

Allister M. Fleming-

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MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No. 430



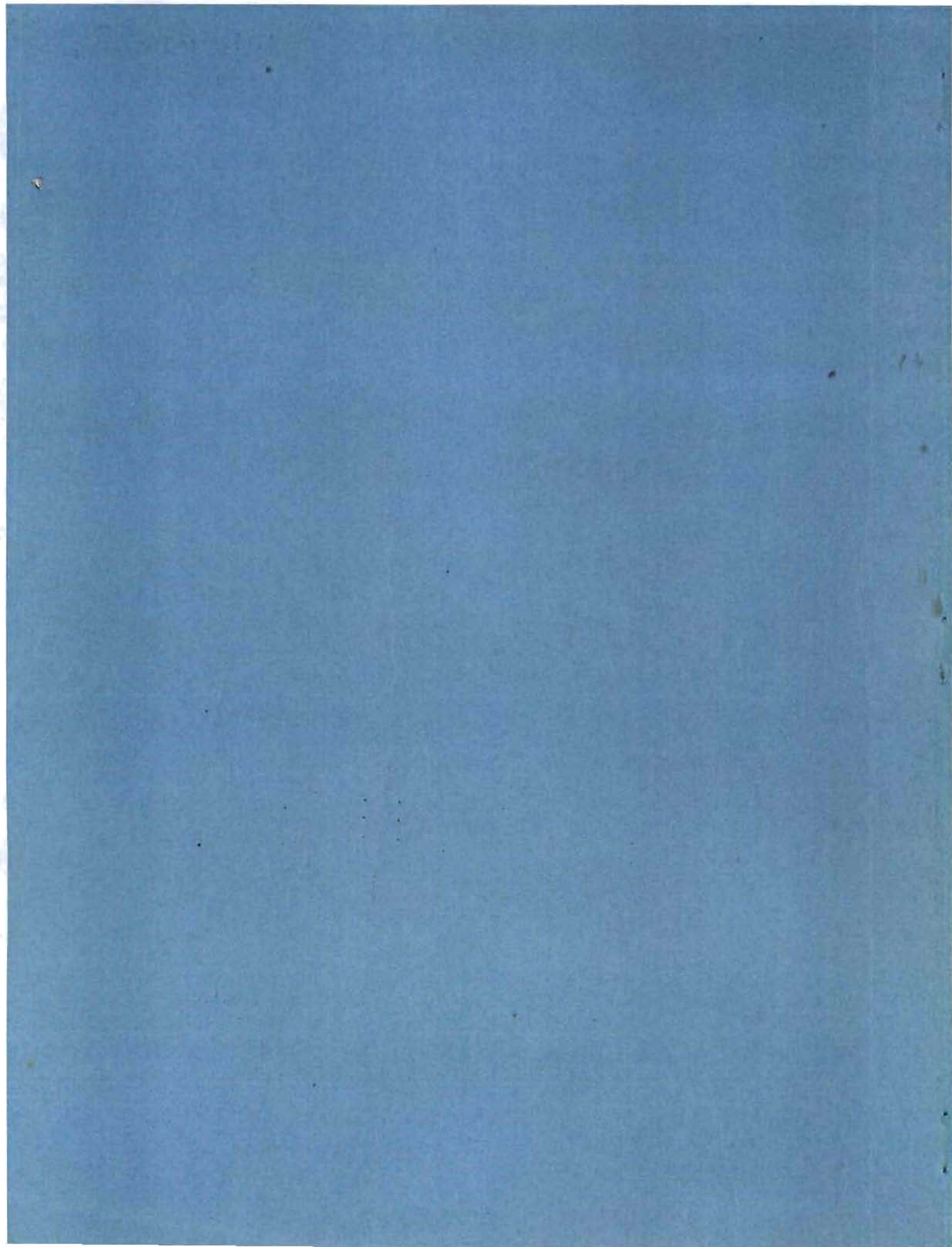
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Newfoundland Commercial Fish and Invertebrates by W. Templeman

Appendix on Whales by D. E. Sergeant
" " Seals by H. D. Fisher
" " Herring by S. N. Tibbo
" " Long-Lining at Bonavista by W. Templeman

An Account prepared for the Newfoundland
Fisheries Development Committee

November 1, 1951.



FISHERIES RESEARCH BOARD OF CANADA

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Newfoundland Commercial Fish and Invertebrates
General Distribution and Related Life History

INTRODUCTION

In the following account we have given an abstract of some of our present knowledge of the distribution of commercial fish and invertebrate species in Newfoundland waters together with such parts of the life history as are pertinent to the question of fish abundance. It has been necessary to consider in brief form the basic hydrography of the area. An account is given of some of the local work in fisheries chemistry and of future fisheries research requirements in the biological field.

COD

Racial Studies

The populations of cod in the Newfoundland and Labrador inshore, offshore and bank areas have been studied by various means such as number of vertebral segments, age, growth and tagging. Thus far the populations of cod occupying the following areas have been shown to be relatively separate and distinct without a great amount of intermingling.

- (a) The Labrador and east coast Newfoundland and northern edge of the Grand Bank.
- (b) The southern part of the Grand Bank and the central area of the Grand Bank.
- (c) The cod population on the southern part of the west coast of which a good part migrates to the Rose Blanche Bank area in the late fall and winter and returns to the Gulf in the late spring.

Distinguishing the separateness of populations is very important since one group not intermingling much with another could be overfished without interfering greatly with the other population.

Tagging is showing that whereas cod on the southern and southeastern parts of the Grand Banks have little mixing with the cod of the inshore areas, the cod spawning on the western side of the banks from late April to early June are feeding heavily on caplin and many of them migrate to the inshore waters with the caplin in late June. These cod were relatively unfished by European fishermen until the past few years when many foreign trawlers have been fishing for them. Similarly there is a very great amount of fishing by foreign otter trawlers in deep water along the northern edge of the Grand Bank. The fishing in this area is of fairly recent development and exploits a stock of cod which is related to the inshore cod, many of our inshore tagged cod being caught by these trawlers in this area. The cod fished by our own otter trawlers on the southern and southeastern parts of the bank appear to be less related to the inshore cod.

Spawning

Spawning is completed by the great majority of our cod in the offshore areas in late April, May and early June before the cod follow the caplin to shore. The migration inshore is therefore a feeding migration and consequently is much less dependable and predictable than a gathering for spawning. Feeding fish are continually on the move and vast schools appear and disappear often with great rapidity.

Cod-Worm Studies

The cod is sometimes infested by a small round or nematode worm which is usually about $1\frac{1}{4}$ to $1\frac{3}{4}$ inches long and is coiled in the flesh. Where these worms are numerous they are a serious hindrance to the marketing of cod. These cod-worms are scarce on the Labrador and on the east coast of Newfoundland - usually less than five per cent of the portion of the fish used for fillets being infected; even scarcer on the Grand Banks - usually less than two per cent; the infection is heavier on the south coast with seven to twenty per cent of the fish infected between Burin and St. Mary's Bay and 24 to 37 per cent infected from Hermitage Bay to Port aux Basques and greatest on the part of the west coast between Port au Port Bay and Cow Head where the infection rate runs between 33 and 49 per cent of the cod. These rates are still lower than those in the southern part of the Gulf of St. Lawrence where the rate of infection with the cod-worm runs as high as 70 to 90 per cent. These cod-worms are young immature worms and the adult worm lives in the stomach of the Bay Seal. Hence in areas with large Bay Seal populations the rate of infection with the cod-worm is high.

The Grey Seal also carries these parasites in its stomach but the only colony of Grey Seals we are fairly certain about in the Newfoundland area is at the northern part of Miquelon Island. There are also other hosts capable of harbouring the adult worm and there is certain to be another intermediate host which eats the eggs of the worm after they pass out of the seal and is in turn eaten by the cod or by some other small fish which is in turn eaten by a cod. Harp Seals can also carry

the adult worm but the role of the harp seal in infecting the cod of the Newfoundland area does not appear to be large.

Ages and Sizes of Cod

The work of determining the ages of cod from the large number of samples of cod ear-stones is underway but a good deal of work still remains to be done. The cod from Labrador are very slow growing, requiring about twelve to fourteen years to grow to a length of two feet as compared with little over half this time for the fish in our fastest growing area - the southern part of the Grand Banks. The east coast cod are intermediate in their rate of growth between these two extremes.

Size of Year Classes

In cod as in most other fishes there may be considerable variation in the numbers of young surviving from year to year depending on favourable or unfavourable conditions of temperature, food and current in the period after hatching. From 1946 to 1948 for example, the cod on the southern part of the Grand Bank were very large with few small. These large cod were not nearly as numerous as the haddock in this area. In the spring of 1950 very large catches of small cod, mostly too small to be utilized, were obtained on the southern part of the bank while in the early part of 1951 these cod, now partly large enough to be retained, were caught in large numbers. Large numbers are still too small to be retained but by 1952 and 1953 these cod should be even more available and should significantly affect the spring fishery on the southern part of the bank. Judging from our measurements at Bonavista in 1950 a new and numerous year class was beginning to enter the fishery in this area also. The first effect of a large popu-

lation of small fish entering the fishery is felt by the trap and handline fisheries resulting in the production of a large quantity of small fish. These studies of size and year class abundance have been begun by the collection of material from the whole Newfoundland area and will be continued indefinitely for a more limited area.

Size of Cod

A very great number of size measurements of cod have been taken in localities well distributed over the whole local area inhabited by cod. In Labrador slow growth results in fish of a rather small size. There is, however, in all areas a good deal of variation in size depending on the success of survival of various year classes, growth and the intensity of fishing. In general, large fish keep to the deep water and hence are caught in greater numbers in the autumn fishery which is in deeper water. Small fish come closer to shore and form the bulk of the trap and handline fishery. There is a tendency also for the long-line (trawl) to catch somewhat larger fish than hand line or trap.

Tagging

Tagging is one of the most useful means of finding out the amount of intermingling of the various cod populations. Over sixteen thousand cod have been tagged in the Newfoundland area thus far and an active program is continuing both of tagging and in the development of better tags. One of the most important problems is the amount of intermingling of bank and shore stocks of cod. The results at the present time indicate that at least some of the cod spawning on the western edge of the Grand Bank

do come inshore with the caplin and that many of the cod found inshore on the southern half of the east coast move off to the north-west and western parts of the Grand Bank to spawn. This movement to the Grand Bank is much greater in the case of the St. John's fish than in the Fogo fish. Tagging has also shown that large numbers of cod from the Gulf of St. Lawrence come out during the winter time to the Rose Blanche Bank area where a large winter fishery is carried on. It is indicated also that there are no important barriers to cod migration in the deep water which extends all along the east coast of Newfoundland as far south as the northern edge of the Grand Bank. It is apparent, however, that there is usually a cold water barrier impeding cod movements southward over the Grand Bank beyond the northern edge. It appears that there is no considerable interchange of cod between the coastal areas and the southeastern part of the Grand Bank.

Hydrography and Cod

Newfoundland lies in an area in which during the winter and early spring, water temperatures from the surface to about 120 to 150 fathoms on the east coast and to somewhat lesser depths on the west and still less but still close to 100 fathoms on the western part of the south coast, are reduced below 0°C (32°F) this chilling on the east coast and on the south coast as far west as Fortune Bay usually producing temperatures of minus 1.5°C (29.3°F) or even slightly lower. This superficial layer is not high in salinity since the contributions of fresh water from the land reduce its saltiness.

Where the water is deep enough there exists below this cold layer even in the winter time a warm layer mostly from 1 to

4°C (34 to 39°F) whose source is the warmer deeper waters of the Atlantic and which remains below the cold layer because its higher salinity makes it heavier to a greater degree than its increased temperature tends to make it lighter than the superficial layer.

