the banks to a greater extent than haddock, otter trawlers are able to avoid concentrations of small cod. Although otter trawls catch and discard large numbers of small haddock it has not been determined whether or not protection of these small haddock might result in a greater production of large haddock and an increased catch.

Cod and haddock populations differ greatly in the relative importance of year-classes (Figure 9, 11 and 12). Haddock catches have for the most part a smaller number of year-classes represented than do cod. There is also more fluctuation in the relative strength of year-classes with haddock than with cod. For example, in 1948 and 1949 the haddock taken from St. Pierre bank belonged mainly to the 1942 year-class (Figure 9). Haddock produced off western Nova Scotia during the same period were largely the result of a strong 1943 year-class. Although cod year-classes differ in relative strength, individual year-classes do not play such an important part in the control of abundance. The greater number of year-classes represented in the catch and

Figure 12  
Age Composition of Cod and Haddock-Western Bank - February to April



the smaller fluctuations in year-class strength make the cod fishery more stable than that for haddock.

### Mortalities

Data for the assessment of total mortalities are being collected for the different areas fished. Abundance and age composition data will provide valuable information but as yet mortality analyses have not been made. Percentage age compositions of Western bank cod for three successive years are shown in Figure 12 as an indication of the rate at which year-classes enter and disappear from the fishery. An accumulation of such data over a long-term period will contribute much to our understanding of mortalities.

These measurements of population boundaries, growth, recruitment and mortalities will form the basis for assessing fluctuations in abundance and their resultant effect on total catch. Such accumulated knowledge permits prediction, planning and, if necessary, control of the fishery of the future.

### Conclusions

In the measurement of the groundfish catches of the Maritimes, the groundfish investigation has been concerned with measurements by species, area and season of total catch, landed value, fishing efficiency, new concentrations of fish, abundance, migrations, growth, recruitment and mortalities. All these measurements are considered to be of importance in determining the potentialities for increasing the groundfish catch of the future. About half the effort of the investigation is spent on a study

of fishing efficiency and exploration and the other half in the collection of statistics for the measurement of abundance and the factors controlling abundance. It is expected that both lines of attack will pay dividends.

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