This coastal layer of very cold water is produced not only by local winter chilling but also by the addition of very cold water from the Labrador Current which continues to flow strongly even in May and June. During the summer the surface layer of water gradually warms up and at this time over the deep water there are three layers. A surface layer of warmer water of increasing temperature which gets thicker as the summer and autumn advance lies above an intermediate layer of very cold water mostly below 30°F. This is winter chilled and Labrador Current water which has not yet warmed up and there is also a third or deep warm salter layer below the intermediate cold layer.

Cod are killed by temperatures of 30°F and lower and consequently during the winter time cod move away from the very cold shallower water in the immediate neighbourhood of the coast, either into neighbouring deeper water as on the coast from Trinity Bay north and from Hermitage Bay west and north to Port Saunders, or toward neighbouring banks as in the area from Baccalieu to Fortune Bay where there is no very deep water close to the coast. (On the west coast, however, a large percentage of the cod migrate southward out of the Gulf to the Rose Blanche Bank during the winter time). The movements of the cod seem to be offshore in fall and winter to deep warm water, winter wandering in the deep water to join spawning schools, spawning mostly in May and early June and feeding dispersal in the deep warm layer toward the cold water barrier with great numbers of the medium sized fish breaking through

the cold water layer in pursuit of caplin, entering the warm upper layer and continuing in the warm surface layer into the shallow inshore water. Large numbers of the bigger fish possibly more sluggish and more sensitive to light than the smaller fish remain in the deep warm layer. On the northern edge of the Grand Bank cod are concentrated in spring and summer in about 100 to 140 fathoms near the cold water barrier plentifully enough for the French and Portuguese trawlers to remain there often from April to November. Large cod in the warm deep water layer are also plentiful enough within twenty miles of Cape Bonavista for long liners directed from the Newfoundland Fisheries Research Station to obtain large catches of large cod between 120 and 150 fathoms throughout the whole summer and early autumn of 1950 and in 1951 from June to the present time. At Bonavista in this deep water it is evident that cod are most plentiful near the edge where the cold below 32°F water and the warmer above 32°F water meet, that is in the mixed water near the bottom border of the intermediate cold layer and the top of the deep warm layer. Since this border is continually shifting both in different years, weeks, and even days, a deep sea thermometer is a very useful instrument in deep water fishing. Some of the cod which come into the inshore shallow warm water layer in pursuit of caplin in June, will undoubtedly, if they continue surface feeding, leave the inshore water again with the caplin schools when they move off in July. Large numbers of the cod, however, glutted with caplin sink closer to the bottom and when the caplin move off begin feeding on bottom organisms. Here they are restricted in their downward movements in search of food by the upper border of the cold water layer. Thus, depending on the amount of heating of the upper water layer by the sun and the mixing by

wind and wave, the inshore cod will usually be most abundant and the surface warm water layer extend down to ten or twenty fathoms in June, ten to thirty or forty fathoms in July and August and progressively deeper to about 40 to 70 fathoms in September to November and about 60 to 100 fathoms in December and January. That is, cod tend to move downward toward the upper edge of the very cold water intermediate layer and accumulate in the previously unused feeding grounds opened up as the cold layer retreats in the autumn. The warmest period of the year in the water between 60 and 100 fathoms is the late autumn and early winter.

From the above discussion it will be obvious that where deep water occurs close to shore, as on the western part of the south coast of Newfoundland, on the east coast of Newfoundland from Trinity Bay north and in such areas as Port Saunders, cod will need to retreat but little from the shore during the wintertime and should be available in the deep water close to the shore during the winter period. While in the more northern parts of this area ice conditions either in the harbours or at sea usually make it impractical to fish during the winter season, in the Port aux Basques to Rose Blanche area there is a well established winter fishery in this deep water near the coast.

In the area from Conception Bay to the Burin Peninsula there is no water in the vicinity of the shore deep enough to have a warm layer of salter oceanic water underneath it. In this area the channel separating the Grand Bank and St. Pierre Bank from the coast is chiefly 60 to 95 fathoms deep and in most winters is filled from top to bottom with very cold water below 30°F , the greatest volume of the deepest and coldest water, down to 29°F , being near the coast. It is not to be expected that in normally cold

winters a profitable winter fishery after January could be carried on by small boats line-fishing in most of this area. Neither is there likely to be in the greater part of this area much possibility in most years of a small boat summer cod fishery in very deep water such as is possible at Bonavista and in fact from Trinity Bay north.

The abundance of fish of the various species in a particular area and depth is undoubtedly greatly affected by temperature. Currents in the sea also play a very important part in the life history of various fish species. The Investigator II is being used during about two months of the year for hydrographic studies of the temperature and salinity of the ocean and important relationships between fish concentrations and temperature have already been obtained. There is need, however, for much greater and more constant attention to the hydrography of the Newfoundland area than can be given with our present staff and boat.

Long-Lining and the Bonavista Long-Lining Experiment

In 1946 the Investigator II carried out three long-lining cruises for halibut and cod. It was soon evident that the otter-trawling method was better suited for the investigation of most fishes in the area and the otter-trawling method has been pursued since that time.

In 1950 the Station carried out on behalf of the Department of Fisheries an experiment to try long-lining with power hauling gear at Bonavista. The preliminary arrangements for this experiment were made by Dr. Needler. Two Cape Island type 42-foot long-lining boats and their skippers from Lockeport, N.S. were brought to Bonavista for the experiment. Fishing was carried on

by two of these boats from June to August while one boat continued fishing in the area till early November.

As a result of the experiment extensive fishing areas were found about eighteen to twenty miles seaward from Cape Bonavista in depths mostly between 130 to 160 fathoms. (In 1951 with less cold water present the best depths for fishing have been between 120 and 140 fathoms). Here the catches of cod averaged about a thousand pounds per tub of twelve lines of gear, consistently from July to September. This catch per tub is considerably greater than the average for these boats at Lockeport. The area is big enough for the use of large amounts of fishing gear and previous to the present experiment was unknown to fishermen at Bonavista. The offshore fish were on the average half a foot longer and over twice as heavy as the trap and handline fish caught in shallow water inshore.

There was no room during the summer months in areas where cod are plentiful in the shallow inshore area to lay the large amount of gear required in long-lining but from late September onward the long-liners could obtain fish in good quantities within five miles of the shore in waters of intermediate depth which were barren of cod during the summer time.

Other than cod, the spotted wolffish and the American plaice or flounder were the only commercial fish present in fair quantities. Very small quantities of halibut, rosefish, and turbot were caught.

In 1951 the experiment is being continued on a commercial instead of a research basis. Two long-lining boats, one 42 feet and one 51 feet from Lockeport, N. S. are being compared from the point of view of the economics of their operation.

Exploratory Fishing for Cod

Since Newfoundland trawlers usually do not fish primarily for cod and since an excess of cod for fresh fish operations is available inshore in summer and early autumn the Investigator II has spent more time exploring for haddock, rosefish and flounder than for cod. A large amount of information on cod distribution, however, has been obtained.

Cod is present in the whole of the Newfoundland Labrador area and is numerous in many places. The winter distribution is typically below or to the east and south of the cold layer of below zero centigrade (32°F) water. However, on the western edge of the Grand Bank in spring cod are present in water of slightly lower temperature and cod feeding on caplin or lance are often caught in numbers in temperatures as low as -0.5°C (31°F). In the summer-time part of the cod population passes into shallow water, either inshore or over the shallower parts of the banks, while a large part on the north and east of the Grand Bank and in the vicinity of the coast remains in the deep warm layer underneath the intermediate cold layer. The central and coldest part of the intermediate cold layer does not contain cod although at times cod are plentiful near and in the upper and lower edge of the intermediate cold layer where mixing with warmer water is sufficient to raise the temperature to zero centigrade (32°F) or to a slightly lower temperature.

Cod are thus typically found inshore in the areas already described under the title "Hydrography and Cod" and under "Long-lining Experiments." Offshore in the deep warm layer cod are not usually to be found in numbers in the water between 150 and 200 fathoms and between 3 and 4°C (37 and 39°F) which is

suitable for rosefish. Near the coast, however, at Bonavista and in Notre Dame Bay where the cold water of the Labrador Current often extends to depths approaching 200 fathoms cod may on these occasions be found in abundance in the early part of the year at these depths as was the case at Bonavista in 1950.

Exploitation

While exact figures for comparison are lacking the total catch of cod in the Newfoundland and Labrador inshore and bank areas has probably not declined since the early part of the nineteenth century. Newfoundland's share was represented by an export of over a million quintals yearly as early as 1815 to 1818, of 1,300,000 to 1,500,000 quintals yearly from 1879 to 1886 and from 1,400,000 to 1,800,000 quintals yearly during the whole period from 1906-7 to 1922-23 with the exception of 3 years when the exports were smaller but were still over a million quintals. In recent years there has been a considerable decline in the Newfoundland share of this cod fishery. Of the very large schooner fleets of the nineteenth century period fishing by line trawl on the Grand Bank, the American fleet has entirely disappeared from the bank and the Nova Scotian and Newfoundland fleets are rapidly disappearing. The place of these North American schooners has been largely taken by European trawlers and by Portuguese line vessels. Newfoundland trawlers do not spend much time fishing for cod. In fact they are too small to fish to best advantage on the rough northern and western parts of the bank where cod are most plentiful and which are most frequented by European trawlers fishing for cod. Our tagging is showing that many of the east coast cod which move off to deep water during the winter

are caught on the northern and western edges of the Grand Bank by European trawlers during the spring season. There has been, in recent years, an increasing tendency for the large European trawlers to fish the western and northern edges of the Grand Bank in spring. Some of these vessels have begun also in the autumn season to fish close to the northeast coastal waters. Thus increases in the catches of cod in these areas by European trawlers are having and will have significant effects on the east coast cod fishery.

HADDOCK

Exploration

Dr. Thompson was the first to call attention to the possibilities of haddock fishing on the southern part of the Grand Bank. Thompson's information was obtained through the work of the trawler Cape Agulhas operated by the Newfoundland Fisheries Research Station for several months each year from 1931 to 1935. The exploratory work of the Cape Agulhas has been continued since 1946 by the Investigator II.

As a result of the explorations of the Investigator II we now know that there are only two large haddock stocks in the Newfoundland area. These are the St. Pierre Bank and the Grand Bank stocks. The St. Pierre Bank stock spends its winter in

the deep water of about 80 to 110 fathoms on the southwest, west, and northwest edges of St. Pierre Bank in the warmer layer below the cold layer. After or shortly before spawning in May, June and early July this population moves in over the shallower areas of St. Pierre Bank which by this time have warmed sufficiently to be satisfactory to haddock. Some of these haddock continue their migration as far as the Burin peninsula and possibly other in-shore areas.

The Grand Bank stock of mature and large immature haddock, gathers during the late winter and spring mostly on the southwestern slopes of the Grand Bank in water generally over thirty-seven degrees Fahrenheit, usually between 40 and 75 fathoms since on this part of the Grand Bank the cold layer does not usually extend so deeply as to the north of the bank and on St. Pierre Bank.

The mature haddock of this Grand Bank population after or slightly before spawning, mostly in late May and early June, spread north and northeastward, still largely over the southern half of the Grand Bank. In certain years there may be excursions of these Grand Bank haddock, apparently in the upper warm layer rather than along the bottom, into the east and southeast coastal areas. Nowhere, however, along our coasts do runs of haddock from the Banks appear to be great enough or regular

enough to be depended on as a fish supply for fresh fish plants. Small amounts are utilized by the fresh fish plants especially in the very occasional years when during the warmer parts of the summer there are larger than usual inshore runs of haddock. There appears to be a comparatively small population of haddock in the Rose Blanche to St. George's Bay area which may be separate from the St. Pierre group but which has not yet been investigated.

The Grand Bank and St. Pierre Bank Races of Haddock

The Grand Bank and St. Pierre Bank haddock are enough different in weight of their otoliths or ear-stones, in general size, in growth and in the relative amount of survival of the various year classes to show that they are different populations intermingling only slightly except possibly in the area south of Green Bank. The St. Pierre Bank haddock grow considerably faster and thus reach a considerably larger size than the Grand Bank haddock. The occasional very large haddock found in the Grand Bank area are of the St. Pierre Bank type of growth indicating either that a few of the largest St. Pierre Bank fish may migrate as far as the Grand Bank or that a few fish on the Grand Bank, living in very favourable conditions for growth, may reach the large sizes common on St. Pierre Bank.

Haddock Year Classes, Survival and Sizes

The haddock is particularly susceptible to variation in year class abundance due to very large survival in certain years and very small survival in others. This variation in year class survival is much greater than we have observed in cod and is probably due to the fact that a great part of the haddock population winters and spawns very close to very deep water to the south. Also

not far to the north the bottom is covered with very cold water. The haddock egg and the recently hatched young haddock have a drifting life of over two months before the young fish settles to the bottom and if the currents are not following a suitable pattern the haddock will be attempting to settle in areas which, if very cold or very deep water is present, are unsuitable. For good survival, suitable food of small size also needs to be available in quantity to these young haddock shortly after hatching. The haddock fishery has from 1947 to 1950 depended for a total of about fifty per cent of its commercial fish on haddock born in 1942 which are now nine years old and are gradually being caught up. In the years 1943-45, hardly any young haddock survived, the average survival in each of these years probably being not greater than 2 or 3 per cent of the survival of 1942. The 1946 year class is abundant and is now being caught in large numbers but mostly discarded as too small. During the next few years the fishery will in large part depend on the 1946 year class.

Since these good year classes come along only occasionally it is important that they be well utilized and not merely destroyed. From the time the Investigator began her work in 1946 until 1949 or 1950 there were large supplies of haddock of moderate size on the Grand Bank. In 1951, haddock of commercial size on the Newfoundland Banks can only be described as scarce - too scarce and small for the Newfoundland boats to fish commercially for them. The size is very small and a great proportion of the haddock brought into St. John's in 1951 has been of sizes which were thrown away in the preceding years. It is dangerous to speak definitely of this reduction of haddock as the result of one year's experience since there is a bare possibility that it may

merely have been a reduction in availability. In 1951 there has been considerably warmer water than usual over much of the southern part of the banks and the haddock may not have been as concentrated as they usually are by low winter temperatures. We have had no evidence, however, that the haddock were spread more widely and thinly than usual and a reduction in numbers of the larger haddock is very possible.

A number of factors have been at work to cause reduction in numbers of haddock and reduction in size. The probable order of importance for this reduction is as follows:

1. The considerable building up of the European fleet of large trawlers since the war and the increasing practice in 1949 and 1950 for a large fleet of Spanish pair-trawlers to fish on the Grand Bank area. The larger French and Portuguese trawlers mostly do some fishing in the spring months on the southern parts of the banks and destroy some haddock. They, however, do not usually continue to fish for the smaller haddock if cod are not present in numbers and tend to move as soon as possible to the north, northeast, and west of the Grand Bank where cod but not haddock abound. The Spanish large trawlers and pair-draggers, however, do not operate so much in these northern waters where the bottom is rough but concentrate on the southern parts of the Grand Bank on the smoother bottom and shallower water where haddock may be numerous. The Newfoundland trawlers usually cease fishing haddock after June since the mature spent fish spread out northward too thinly to be worth fishing commercially. The Spanish trawlers, however, are able profitably to dispose of even very small haddock and may continue during the whole summer and autumn fishing for the small immature haddock of about a foot to a foot and a

half in length which migrate little and remain on the southern grounds. These boats catch great quantities of small haddock, therefore, several years before they have reached a size where they are utilized in Newfoundland.

2. Whereas usually the mature Grand Bank fish scatter so widely as to be relatively unfished after June, in 1950 in July and August caplin spawned in numbers on the southeast shoal of the Grand Bank, producing a great concentration of mature and immature haddock feeding on the caplin eggs and of cod feeding on the caplin. This in turn led large numbers of European and most Newfoundland trawlers to concentrate on this haddock fishery for about one and a half months and very great catches were obtained. Thus there was a much greater attack particularly on the adult haddock in 1950 than in previous years.

3. Previous to and during the war and up to 1948 there was not a great amount of fishing for the Grand Bank haddock population. The fishing effort has increased greatly in recent years owing principally to the increase in the European fleets particularly the Spanish pair-draggers and to the increase in the Newfoundland draggers. Whereas the Spanish draggers have been catching the small fish and utilizing them, thus catching large numbers before they become mature, the Newfoundland draggers have been discarding as too small about fifty per cent of the numbers of haddock caught.

4. The almost complete failure of the haddock year classes of 1943 to 1945 has resulted in a loss of the haddock sizes between the successful 1942 and 1946 year classes. Thus while the 1942 year class has been contributing to the commercial fishery for five years and is now becoming reduced in numbers, the 1946 year

class is just entering the commercial fishery and a good deal of this year class is being discarded as too small by our fishermen. The large 1946 year class now composed of small fish and the reduction of the 1942 and earlier year classes by fishing and other mortalities have lowered the average size of haddock available to the fishery.

Providing that in the next few years the haddock picture is the same on the Grand Bank as at present there will be serious concern for the future of the Grand Bank haddock fishery.

Spanish draggers are apparently for a great part of the year fishing small haddock probably between 30 and 45 cm. (12-18 in.) in length whereas until 1951 our draggers were throwing away many fish at all the sizes below 50 cm. (20 in.) and almost all the fish below 45 cm. (18 in.). On the Grand Bank it takes from about 4 to 7 years for a haddock of 30 cm. (12 in.) to grow to 50 cm. (20 in.). It is obvious, therefore, as the fishery develops, that unless our plants instruct or allow their skippers when haddock are scarce to bring in all haddock down to 40 cm. (16 in.) there will probably be few Grand Bank haddock available to these plants. Another method of attack would be through the International Commission for the North-West Atlantic Fisheries and the general introduction of savings-gear with larger mesh than used at present which would liberate most haddock below 40 cm. This measure would probably be resisted by the European fishermen and it is at least very doubtful whether European and particularly Spanish agreement to the measure could be obtained. An experiment in savings-gear to be begun in the near future on George's Bank may give some answer regarding the benefits to be expected from this increase in the size of mesh in the trawls.

ROSEFISH (REDFISH OR OCEAN PERCH)

Exploration

From the exploratory fishing of the Investigator II and the operations of local trawlers there is now a fairly good general picture of the distribution of Rosefish in the Newfoundland area. Rosefish are extremely sensitive to light and the great concentrations are therefore to be found in deep water. They also require warmer water than cod, consequently they are to be found in the layer of warm salter water underneath the cold layer of the Labrador Current mostly in temperatures of 3 or 4 degrees centigrade (37 to 39⁰F) or higher. They are not particularly bottom fish but where the water is not too deep are driven to the bottom by sunlight and come up off the bottom to feed at night. The trawl fishery for rosefish, therefore, ceases at night.

Rosefish are distributed in numbers, mostly below the hundred fathom line, everywhere from Port Saunders around the west and south coast to Hermitage Bay and to a lesser extent in Fortune Bay, north of Anticosti Island and in the deep channel leading up toward Gaspé, around the western and southern parts of St. Pierre Bank, the southwestern, southern, eastern and northern edges of the Grand Bank and in the deep water from the Grand Bank at least as far north as Hamilton Inlet Bank off Labrador. Fishing the deep water off Cape Chidley also produced some rosefish so that there are probably commercial amounts north of Hamilton Inlet Bank.

The area between Conception Bay and the Burin Peninsula is either too shallow or contains too cold water or both for the presence of rosefish in large amounts although there are small quantities of small rosefish in the deep channel of Fortune

Bay which is usually filled by relatively cold water. The depth of the rosefish population increases to the northward so that whereas it is sometimes possible to catch large quantities of rosefish in the warm water on the southwestern part of the Grand Bank in 80 to 90 fathoms, in Hermitage Bay where warm water lies deeper large quantities of rosefish may be caught at 140 fathoms, on the northeast edge of the Grand Bank and on Flemish Cap the best catches were at 160 to 190 fathoms while in Labrador the greatest depth tested - 200 fathoms, produced the greatest quantities of rosefish.

The sizes of rosefish to the north and northeast of the Grand Bank and on Flemish Cap, also in Hermitage Bay and off Port Saunders are considerably greater than those on the southern part of the Grand Bank.

Abundance of Rosefish

Rosefish are exceedingly abundant in many parts of the Newfoundland area. They probably occur in numbers at appropriate depths over large areas too deep for them to be forced to the bottom. Consequently apart from such local areas as Hermitage Bay (where rosefish fishing has temporarily ceased) only fringe populations in our waters are being attacked by fishermen. It is certain that the rosefish can be fished very much more heavily than at present.

The rosefish, however, is a very slow growing fish, taking according to American investigations about ten years to grow to 10 inches in length, and sizes and ages will need to be continually checked to determine the effects of fishing.

Life History

The general life history of the rosefish in the area is under continuous study by the Station.

AMERICAN PLAICE (DAB OR FLOUNDER)

The Investigator II has done a good deal of exploratory fishing specifically for American plaice and much information is now available on the life history and on the area, depth and temperature relations of this fish.

The trawler Cape Agulhas when operated by the Newfoundland Fisheries Research Station at Bay Bulls in the early nineteen-thirties had one or two successful drags for plaice on the eastern edge of the Grand Bank. No further information was available for the eastern Grand Bank area until the Investigator II found plaice fairly plentiful near the southeastern edge of the Grand Bank in 1946 and especially plentiful with some cod in June 1948 at 60-75 fathoms near latitude $45^{\circ} 33'N$ and longitude $48^{\circ} 44'W$. Some Newfoundland trawlers began fishing for these plaice and cod at first in the area found by the Investigator II and later following the eastern edge of the bank toward the south and to a lesser degree toward the north. From the operation of these commercial trawlers and especially from the exploratory fishing of the Investigator II along the whole eastern and northern edge of the bank in 1949, there is now available a fairly good picture of the possibilities of a plaice fishery mostly between forty and a hundred and thirty fathoms along the slope area of the whole eastern edge of the Grand Bank.

Since 1948 a good flounder fishery has been developed on the eastern edge of the bank mostly in late summer, autumn and

early winter. This population of plaice is very much underfished and there is some trouble with a jellied condition on which a good deal of work has been done by the Newfoundland Fisheries Research Station. This condition in which too much water and too little protein are present in the plaice flesh affects especially the larger and older fish and will be considerably reduced as more intensive fishing reduces the number of very large and increases the proportion of medium sized plaice in the catch.

The plaice is one of our most plentiful fishes and the fishing for plaice on the eastern edge of the Grand Banks is capable of much expansion. The plaice is also common over the central and western portions of the Grand Bank but the bottom is rougher and the plaice smaller so that the fishing is not so profitable. From the ten fathom line outward the plaice is also common in inshore waters but again the bottom is usually rough and the fish caught by otter trawl mostly smaller than are acceptable to Newfoundland plants. There are certain deep water inshore areas, however, where the plaice caught by long-line will form a worth while addition to the cod fishery if they can be sold fresh.

WITCH FLOUNDER (GREY SOLE)

The witch flounder or grey sole is common on the southwestern slopes of the Grand Bank and St. Pierre Bank. Large catches are mostly below the fifty fathom line. The witch is only occasionally numerous enough to be the object of a primary fishery. Its mouth is so small that it must be taken by otter trawl or Danish seine and it is usually taken incidentally in the course of the otter-trawl fishery for haddock.

In the deep water north of Banquereau the witch flounder is sometimes present in large numbers for several weeks in winter or early spring so that American draggers have for a short period of the year for several years engaged in a fishery primarily for the witch flounder. For the short period of a week or two in the spring of 1951 it was concentrated enough to be the object of a primary fishery on the southwest edge of the Grand Bank. To the north and east of the Grand Bank area and over the bulk of the Grand Bank itself the witch flounder is apparently scarce judging however only by otter-trawl catches.

The Matthew II has recently found moderately profitable fishing for witch flounder by Danish seine in the deeper parts of Fortune Bay. Previous explorations by the Investigator II by otter trawl in this same area had shown the presence of moderate quantities of rather small rosefish but only small quantities of grey sole. It may be that the Danish seining method is more suitable for catching grey sole than is the otter-trawl. Since the previous exploration of the deep water areas by otter trawl had for its main object the catching of rosefish the trawl was pulled much faster than would be the case in fishing for grey sole which are apparently on or very close to the bottom and would need a more slowly moving net to catch large numbers. It has already been demonstrated, however, in Chedabucto Bay, in Nova Scotia, by the Atlantic Biological Station, that the Danish seiner could outfish an otter trawler of the same size in fishing for witch flounder. In the North Sea it has been shown that the Danish seiner can outfish an otter trawler in fishing for the European plaice.

The witch flounder is marketed as fillet of sole and is a valuable fish which may repay further investigation into methods of developing a primary instead of an incidental fishery for this species. It cannot be regarded as a heavily fished species but the evidence at present is that it is unlikely to be as much as five per cent as plentiful as the American plaice in the Newfoundland area as a whole.

YELLOWTAIL FLOUNDER

The yellowtail flounder is present on the shallower parts of the Grand Bank but is not plentiful enough to be the object of a primary fishery. Several hundred pounds per hour's dragging can be sometimes obtained by commercial trawlers working in the shallower areas primarily for cod or haddock. This flounder is also present inshore but its small mouth prevents its being caught in commercial quantities by hook and bait.

WINTER FLOUNDER

The winter flounder which in the American market sells as blackback or in larger sizes lemon sole is not present on the Newfoundland banks but is common in the inshore shallow water, probably mostly less than five to ten fathoms, in Newfoundland and Labrador. Large numbers come within a few feet of the beaches at caplin spawning time and many are stabbed for lobster bait. This is a small mouthed flounder which must be caught commercially by otter trawl or seine. Most inshore specimens are too small to interest local plants but there may be some local areas where the bottom is smooth enough to obtain these flounders in very shallow water by trawl or seine. No commercial development except for

lobster bait is likely unless the fresh fish plants can use smaller flounders than are accepted at present.

HALIBUT

The Investigator II made three long-line trips for halibut in 1946. Some information on halibut is also available from local catches by otter-trawl and line-trawl. In the Newfoundland area halibut are most numerous on the southern slopes of St. Pierre, Green and the Grand Banks and on the southern part of the eastern edge of Grand Bank and as a primary fishery are fished by long-line trawls. These fish are most plentiful on the slopes of the bank from 80 to as much as 300 fathoms. The smaller halibut spread over the southern part of the Grand Bank and especially on the slopes between fifty and a hundred and twenty fathoms are caught by the European and Newfoundland otter trawlers incidentally to cod and haddock fishing. Halibut also occur in the deep water from Hermitage Bay around the south and west coast and on the west coast during the late spring and summer come into very shallow water. They are also found over a very large area between about 120 and 300 fathoms northeast of Bonavista and north of the Grand Bank, in similar deep water in the vicinity of Hamilton Inlet Bank and probably in the offshore deep water between about 120 and 300 or more fathoms all along the coast of Labrador.

The halibut is a slow growing fish which for a considerable period before 1950 had not been fished heavily. In 1950 there was a great expansion of the Canadian Atlantic halibut fishery. It is to be expected that after a period of fishing as in-

tensive as that in 1950 and 1951 the catch will decline somewhat. The catching of halibut in Nova Scotia has been shown to depend on the maintenance of a very large ratio in price between cod and halibut. In Newfoundland the ratio of price of halibut to cod in relation to the relative abundance of these two species is not usually high enough to encourage the local landing of halibut. Newfoundland vessels engaged in this fishery usually land at Halifax because of the higher prices received in Nova Scotia. The Newfoundland landings are often incidental catches by otter trawlers and small boats engaged in the fishery for cod or haddock. There is a small local fishery on the west coast of Newfoundland by south-west coast boats after the completion of the winter and spring fishery on the south-west coast in April.

GREENLAND HALIBUT (TURBOT)

The Greenland halibut or turbot is an inhabitant of deep and moderately cold water such as occurs in Trinity Bay, White Bay, Fortune Bay, Placentia Bay and the various deep arms of Notre Dame Bay, the deep water area between Bonavista and Cape Bauld and the deep water off Labrador. Large turbot may be caught at least as deep as 300 fathoms. The species has a moderately high fat content, breaks up readily when cooked as a fresh fillet and is marketed in the salted condition. There has been no special investigation of turbot in our waters apart from the body of information gathered during the otter-trawling trips of the Investigator II in deep water with the primary object of seeking for rosefish and cod. For this fish as for the halibut the long-line or line-trawl method of fishing will probably be most productive and there will generally be a production of tur-

bot as an incidental product of a long-line fishery for cod or halibut in deep water. If the market demand justifies it or even merely for knowledge some primary investigations of turbot with long-line may be justified.

CAPLIN

In 1941 an intensive study was carried out on the caplin in our inshore waters. Attention is now being directed to the life history of the caplin living and spawning on the offshore banks. In 1950 for the first time caplin-spawning in very large amounts was demonstrated on the Grand Bank. A very large fishery for haddock and cod developed in July and August in this caplin spawning area on the South-east Shoal of the Grand Bank.

Caplin are circumpolar in distribution. In the Newfoundland area they are distributed in large quantities over the northern half of the Grand Bank as well as in the deeper water near shore. The schools can often be detected by echo-sounder. They are usually available for capture in the shallow water during the spawning season beginning in early June on the west coast, a few days later on the south coast and in the latter third of June on the east coast of Newfoundland. In any one area they are usually readily caught only for a few days or weeks. The indications are that they could safely be taken in considerably greater quantities than at present but the fishery in any one area lasts only a short period usually one to four weeks. Like the herring, caplin can be used for the manufacture of meal and oil. The season, however, is short, the fat content low and the water content high in comparison with herring and consequently caplin meal and oil manufacture is likely to be successful not as a separate venture but in herring meal plants where the season of manufacturing

meal and oil may be extended for about a month by using caplin after the herring season is over.

Caplin are already used in very large quantities as bait for cod, in fertilizing soil for vegetables particularly potatoes, for dogfood and to some extent, mostly locally, as a human food. They also form a great part of the natural food of the cod and other fishes of our waters, of the sea-bird colonies, of whale-bone whales and seals. There is some small possibility of using them for canning where owing to their large moisture content some of the moisture needs to be removed preferably I believe by a preliminary light smoking. While there would be some acceptance in the local market, sales in the United States and the remainder of Canada would be handicapped by the lack of knowledge by the public of the name "caplin" and by the cheapness of the better known sardine. The short season in which caplin can be caught is another handicap which would require the caplin cannery to have considerable refrigerated storage.

DOGFISH

The life history of the dogfish and the vitamin A values of dogfish liver oil have been investigated by the Newfoundland Fisheries Research Station. Dogfish are chiefly worth notice at the moment from their nuisance value in their interference particularly with the bait fishery for cod. In the dried condition they are used to a limited extent as food for dogs. From tagging studies it is apparent that dogfish spread very widely, some tagged at St. John's travelling as far as Cape Breton, Bay Chaleur in New Brunswick, Massachusetts and even to Virginia. Local measures of control which are sometimes proposed

would therefore be expensive and worthless. The liver oil of the Atlantic dogfish possesses only moderate amounts of vitamin A and very little vitamin D and the fishing of these dogfish for their livers alone would not be profitable. Further tagging of dogfish is contemplated.

LOBSTER

In a three year study of the local lobster population enough research was carried out to obtain information on the main features of the life history of the lobster, to check the adequacy and effect of most local laws and to suggest some changes for the improvement of these laws. The lobster is an animal of moderately warm waters existing in numbers in the Newfoundland area mostly in water less than ten fathoms. The thinness of the warm water layer and on many parts of the coast the lack of a great extent of shallow water allow only a relatively small area suitable for lobsters. These areas are also so close to the shore that the lobsters are readily attacked even by primitive equipment. The lobster is being fished heavily and it is doubtful that very much increased long term yields can be expected from more intensive fishing. Indeed, quite the opposite might be the case if the animal is overfished. It is, in my opinion, probable that the major changes in the lobster population come as a result of major long term changes in climate, warmer periods being favourable to the survival of young lobsters and lobster growth, and colder periods unfavourable. Since the early nineteen-twenties the northern hemisphere has been experiencing climatic conditions in both air and water warmer on the average than usual. This has been accompanied by an increase in the apparent abundance of the lobster

population as judged by the catch. It may confidently be expected that a colder period of years will come which on the whole should be unfavourable to the survival of young lobsters.

It is hoped that if increased money for staff and field work can be obtained a moderate amount of continuous lobster research can be again carried out.

SALMON

The study of salmon is an important part of the Station's research program. The commercial catches have been studied for age and growth, tagging has been carried out, obstructions examined in rivers, fish ladders built and their operation studied and researches begun on the life history of the salmon in the various rivers. This fish so important to anglers and to commercial fishermen was caught in greatest amount in 1930. (The local salmon fishery first began to be prosecuted heavily for export in the frozen and fresh condition in the early nineteen-twenties.) Since 1930 the fishery has declined somewhat and it is not to be expected that further intensification of the fishery would result in a sustained yield of a much greater amount of salmon. It is probable that for the best economy of the whole country as many salmon as possible should be caught by rod in the rivers rather than by net in the ocean but as far as Newfoundland itself is concerned the problem is complicated by the fact that our tagging has shown that while most of the grilse on the east coast of Newfoundland are proceeding to Newfoundland rivers most of the larger salmon over six pounds in weight are on their way to Maritime and Quebec rivers to spawn. Thus our east and also the southwest coast salmon fisheries depend to a great degree on salmon which spent their early

life in Maritime and Quebec rivers and the problems of our salmon fisheries are therefore related to a much wider area than Newfoundland alone. As for that part of the salmon population which spends its early life in our rivers it is obvious that the salmon are so few in the sea compared with such fishes as cod that food or space restrictions in the sea can have no part in restricting the numbers of salmon. Rather it is in the river that the restriction of food, shelter and space together with water pollution, predation by birds, eels and possibly trout allow only a limited number of young salmon to grow up to the smolt stage at which size, only a few inches long, they proceed to sea. It is only by increasing the numbers of salmon smolts going to sea that adult salmon can be increased in numbers. From studies carried out on local river obstructions it is probable that the river space inhabited by young salmon and the young salmon population can be greatly increased. The presence of a salmon hatchery in the province with a competent local fish culture unit interested in building up new salmon populations would be a great assistance both to research and practice in building up salmon populations in parts of rivers now blocked or newly opened up to salmon.

HERRING

The Newfoundland Fisheries Research Station has carried out four years work on the herring in the Newfoundland area followed by five years work as part of the Atlantic Herring Investigation Committee. The member of the staff responsible for the herring work has recently been transferred to the staff of the Atlantic Biological Station at St. Andrews. ~~During the period of~~ Newfoundland research on herring it was shown that the Fortune Bay,

Bay of Islands and Notre Dame Bay stocks of herring were separate entities not mingling significantly. It was indicated that the Labrador herring consisted of large individuals of the Notre Dame Bay type. Since these Labrador herring are possibly on a long migration and are feeding, their abundance in any one place has varied greatly especially in recent years. It is hoped to begin herring research again locally as soon as money for staff and field research is available. The herring can be exploited to a considerably greater degree than at present but it would be preferable to catch them during the summer and fall season when they are fat rather than in the spring when they are thin. Researches on their summer, fall and winter abode and their hydrographic and food relations are important. In areas of intensive fisheries such as Bay of Islands and Fortune Bay, the size, age and abundance relationships should be followed continually so that the use of the herring population can be most wisely administered.

SQUID

During the period in the early thirties when the Newfoundland Fisheries Research Station operated from Bay Bulls some studies of the appearance and sizes of squid in the inshore waters were carried out. At present squid captured in the course of trawling by the Investigator II are receiving attention. It is indicated that squid spend the winter in the deep warm water on the eastern and southern slopes of the banks and off the east coast. Here they are caught in water mostly of a hundred fathoms or over as early as ^{May}~~April~~. Most of these squid captured in the spring months are small, only about six or seven inches

long. In years when squid are plentiful they spread across the banks as the water warms until in June or July they are near the western side of the Grand Banks and on the shallow parts of St. Pierre Bank and by the latter part of July or early August they reach the shore. Meanwhile they are growing rapidly but do not reach full size until autumn. No really small short-finned squid, the species common to Newfoundland waters, have been caught. During the inshore summer and autumn migration the reproductive organs are very little developed. It is probable, therefore, that spawning occurs over winter in very deep water below the two hundred fathom depth fished by the Investigator's gear.

The chief practical problem in the squid fishery, which is at present mainly a fishery for squid to be used as cod bait, is the great fluctuation in numbers available inshore. In some years squid are extremely abundant, in other years they are absent except for a few individuals. Since squid is the favourite fall bait for cod this fluctuation has a great influence on the amount of fish caught in the inshore fall fishery. The fluctuation in numbers can come from several causes such as variations in numbers of squid and variations in temperatures which may allow squid to come inshore or may repel them. From the fact that mostly small squid are caught in the spring and that these grow larger during the summer to become large sized by autumn, it is quite likely that only one year class of squid is principally involved in the migration to shore. If this is so, in agreement with the usual condition in the sea in some years many young recently hatched squid will survive and in other years few will survive. We do not

think it likely, however, that the six or seven inch squid caught in the spring were born in the same year. Squid are animals favouring moderately high rather than low temperatures and temperature is probably a considerable factor affecting their movements. We do not know enough yet, however, about the relationship of abundance of squid and the prevalence of high or low temperatures to make a definite statement on the matter.

SHRIMP

Explorations of the Investigator II for groundfish, not using shrimp trawls, but with shrimp netting in the cod end of the ordinary otter trawl have shown that the shrimp, Pandalus borealis, is present at least in moderate numbers in most of the Newfoundland area deeper than about one hundred fathoms. This is the commercial shrimp of Norway and Greenland. Much of the bottom where this shrimp is present appears to be too rough for the operation of the shrimp trawl which is made of light twine. It is, however, planned to make tests with shrimp nets but probably not before 1952. At present the Station has no suitable boat for shrimp trawling, the Investigator II being too large and too heavily powered.

SCALLOPS

There are two species of scallop in the Newfoundland area, the Giant or Sea Scallop, which is the species caught commercially on Georges Bank and at Digby, N.S., and the Iceland scallop.

The Iceland scallop is more heavily ribbed, is considerably smaller than the giant scallop and is the common scallop of the Newfoundland banks and of the colder deeper waters. It usually does not grow longer than about four inches in length and is unlikely to be of primary commercial use although the larger specimens would probably be used if caught incidentally during a fishery for the giant scallop.

The giant scallop, which grows to a diameter of six inches or more, has been fished for many years in moderate numbers in Port au Port Bay. A fishery begun a few years ago in St. George's Bay was not maintained. Some surveying of the west coast as far north as the Bay of Islands and some in Notre Dame Bay has been carried out by private firms without finding large resources of scallops. Scallops are reported to be present in many of the arms of the south coast and in parts of Notre Dame Bay. The usual reports are from shallow water where the beds would not be expected to stand heavy fishing. In June, 1951, the Investigator II obtained a few giant scallops on both the northern and southern shallow water areas of St. Pierre Bank.

It is indicated that some research and exploratory work on scallops should be carried out without too great expectations of very large commercial results.

SMELT

Smelts are reported in moderate quantities in ^{St. George's Bay,} Port au Port Bay, St. Pauls Inlet, Pistolet Bay and Lake Melville in Hamilton Inlet. They are also reported in many of the west and south coast, Notre Dame Bay and northern Bonavista Bay estuaries, rivers

and brooks. There has been no local investigation of smelts and there is no evidence at present of very large quantities being available although in some of these areas production in the vicinity of at least a hundred thousand pounds a year is possible. They are in best condition in the late autumn when a good deal of the fishing takes place. Difficulties and costs of freezing and transportation have limited this fishery to the more accessible areas although it has been tried out commercially as far north as Pistolet Bay.

HAKE

Hake are present in the deep water on the south coast from Hermitage Bay west and particularly in the deeper water on the southwest edge of the Grand Bank and south of Green Bank. As fresh fish they are discarded by our trawlers since apparently the market price does not encourage the plants to accept them. They can be sold for only moderate prices as light salted fish and a small quantity of inshore caught hake are thus marketed. Some information on hake is being obtained by the Investigator II.

POLLOCK

Pollock are related more to the middle and upper waters than to the bottom. They are not usually very plentiful in the Newfoundland area but are generally present on the south coast and several hundred pounds of pollock per drag are often obtained by otter trawlers on the Newfoundland banks. These fish are discarded at sea because of their low price on the fresh and frozen market. Light salted pollock can be sold at moderate prices. When

our offshore exploratory work began in 1946 pollock were extremely scarce, only a few large pollock being present in the area. A few years ago there was apparently a very successful survival of young pollock and since that time large quantities of small pollock have been noted in the harbours of the south coast. These fish are just now beginning to approach a small commercial size and larger numbers than usual are being caught on the banks and on the south coast. The pollock is a fish which like the mackerel is at the extreme northern end of its range in local waters and which has evidently responded to the recent period of warm water temperatures by increasing its numbers significantly. Information on pollock is being gathered incidentally to our general groundfish explorations and research.

MACKEREL

The mackerel is a fish of the warmer waters which has recently increased in numbers in the Newfoundland area. Particularly is this statement true of the east coast where the mackerel were rare at least for a considerable period before the recent several decades of increased water temperatures. They can probably be expected to decrease again when a colder period arrives. Even further south in United States waters the mackerel population is subject to very great fluctuations in numbers. The high fat content of the mackerel in the summer and autumn in Newfoundland waters makes them very susceptible to spoilage and they must be salted or frozen very quickly after capture. Doubtless in their seasons of abundance they can be caught in much greater quantity than at present but their great fluctuations in numbers make the provision of

costly equipment solely for mackerel catching and processing very much a gamble. No research has been done on mackerel in this country and only a small amount in the Maritimes. Some information on mackerel is usually obtained incidentally to research on herring.

CLAMS AND MUSSELS

There are a few good beds of soft shell clams in the more sheltered parts of the bays and there is some occasional use of clams as bait for cod particularly on the west coast. It is possible that the clam population from an occasional area such as Port au Port Bay could be used for canning or for export in the fresh shucked condition. Some soft shell clams are present even in northern Labrador. On the whole, in Newfoundland the clams appear to be more restricted by pebbly beaches or beaches of shifting sand rather than by temperature. Clams need a bottom made up of a firm mixture of sand and mud and such areas are very limited in Newfoundland. The small tides are also a hindrance in allowing the exposure of only a limited area of beach for digging.

Mussels appear to be plentiful in some of the bays but mussels are plentiful along the Atlantic seaboard generally and have not been greatly exploited probably from lack of market acceptance. Because of the lack of a large commercial fishery there has been no research in Newfoundland on either clams or mussels.

WOLFFISH

Three species of wolffish are found in Newfoundland waters, the striped, spotted and broad-nosed wolffish. The broad-nosed wolffish is gelatinous in texture and is probably unsuitable

for marketing. Both the striped and spotted wolffishes are excellent food with a taste and texture about midway between cod and halibut. The filleted flesh sells well on the American market as "catfish".

Wolffish are not found in thick schools as are cod and haddock and consequently the otter-trawl catches produce only small but significant quantities of them. They are typically fishes of the deep water below a hundred fathoms and in deep water line fisheries for cod and halibut, such as that now being carried out by the Nova Scotia boats at Bonavista, marketable wolffishes are caught in moderate numbers forming about five per cent of the weight of the cod catch. Some of the Newfoundland fresh fish plants utilize wolffish and the Bonavista plant is accepting them from the long-lining boats for the first time this year. The skin, particularly that of the beautiful spotted wolffish, makes an excellent leather product. Information on wolffish is being gathered by the Station as an incidental part of the work of the Investigator II.

SEA TROUT (ARCTIC CHARR)

In northern Labrador there is a commercial sea-trout fishery of particular interest to the Eskimo population and based on the Arctic charr, Salvelinus alpinus. (The typical Newfoundland sea trout is a sea phase of the brook trout Salvelinus fontinalis. In addition in the Avalon Peninsula there are sea trout derived from the introduced European brown trout. Doubtless these large sea trout will gradually spread to more rivers and brooks). No local research has been carried out on the Labrador sea trout

but some research is being done on this species by Dr. Dunbar's group from McGill University which engages in summer researches for the Fisheries Research Board of Canada in the Ungava Bay and Baffin Island region. Little is known about the sea trout resource but it is at least questionable whether this fishery could be greatly increased in the Labrador area. Greater profits could probably be obtained if it were proven possible to market these fish in some other way than in the pickled condition. Some research on the Arctic charr will be carried out as soon as the staff of the salmon investigation can be increased sufficiently for this purpose.

EELS

Eels enter our streams from the ocean as small elvers about three inches long. They grow to full size in the streams, lakes and estuaries and then leave for spawning in the Atlantic. From this spawning migration the parent eels do not return. During their abode in the brooks, rivers, and lakes they are competitors for food with the salmon and trout and also prey considerably on the young of these species. It is during the migration to sea that the eels suitable for market must be caught. In Quebec in the St. Lawrence River area there is a commercial operation based on the supply of live eels to the New York market. It is possible that frozen eels could be sold. The capture of eels offers no great difficulty the only question being whether the available supply from tens of thousands of rivers and brooks could be collected and sold on an economic basis. It is doubtful whether much can be done with the utilization of eels commercially unless a large

source of supply can be located in a limited area. Of the supplies available there is only hearsay evidence.

FISHERIES TECHNOLOGY

Artificial Drying of Light Salted Fish

Some of the earliest scientific work on the artificial drying of salt fish was carried out by the Newfoundland Fisheries Research Station during the period of its operation at Bay Bulls. More recently in 1947 and 1948 the station demonstrated that light salted fish, of a quality approximately equivalent to that produced by sun drying, could be produced in an artificial dryer by increasing considerably the speed of the airflow over that needed for drying heavy salted fish. Similar and more detailed studies have been carried on at the Gaspé Experimental Station on the light salted Gaspé cure. The Atlantic Experimental Station is now conducting an experiment at Bay Bulls to test out on a pilot plant scale the methods and economics of the artificial drying of light salted fish.

Fish Liver Oils

The Newfoundland Fisheries Research Station is conducting an investigation on the yield and vitamin A value of the oil from the livers of available species of Newfoundland fish. A great part of this work is on cod livers which have been shown to be the greatest source of vitamin A available in the area. Vitamin A is low when the livers are fat and the fish are small and high when the livers are lean and the fish are large. Newfoundland cod liver oil produced from trap-fish livers is moderately low in vitamin A. The best livers from inshore cod, high in

vitamin A, are from the larger fish caught in summer and autumn and during the winter time by line-trawls in deeper water. The livers from the large bank cod also high in vitamin A are usually thrown away.

Additional good sources of vitamin A are halibut, hake, pollock, Greenland sharks, very large skates and rosefish. Apart from the rosefish these fish are not usually present in large amount and in the rosefish the liver is very small.

The Station has shown that oil extracted from local rosefish waste contains good quantities of vitamin A and one firm is at present extracting this oil. Studies are proceeding on the variation in oil yield and vitamin A from rosefish waste.

SOME METHODS OF FISHING FOR GROUND FISH

Hand Line, Line Trawl and Trap

The three traditional methods of catching cod in Newfoundland are by hand line, long-line or line trawl and by trap. The hand line is effective whenever quantities of cod can be caught in ten to twenty fathoms, especially on the tops of small shoal grounds where many boats may fish by hand line and yet the area is too small to lay quantities of long-line gear. These shoals appear to hold the fish from the quantity of food available on the top and along the edges and by the edges of the shoal acting as a leader so that the fish can swim round and round. Fish on shoals in typical sunny weather can be caught in greatest abundance at dawn or dusk, the fish rising up to the tops of shoals at such periods and in dull weather and descending deeper around the sides of the shoal on bright sunny days. A better equipped fish-

erman or the bank fisherman is likely to use a long-line or trawl equipped with many hooks and especially when depths approach thirty fathoms or more and fish are somewhat scarce it becomes unprofitable to handline. With line trawls fished in the deeper water there is the advantage that fishing may proceed over the whole daylight period.

Traps are used mostly from June to early August and are on the average the most successful commonly used inshore gear in terms of catch per man during the period of the trap fishery. The trap is a very effective method of catching cod in relation to the relatively small capital investment. Trap fish, however, have the disadvantage for the salt fish trade of being on the average small. The handline fish also are small as compared with the somewhat larger fish caught on trawls in the deeper water. Trapping usually comes to an end in early August when the larger fish have moved deeper than the shallow trapping area and jellyfish have grown large enough to be strained out in great quantities on the walls of the trap causing serious damage from their weight when the currents are strong.

Gill Net and Jigger

A few gill nets are still used in the cod fishery and much larger numbers were fished before the traps became so numerous. In the early part of the year before bait is available and as a general principle in line fishing on the northern Labrador, where bait is scarce, the jigger is used in the cod fishery. It is quite possible that in the northern Labrador area the jigger is more effective than bait in any case.

Long-Lining

In very deep water below a hundred fathoms, or in shallower water whenever there is room to lay a very large amount of gear, the method of hauling line-trawl or long-line gear by using a gurdy operated from an engine has many advantages. By this method, with a small crew of two or three men on the boat and a part time man on shore to bait gear a boat can operate at least as much gear as could be handled by two boats or two dories hauling gear by hand. For best operation this method requires for each crew a part time man on shore to repair and bait gear, a cold storage for bait, cold storage space for baited gear and a fresh fish or salt fish plant to take the head-on gutted fish on landing. The crew of a small long-liner as described above is too few, the work too long and arduous and the quantities of fish caught too great for the long-lining method to be fitted to the typical Newfoundland catching, splitting, salting and drying operation by the fisherman and his family. For such a salt fishing operation a much larger crew would be required and a good many of the benefits of the operation lost.

Otter Trawl

The otter-trawling method is that most suited to catching a great variety of species of groundfish. The typical inshore bottom, apart from some areas, mostly in deep water, on the south and west coasts, is rough and not suited for small trawlers. Rosefish are plentiful in some inshore deep water areas on the south and west coasts but it has not yet been demonstrated that the very small trawlers which might be allowed to operate in territorial

waters can catch them effectively. With suitably increased power and larger winches they probably can do so.

A great portion of the Grand Bank is too rough for small trawlers but the southern and eastern parts are relatively smooth. Newfoundland should encourage trawlers and look forward to the day when at least a hundred large Newfoundland trawlers will be operating on the offshore banks. These local trawlers are not particularly competitive with the inshore fishery since they preferably attempt to catch haddock, flounders and rosefish rather than cod, the fresh fish firms obtaining a great part of their cod inshore.

Danish Seining

Danish seining is a very successful European method of catching bottom fish, particularly the flat fishes. For its best operation an area of about a quarter or a third of a square mile of very smooth bottom is required. Its success in inshore Newfoundland waters is likely to be quite local and gradual, depending on the finding of the smooth bottomed areas with flatfishes or other fishes large and plentiful enough to provide profitable trips. In these areas it will prove a useful addition to our fishing methods. This method of fishing is being given a good introduction by the Matthew II.

GENERAL REQUIREMENTS FOR FISHERIES

RESEARCH IN NEWFOUNDLAND

Speaking only of the needs of the Newfoundland Station it is apparent that considerably more floating equipment and laboratory staff are needed.

If Newfoundland is to develop a large fresh fish industry based on a variety of fish a large increase in the number of trawlers must be expected. To do its offshore research properly the Station needs a large trawler estimated at about 175 feet in length. A smaller inshore long-line and dragger type of boat of about 55 feet is also required. With these boats the Investigator II would still be needed for hydrographic work and offshore long-lining, shrimp trawling in deep water, and scallop dragging, otter trawling and Danish seining in the inshore areas and on the banks supplementing the work of the larger boat. To provide for increases in staff and expenditures to operate the larger boat and to carry out other necessary expansions of the Newfoundland Research it would be necessary to more than double the present amount spent on the Newfoundland Fisheries Research Station.

W. Templeman

Newfoundland Fisheries Research Station

September 5, 1951.

Appendix A

WHALES

(a) Large Whales

Stocks of the larger whales in Newfoundland and Labrador waters are exploited currently by two shore stations, operating between them 8 catchers. These stations are at Williamsport, Fourche Bay, and at Hawkes Harbour in southern Labrador. The total annual catch since 1945 has been as follows:

<u>Species:</u>	Blue	Fin	Sei	Humpback	Sperm	Total
1945	-	-	-	-	-	393
1946	11	502	Nil	5	11	529
1947	14	414	4	6	17	455
1948	57	668	3	14	14	756
1949	30	425	23	11	53	542
1950	16	408	16	16	29	485
1951	- figures not yet available					

Fin whales therefore constitute by far the greatest part of the catch. The Blue whales are also of great value, since a single Blue yields on average as much oil as two Fin whales. At both stations the blubber, meat and bones are processed for oil, and the meat residue dried for guano, used in cattle feeds.

Information about the biology of the different species of whales is available so far only from the International Whaling Statistics, compiled at each station by the gunners and by an Inspector. These give data on date and position of capture, length and sex of whales caught, contents of stomach, and the length and sex of the foetus in pregnant whales. During the 1952 season collection of further data will be started from the Newfoundland Fisheries Research Station.

The catching fields of the two stations overlap, extending between about 49° and 54° N. Lat., and from the coast to about 200 miles offshore; the catchers also operate in the Strait of Belle Isle and the neighbouring eastern part of the Gulf. To operate at longer distances is uneconomic, since the whales decay while being towed back and the quality of oil greatly deteriorates.

Fin whales are caught throughout the season, which extends in most years between the end of June and the end of October. This season has been determined by weather factors rather than by the availability of whales. During the last three seasons (1949 to 1951) however, there has been a marked decline in the number caught in September and October, although the total catch has not showed a decline. It is also evident from the positions of capture that whales are no longer caught close inshore, as they were up to 1948. It is not known whether this change in movements is connected with heavy catching, or with changes in hydrographic and feeding conditions. The majority are caught some 100 miles offshore. Concentrations of Fin whales in certain areas, as shown from catch statistics, appear to indicate rich feeding grounds and may lead to the discovery of new fishing grounds. The food of the Fin whales throughout most of the catching season consists of Whitefish (non-spawning Capelin).

Blue whales are caught over a short period during late June and July. Since they are of larger size than the Fin whales, the catchers seek them out first, principally in the Strait of Belle Isle. They appear to be migrating north at this time. Only isolated individuals have been caught in the autumn, and the time of the return migration is unknown. The food consists of "Krill" i.e. planktonic crustacea.

Sei whales are caught in small numbers in September and October. Their movements are unknown.

Humpback and Sperm whales are caught sporadically throughout the catching season. All the Sperm are males, and do not constitute a regular stock in these waters; rather they are to be considered as occasional wanderers from tropical seas.

Research on the larger whales will be directed to determining: (a) the age composition of the stock, and (b) the distribution and movements of the whales in Newfoundland and southern Labrador waters. To these ends it is proposed: (a) to start collection of material from whales caught at the two stations; ovaries and baleen plates can be used for determining age; (b) to attempt marking of whales at sea. Steel marks can be fired from a shotgun to penetrate the blubber, and it is hoped to undertake marking from the "Investigator II". It is probable that recoveries would come largely from the two stations, the only ones known to exist in the western North Atlantic. However, large scale marking would help also to determine whether there is interchange with eastern Atlantic stocks of whales.

Conservation

To determine the effect of the present rate of catching, it will be necessary to determine the age-composition of the stocks over a number of years. It can however be roughly estimated, from a survey of the history of whaling in Newfoundland waters, what order of catch is an optimum, i.e. that which will give a sustained yield. Modern whaling began in these waters in 1902, and developed rapidly; at its peak, in 1904, the catch was as follows:

Blue	Fin	Humpback	Others (unspecified)	Total
264	690	281	40	1275

With unrestricted catching this catch fell steadily, reaching by 1914 a total as follows:

Blue	Fin	Humpback	Sperm	Total
5	142	13	1	161

Between the wars the figures of catch are very incomplete, but it appears that the industry was limited by economic factors rather than by the available stock of whales. The catch since 1945 does not show any clear signs of being too heavy. It is possible that an annual catch of some 500 Fin whales can be maintained. Humpbacks however are a species always liable to overfishing, since they remain in coastal waters, are more easily caught, and are known to exist in isolated stocks in any geographical region. The catch of Humpbacks in western Atlantic waters is at present very low and of little economic importance; total protection may be necessary in order that the stock of this species may be built up. Such protection has been deemed necessary on the eastern side of the Atlantic.

Blue whales passing through the Straits of Belle Isle are also vulnerable, and a large percentage are probably killed here each year. However it is not known what proportion of the stock passes northwards outside the Straits, where fewer are killed.

(b) Small Whales

A single Company with a shore station at Dildo South operates two catchers within Trinity Bay. These catch the small rorqual known as Minke, and the gregarious Pothead or Pilot whale, as well as rare Fin and Humpback whales. The Minke have thin blubber, and are valued for the meat, which is frozen and

marketed both for human food (under the name of "Arctic Steak") and for animal food. The oil of the Pothead is of high quality, particularly the head oil, which is rendered separately for use as a fine lubricant. The meat is less palatable than that of the Minke, and is used for animal food, principally on fox and mink farms.

Minke are caught by harpooning, as are a proportion of the Potheads. However the larger number of Potheads are taken in drives. The catchers drive a herd into a shallow arm (Chapell Cove) of the bay, whence they are driven into shallow water and killed by the fishermen in motor boats. In this way large numbers may be taken at once. Occasional drives are made also in Bonavista Bay by the fishermen unaided. The fat from the whales is the property of the fishermen, and is sold to the Company for extraction of the oil. This system has the disadvantage that full use cannot be made of the carcasses; the drives take place at a considerable distance from the plant, and the meat is mostly left. All meat from harpooned Potheads is frozen or used for guano.

The success of this unique industry depends upon the whales entering inshore waters in sufficient numbers.

The Minke come into Trinity Bay during early summer, following the Capelin, and are caught usually between mid-May and mid-August. Their numbers fluctuate from year to year. The Potheads come in later, following the squid, which is their sole food at this time. Drives may be made between about the end of July and the end of October. However in a year when the squid fail, no or very few Potheads are caught.

Minke are stated to be present in other bays, e.e. Placentia Bay, and might be in sufficient numbers to justify expansion of the industry. There appears to be a good market for the meat, particularly in Quebec province. In Norwegian waters the Minke is hunted very extensively and the meat used for human consumption; it is extremely palatable, being finer-textured than that from the larger Rorquals.

It is probable that the numbers of Potheads in Newfoundland waters are very large. However exploitation of this species by harpooning is of doubtful value, owing to its small size; the method of driving demands a suitable shallow bay into which the whales can be driven, as well as some skill and a measure of co-operation from the fishermen. It is therefore likely to remain rather a folk-culture than an industry, as in the Faeroe Islands.

A study is being made of the biology of the Pothead, which is a little known species zoologically.

D. E. Sergeant

Newfoundland Fisheries Research Station

October 27, 1951.

Appendix B

HARP SEALS

The commercial seal hunting depends mainly on stocks of harp seals which, as far as is known, are more or less separate from the stocks involved in the seal hunting at Jan Mayen and to the east, and therefore from the biological and conservation point of view constitute a separate problem. About 85 per cent of the kill is composed of the recently-born young of "white-coat" pups of the harp seal, the remainder being made up of sub-adult or "bedlamer" and adult harp seals and to a lesser extent of young and old hooded seals.

Sealing has been intensively pursued off Newfoundland for over 150 years, and while numbers and types of ships have constantly changed during this time, hunting methods on the ice have remained essentially unchanged. The hunting was at a peak in the middle 1800's, when over half a million seals were brought in annually. The present hunting effort has increased steadily since 1943 to a take this year of over 400,000. The seals are being taken principally for the oil and for the fast fur of the white-coat pups, although hides are also marketed for leather.

Exploitation

The stocks of harp seals supporting the Newfoundland industry have been exploited most by Canada, next by Norway, to a limited extent by hunting in Greenland, and to an almost negligible extent by the United States. The Norwegians first began sealing here in 1937, having been forced out of the White Sea sealing grounds by Russia. With a period of non-activity during World War II, their fleet has increased to 14 ships this year, with a capacity of about 10,000 seals per ship. Canada had about

21 vessels sealing this year, which took over 250,000 seals, while landmen accounted for another 50,000.

The results of attempts to estimate the size of the stock through aerial photography for the past two seasons have not indicated an urgent need for restrictive measures if the total take remains near the 200,000 level. There is reason for concern, however, if the take rises much above that level, which it is doing, especially if sub-adults and adults are being destroyed. Since the whelping areas of the seals on the ice fields are for the most part outside of the 3-mile limit for territorial waters, there is urgent need for an international agreement on the conduct of the sealing, and formal discussions with Norway are expected to be held in the near future.

The major point of disagreement both on the international level and within Canada is on the starting date for the killing of the pups. The white coat of the harp seal pup is fast for about 12 days after birth. During this time and for about a week after it gains blubber at the rate of three to five pounds per day. The crews of the Norwegian vessels and those of Karl Karlsen and Co., Halifax - a Norwegian financed firm - are paid on the basis of the value of fast fur and skins as well as of oil, and their pay is substantially higher than that of crews of other Canadian firms. Because they receive more for fast-furred white-coat pelts than for fat pelts with slipping fur, they naturally prefer to begin killing as early after the whelping as possible. Because the Newfoundland crews are paid by weight only, they naturally prefer to wait until later in the whelping season before killing, when the pups have gained a good amount of blubber. If Newfoundlanders hold out for a later

killing date than the Norwegians, the latter might well ask why their crews are not paid on the same basis, thereby earning much more than they have been, in which case they would be as willing as the Norwegians to kill light-weight pups. The problem in this case therefore is an economic one rather than a biological or conservation one. It seems essential that the market values and marketing procedures both in this country and in Norway be investigated as soon and as fully as possible, in order to compare the values of oil, fast fur and skins, and to determine whether Newfoundland firms are able to market their fast fur and skins as profitably as can the Norwegian operators. This knowledge is essential before decision can be made as to the stand Canada is to take in international negotiations, a stand which, of course, must be that which is most valuable to her interests.

Investigations

The Atlantic Biological Station began investigations on harp seals in 1949. Aspects of special interest to Newfoundland are:

1. Aerial photographic survey of whelping patches in the Gulf of St. Lawrence and off Newfoundland which has indicated a total population of between two and three million.
2. Tagging and release of pups on the ice fields, to determine relationships among different populations, migration speeds and routes, etc.
3. Collection of material each year from shore netting stations and from vessels, to determine size of coming breeding stock, length of breeding life in both sexes, food habits, etc.

Summary

Exploitation of harp seal resources has reached an extent where it appears essential that international agreement on a regulation of the take be reached, especially with regard to the opening date and length of the killing season, and to a reduction of the kill of older seals. An investigation into the economics of the sealing industry is necessary in order to determine the most desirable method of operating.

H. D. Fisher

July 7, 1951.

Appendix C

HERRING

Introduction

It is well known that practically all the large bays in Newfoundland are frequented by spawning schools of herring at various times during the winter and spring months. Extensive fisheries have been carried on for many years principally in the Bay of Islands and to a lesser extent in Fortune Bay. Other areas such as Placentia Bay, Trinity Bay and Notre Dame Bay have only been sporadically exploited. There has also been in some years, a summer fishery for feeding herring along the Labrador coast but the supply there has not been reliable.

Exploitation

It is believed that the Newfoundland herring resources have never been fully utilized. The spawning schools which are presently being fished are made up chiefly of very large and very old fish most of which have already spawned several times. Except for the fishery along the Labrador coast catches are made from pre-spawning and spawning schools which are found close in-shore. The principal method of capture has been by means of anchored gill-nets although shore and beach seines have been used to some extent. Purse seining is a recent development and may still be considered to be in the experimental stage.

Availability

It seems certain that much greater use could be made of the spawning schools particularly in areas which are only lightly fished at present. These fish, however, are in very poor condition and are suitable only for reduction to oil and meal and for low grades of pickled herring. After spawning the movements of

the herring become obscure. They move offshore into deeper water where they quickly recover from the effects of spawning and low temperature conditions. If the main schools could be located on their summer and early autumn feeding grounds they could be caught in far superior condition. Practically nothing is known of the distribution of the immature fat herring, 1 to 4 or 5 years old, which could also form the basis of an industry if they could be located in quantity.

Investigations

It would be unwise to estimate the possibilities of further development of the herring fishery until there has been an adequate assessment of the resource. An extensive survey should therefore be made throughout the area using methods of capture which have been successful in other countries such as trawls, drift-nets and purse seines. The Atlantic Biological Station is continuing drift-net explorations which were begun in 1950 in the Gulf of St. Lawrence. The results of these explorations indicate that high grade herring can be caught profitably throughout the summer months. A similar exploration seems desirable for the Newfoundland area. Intensive biological studies should also be made to determine what divisions exist in the stock, what the annual recruitment is, what the rate of growth is, the age at maturity and other pertinent facts of the life history of the herring. It is also desirable to know the variations in quality throughout the year.

Summary

The herring fishery in Newfoundland has never attained a stable position. Many attempts have been made to establish the industry on a firmer foundation but with little success. The

chief difficulties appear to be the inability to penetrate existing markets and the lack of success in developing new ones. This may be due to the fact that existing markets demand (a) "matje" herring for Scotch cure, (b) immature fat herring for the fresh and frozen trade and for canned products and (c) large fat herring for kippering. Only small quantities of herring suitable for these demands are now caught in Newfoundland and the future of the fishery would be considerably brighter if these kinds of herring could be captured in quantity. The market for herring meal and oil is strong and further development of a spring fishery for poor quality herring to supply this demand is quite feasible.

It is possible that the quality of herring would be improved by increasing the catch and thereby removing a large proportion of very old, slow-growing fish, the flesh of which is very coarse and tasteless even during the summer months. The removal or revision of restrictions on fishing dates and methods might be beneficial to the stock as a whole.

S. N. Tibbo

Atlantic Biological Station

July 12, 1951.

Appendix D

LONG-LINING AT BONAVIDA 1950-51

Since the original note on long-lining was written and mimeographed enough information on 1951 operations has been received to make possible a further assessment of the possibilities of long-lining in the Bonavista area. It has been necessary to consider frankly individual boats. This appendix is concerned with the fishing at Bonavista up to the end of October 1951.

In 1950 two 42-foot Cape Island type long-lining boats with skippers from Lockeport were used. Fishing began on June one boat fished to the end of August and the other until early November. Although an attempt was made to use one of the two boats as a commercial boat, the type of contract with crews on salary, the Captain on a fixed charter and bearing all expenses, the fishermen on salary and the government receiving the value of the fish caught resulted in an experimental rather than a commercial operation. This was possibly a fortunate result and in all such operations in order to obtain the best future commercial success the first approach should be experimental and not commercial. During the experiment a planned survey was made of the Bonavista area including especially the offshore areas and temperature in relation to cod abundance was studied as an aid in choosing the proper depths and localities. As a result of the experiment in 1950 excellent and new cod fishing grounds were found about eighteen to twenty miles seaward from Cape Bonavista in an arc with compass bearings between east by north and southeast of the Cape in water usually between 130 and 160 fathoms. In this area the catch of cod was consistently good from July to October 1950 and from June to the present time in 1951. The cod

are on the average considerably larger than the inshore run. In the deep water, power-hauling of long line gear has a great advantage over hauling by hand. In 1951 there has been less cold Arctic water present than in 1950 and correspondingly the fishing is slightly closer to shore, about 18 miles off Cape Bonavista instead of 18 to 20 and in 120 to 140 fathoms instead of 130 to 160. Cod have also been more plentiful than in 1950 on the grounds used by the long-liners.

In 1951 a comparison was attempted in the Bonavista area between two long lining boats of the Cape Island type with boats and skippers from Lockeport, N. S. One boat was an open boat of 42 feet, the "O Johnny O" and the second a 51-foot decked boat the "Miss Osborne". The contracts have been more suited to commercial operation, with the boats retaining the value of the catch and with the fishermen partly on a share basis. Between June 9 and September 30 the "O Johnny O" has caught 289,000 pounds of commercial fish, mostly cod. During this period the gross stock from the sale of fish by this boat was \$6829, the boats share at 20 per cent \$1366, the expenses \$1603 and the share per man for each of the crew of three \$1287.

The larger boat the "Miss Osborne" caught 215,000 pounds of fish between June 13 and August 15, when she blew up, as compared with the catch by the "O Johnny O" of 177,000 pounds in approximately the same period. It is probable therefore, using direct calculation, that the 51 foot "Miss Osborne" would have caught about 350 thousand pounds of fish in the June to September period as compared with 289 thousand for the "O Johnny O". During this period the "O Johnny O" had one days fishing before the "Miss Osborne" began and lost one days fishing due to engine

trouble so that both boats fished the same number of days. The echo sounder of the "Miss Osborne" was a great help to both boats since the "Miss Osborne" held to the presumed best depths with her echo sounder and the "O Johnny O" set her gear parallel to that of the "Miss Osborne". The "Miss Osborne" carried 4 men during most of her period of fishing, being a costlier boat took 25 per cent for the boat's share and the share per man was considerably less than that of the "O Johnny O" in spite of the extra catch, \$715 for the share of the "Miss Osborne" as compared with about \$768 for the "O Johnny O" for the June to August 15 period. Captain Hemeon of the "Miss Osborne", however, came to the conclusion at the end of July that with the returning to port after each days fishing the extra man was not profitable so in the first half of August he fished with a crew of three men only and still maintained his advantage in fish caught to approximately the same extent as in previous months.

Apart from the advantage given by being able to select fishing depths by means of his echo-sounder it was apparent to our observer that the larger boat fished more gear than the smaller boat and the larger catches of the larger boat are to be attributed to these factors neither of which is inherent in the size of the boat on one day fishing trips; that is the main difference was a difference in fishermen and gear rather than in size of boat. The larger boat fished only on the same days as the smaller boat. The only way in which the larger boat could possibly have obtained some real advantage was in taking ice to sea and remaining out for two days. Both captains were of the opinion however that the best method of operation at Bonavista by a fast boat such as the Cape Island boat was by returning to port

daily and having some of the baiting and repairing of gear carried out by a hired hand on shore.

After the destruction of the "Miss Osborne" by a gasoline explosion on August 15 Captain Hemeon fitted up the "East Wind" with a gurdy for long-lining. The "East Wind" is a 47-foot, 21-gross ton Newfoundland Jack boat or schooner type powered with a 30 H.P. heavy duty Atlas. The "East Wind" was suitable for long-lining once on the ground, kept up to the gear and made good catches. She proved however to be too slow - only about three knots - for the journey to and from the Bonavista offshore fishing grounds which are over twenty miles from Bonavista. On the south coast of Newfoundland in the winter fishing relatively close to shore the Jack boat type has had a long history of successful fishing using two dories and long lining from Jack boats should be possible in this area.

Since September 22 Captain Hemeon has used the "Edward Humby", a 54-foot Newfoundland boat with a speed of 7 or 8 knots successfully as a long liner in the Bonavista area.

Neither the "East Wind" nor the "Edward Humby" was built or designed as a long lining boat consequently it has not been possible to arrange for as simple operations in handling the boat, operating the gurdy and removing the fish by one man as is possible in the Cape Island boats. There is enough extra work and lack of flexibility in the two schooner type boats that four men have to be used instead of the three necessary on the Cape Island boats. This reduces considerably the catch per man and makes the operation less attractive. Captain Hemeon calls the extra man a dead share which seems to be a very fitting expression. The Cape Island type boat is also a ten knot boat whereas the sturdy local

boats are usually considerably slower. The Cape Island boats are of shallow draft and go over rather than through the seas after the manner of a dory.

Two boats with Bonavista crews are now long-lining in the Bonavista area. One the "Bonnie Glendee" owned by Mr. Clyde Little is 38 feet long, $7\frac{1}{2}$ gross tons powered by a 44 H.P. Kelvin diesel, with a speed of about 6 knots and a crew of 4 men. This boat began fishing on August 16 inshore and by August 25 was fishing the offshore grounds which they continued to fish until October 2. From August 16 to October 6 this boat has caught 119,000 pounds of cod (we have no figures on wolffish and flounder by this boat). Neglecting August when the crew was learning how to use their gear, in September the "Bonnie Glendee" caught 52,500 pounds of cod as compared with 48,215 pounds for the "O Johnny O". On the offshore grounds this boat is usually outfished by the "O Johnny O" but on the inshore grounds she usually catches more since these grounds are very irregular and small and the Bonavista fishermen know them better. The "Bonnie Glendee" fishes more days than the Nova Scotian boats - the latter being under charter and with the crew paid are disinclined to spend a day fishing for the smaller amounts to be caught on the inshore grounds. This boat, although seaworthy and sturdy, is proving as the daylight period gets shorter, rather slow for the offshore grounds and is now tending to fish more inshore except on the very good days. The "Bonnie Glendee" has not settled up and we have no information at present on its economics. However with a diesel engine its running expenses should be low. The food, fuel and some of the other expenses will also be much lower on the Bonavista operated boats than the amounts incurred by the "O Johnny O".

Preliminary Comparison of Long-Lining Boats in October

The "East Wind" is now crewed by Bonavista fishermen and is using a gurdy for long lining with a crew of five. In October this boat has made 7 inshore trips and two offshore for a total catch of 40,370 lbs. of cod as compared with 6 offshore and 2 inshore trips for the "O Johnny O" with a catch of 49,385 lbs. cod and 8 offshore and one inshore trips for the Edward Humby with a catch of 89,630 lbs. cod. During the month the "O Johnny O" lost $2\frac{1}{2}$ fishing days undergoing repairs and the "East Wind" is apparently limited by her low speed to very good days for fishing offshore where the heavy catches are to be made. This boat needs considerably more power. The "Humby" a larger 54-foot well powered boat has shown to much greater advantage than the other boats in October and it may well be that a larger sturdier boat will pay for its extra cost in this way. There is so much difference between the handling of boats by different skippers however that only experience on a large scale over a number of years will bring out the fishing and economic merits of the smaller and larger boats.

The "Hubert G. Smith"

A converted Labrador schooner the "Hubert G. Smith" operated by the Provincial Government has been long-lining in the offshore Bonavista area but has now left to continue long-lining out of St. Anthony. This boat is 70 feet long with a gross tonnage of 78, a 115 H.P. Caterpillar diesel, a speed of 9 knots and a crew of 11 men. The "Hubert G. Smith" began fishing at Bonavista on September 6 and continued throughout September, during which time a catch of 59,000 pounds of cod was made as compared with a cod catch by Decker's "O Johnny O" - with a crew of three,

by Hemeon's "East Wind" and "Edward Humby" with a crew of four, and by Little's "Bonnie Glendee" with a crew of four of 48,000 lbs., 53,000 lbs. and 53,000 lbs. respectively during approximately the period September 4 to 30, the latter three boats fishing on the 4th and not on the 5th which was the first days fishing for the "Hubert G. Smith".

During this period the Hubert G. Smith left Bonavista in the mornings and returned at night like the Nova Scotian boats and fished on essentially the same days. It is evident that the larger boat with the larger crew will not be successful leaving port and returning to port on the same day since a small boat with a crew of three will do almost as well.

Remarks by L. N. Cluett on Future of Long-Lining at Bonavista

(These remarks were requested by me and included in a letter from Cluett on October 11. Cluett is our technician at Bonavista who has been constantly with the long-lining boats for the past two years.)

"Quite a few of the Bonavista fishermen appear to be interested in this type of fishing and this kind of boat. In fact those that are against it seem to have as their biggest argument the fact that they are unable to get the fish they catch now sold at the plant, so they argue what is the point in getting new boats and more fish. I think that those who would like to have boats of this type are afraid of the money involved, they feel that this much money would have to come from the merchant or the Government and I don't think they are prepared to give up a tried and true method of fishing in which they own their own boats and engines and accept a new method for

which they will have to get a loan to obtain the boats and engines. Some of the better fishermen who could advance this money themselves seem to be interested and I would think with a little encouragement would get one of these boats. These men look upon the present experiment as something apart from them. If these boats were owned in Newfoundland they might feel differently about it, but at present although they know the crews make very good money they think without Government assistance and the fresh fish plant's co-operation, which they feel they would not have, they could not get along so well. Practically all the fishermen in Bonavista, with the exception of the three local men who have been fishing on the the long liners, know very little about this method of fishing except seeing the boats coming in. The local crew of the "Bonnie Glendee" have adapted their method of hauling by hand to that of power hauling but not using the correct method of hauling and coiling trawls have doubled their work as compared with the Nova Scotians in handling the same amount of trawl.

This year the "Bonnie Glendee" has had a chance by following along with the experimental boats to gain some experience in offshore fishing, this I feel is a great thing for any fisherman starting long-lining at Bonavista. There is quite a difference in the offshore fishing to what they are acquainted with inshore and by having other boats fishing in this area to follow, in time gives them confidence in themselves and the boats. I feel that in the future if the Bonavista fishermen do obtain long

liners, without one or two leaders who have some experience in offshore fishing and who are prepared to go out there whenever possible, that they would revert back to their old method of using the boats hand-lining or trapping inshore.

I do not think it is possible to adapt any of the present inshore boats at Bonavista to long lining with the engines they are using, because they are all one or two cylinder engines not equipped with a clutch gear. To install separate engines to run the gurdy would take up extra space aboard boats which are entirely unsuited for fishing outside, both from their slow speed and poor layout and to install gurdies on these boats for inshore fishing would not increase their catches because the limited grounds inshore make it impossible to fish long strings of trawl.

Unless the Cold Storage Co. installs a gurdy on the "Right Wind" which is a boat similar to the "East Wind" I do not think there is any other boat in Bonavista except the "Bonnie Glendee" which will fish long lining next year. The "East Wind" is at present fishing inshore using a gurdy. One of the local fishermen is using her with a crew of five and 48 lines of trawl. Since their first trip on September 28 they have made 4 trips altogether, all inshore and landed 11,290 lbs. They use the old method of coiling trawl with the hooks around the tub.

I would imagine that Mr. Tucker, who bought and is repairing the "Miss Osborne" will fish here next year

using long-line. Mr. Clyde Little told me earlier in the season that next year he is hoping to send his boat offshore for a trip as soon as ice conditions permit to see if there is any fish out there, so apparently he intends to do some long-lining next year also. I would say that probably the "East Wind" and the "Right Wind" would fish this way but with the power they have now I do not think they can do much offshore work."

General Impressions on Long-Lining in Newfoundland

My general impression of long-lining in the Bonavista area is that as far as the returns to the fishermen are concerned it has been very successful and the amounts earned by the small boats are apparently sufficient for profitable operation.

This year 1951, however, has been notable for a much greater abundance of cod in the offshore Bonavista area than in 1950, the catches per tub of gear during the latter part of August and early September being twice as high as in 1950.

The general picture at present is that a sea worthy decked boat of about 38 to 45 and probably not over 50 to 55 feet with a carrying capacity of fifteen thousand pounds and a speed of eight to ten knots will be suitable for long-lining in the offshore Bonavista area. The boat should be designed for operation by a crew of three.

Except probably for the rougher autumn fishing no real economic advantage can be shown by larger boats over the 42 foot open boat in daily fishing trips but for safety we would like to see a slightly larger decked boat in operation in the area. The rugged well powered boat will doubtless also show to advantage in the autumn. The Cape Island boat with its high speed, its low

set in the water for ease of removing fish from trawls and general adaptability to easy operation with a small crew cannot be neglected as a type for the area. The local schooner or Jack boat type while sturdy is likely to be slow moving and there is no protection on deck. A crew of 4 is needed for long-lining. If the more sturdy local boats are to be given a fair trial the on-board arrangements must be redesigned for ease of operation by three men instead of four. The hull also will probably need redesigning for greater speed. That is a new design is needed.

Profitable long lining also depends on the use of a small crew with a hired hand on shore for repairing and baiting gear, refrigeration is needed for baited gear, bait storage for frozen bait and since the boats typically come in late, a plant needs to give long-liners special privileges in the acceptance of fish, otherwise the early landings of the trap and other inshore boats will have the plant full of fish before the long-liners get in.

We do not believe that it is worth while trying to adapt the long-lining method to the common Newfoundland practice of splitting, salting and drying of fish by the fisherman and his family. This would require doubling the crew and consequent small earnings. The long-line caught fish from small boats should be sold fresh either to a fresh fish or a salt fish plant. At present at Bonavista during the summer time the fresh fish plant can handle only a part of the landings by the local fishermen. Consequently there will need to be an increase in the shore plant facilities in the area before any large expansion in long-lining is likely. On the other hand in warm springs such as 1950 it should be possible to start long-lining on the offshore grounds

early in May whereas the inshore fishery usually only becomes large during the latter half of June. Long line fishing should extend to December. There will be more inshore fishing in the late autumn and early winter months because of weather conditions and the short daylight period. The fish should still be present in the area in January and February but freezing in the harbour will probably usually prevent fishing from Bonavista harbour in these months. Possibly Port Union Harbour can be used in the early winter months.

South Coast Area

Another place where the long-lining method will undoubtedly become effective is in the area of the winter fishery on the western part of the south coast where fishing is carried on at about a hundred fathoms and the Jack boat with two dories is the common method of fishing at present.

For best operation a long line boat should operate at Bonavista from May or June until November or December and in the winter fishery on the south coast from December to April. If this were done the long-lining would doubtless be very profitable both for boat and crew.

W. Templeman

Newfoundland Fisheries Research Station

October 31, 1951.