G. Anderson

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FISHERIES RESEARCH BOARD OF CANADA

ANNUAL REPORT

of the

NEWFOUNDLAND BIOLOGICAL STATION

for

1 9 4 9

With Investigators' Summaries as Appendices

by

W. Templeman, Director

ST. JOHN'S, NFLD. DECEMBER, 1949

REPORT FOR 1949 OF THE NEWFOUNDLAND BIOLOGICAL STATION, ST. JOHN'S, NFLD.

BY W. TEMPLEMAN, DIRECTOR

REORGANIZATION

Before Union of Newfoundland with Canada in April 1949, the Newfoundland Government Laboratory carried on biological research, some technological and hydrographical research, fisheries analyses, canned and fresh fish laboratory inspection, and general analyses.

After Union the biological and hydrographical section of the Laboratory was placed under the Fisheries Research Board of Canada, renamed the Newfoundland Biological Station, and most of the original staff remained with this Station. The responsibility for technological research and services was transferred to the Atlantic Experimental Station at Halifax, the fisheries analytical and laboratory inspection group work is being set up as a Department of Fisheries Fish Inspection Laboratory and the general analytical laboratory remains under provincial control.

BUILDING

At the present time the Newfoundland Biological Station essentially occupies the top floor of the government laboratories building which was constructed in 1940. Space for new staff is not available and the present staff is very crowded. This whole building is needed for the use of the Station.

RESEARCH

In Newfoundland the Groundfishes, particularly the cod, haddock, American plaice and rosefish are of the greatest importance. Of these the fishery for cod is at present more valuable than all the other fisheries together and the volume could be greatly increased by devoting more attention to fishing the offshore banks. The haddock, plaice and rosefish fisheries are only in the early process of development and particularly in the latter two a much greater catch is possible even from the stocks discovered during the past three years.

There has always been a shortage of research staff at the Newfoundland laboratory so that problems have to be attacked in rotation. Thus while within the past ten years a good deal of biological research has been completed on the lobster, dogfish, caplin and herring we have during the past three years concentrated our research largely on the Groundfishes. This policy of directing most of the research effort toward the groundfishes will

probably be a wise plan in the future also for the Newfoundland Biological Station.

In addition to the Groundfish research Salmon research has been continued because of the wide public interest and of the many problems and the vulnerability of the salmon population. A member of the staff, Mr. Tibbo, has been for several years seconded to the Atlantic Herring Investigation Committee and is stationed at St. Andrews.

Research on the Vitamin A value and yield of liver oil of the various Newfoundland fishes has continued for three years and is now being brought to a close.

Groundfishes

In the Groundfishes there are a number of considerations which motivate our research. First of all in the present poorly developed state of the offshore fishery for these groundfishes and of the poor returns to the individual fisherman from the inshore fishery must come exploratory fishing and the related hydrographic studies to obtain a better knowledge of these fish populations with a view to greater and more economical exploitation. Secondly there is need to lift the veil of ignorance on the general life history of these fishes so that we can think about the fish intelligently and come to wise conclusions. In the second regard no major phase of the life history should be left unstudied. Thirdly a basis should be laid by which major changes in the fish populations can be recognized. While the Newfoundland Station is to some small degree in a position to carry out work on the first two of these objects and by a study of fish lengths and year classes to carry out part of the third task we do not believe that we can gather enough statistical information on the inshore cod fishery for a sound basis of conservation studies and believe that this should be done by some other agency than the laboratory. Also the main centre of fishing on the Grand Bank by the foreign trawlers, where depletion is mostly likely to occur, is not fished by our fishermen. It is possible that an International Commission for the North West Atlantic will help in the providing of the necessary statistics on the Grand Bank.

Research Boat. Since for most of the groundfishes trawling is the only practical way of catching them commercially a groundfish research boat should be a trawler. Our present research boat the Investigator II is doing useful work but to carry out exploratory fishing properly especially in deep water where so large a proportion of these groundfishes is found a considerably larger research boat of the trawler type is required. This boat should be capable of trawling in 300 fathoms. There is also room for a smaller boat for work in hydrography and with long lining trawl and other gear in relation to the inshore fisheries.

Hydrography and Fish Concentration. Although one can easily make serious mistakes by assuming too precise regulation of fish abundance by temperature in particular cases, the general correlation between particular types of bottom temperature conditions and abundance of various kinds of groundfish is indicated in many parts of the area.

Haddock on the Grand Bank in March and April 1948 were in deeper water than in 1947 corresponding with colder water than in 1947 being present in the shallower depths in 1948. The haddock were present in numbers in the warmer deeper water. On St. Pierre Bank the spring fishery for haddock is unusually deep often in the vicinity of 90-95 fathoms while the Grand Bank spring haddock fishery is usually at 50 to 60 fathoms. In both areas during the Spring and in June the greatest quantities of haddock are in the water several degrees above zero centigrade a few fathoms below the zero centigrade layer which extends much deeper on St. Pierre Bank than on the Grand Bank.

Cod are available throughout spring, summer and autumn in water of one or two degrees centigrade situated at about 100 to 120 fathoms, below the layer of cold Arctic water below zero centigrade on the northern and eastern slopes of the Grand Bank. The below zero water appears to act as a partial barrier although it is apparent that at times especially after spawning some of the cod break through the overlying cold layer and mount into the warmer layer above. There is much investigation needed here as the amount of this breaking through after spawning may determine the extent of the fishery inshore and on the shallower parts of the bank.

American Plaice are found in numbers on the eastern Grand Bank in water ranging from -1.2 to +1.1° Centigrade.

Exploratory Fishing. Successful explorations have been carried out for haddock on St. Pierre Bank and on the Grand Bank. The finding of haddock on the Grand Bank from February to June generally offers no difficulty as it is usually only necessary to try between the 45 and 70 fathom contours on the south west edge of the bank where the bottom is exceedingly smooth. Explorations along the northern and eastern slopes of the Grand Bank have shown good populations of cod in a number of areas, sometimes below the cold layer and sometimes in the upper part of the cold layer. Large populations of American plaice of commercial size have been shown to exist all along the eastern slopes of the Grand Bank. The plaice and cod populations are now being actually exploited by local trawlers, many millions of pounds having been taken from the eastern Grand Bank area during the past two years. The presence of rosefish has been demonstrated in deep water all along the south western edge of the Grand Bank, the western edge of St. Pierre Bank, the south coast of Newfoundland west of Fortune Bay, the west coast of Newfoundland north to Port Saunders, and north of Anticosti Island. In several of these areas large quantities of rosefish are

present. In one of the areas, Hermitage Bay, over seven million pounds of rosefish have been taken since its discovery by the Investigator II in 1947.

Haddock Losses in Commercial Trawling. Measurements in 1949 at sea and on shore during four trips of commercial trawlers have shown numbers of haddock discarded at sea of 47, 32, 71 and 49 percent of the total catch. Varying percentages of the haddock below 50 centimetres were discarded.

Otolith Weights and Lengths as Indices of Distinct Populations of Fish. An apparently new method has been developed of distinguishing between fish populations by means of otolith weights. Using this method it has been found possible to distinguish between the Grand Bank and St. Pierre Bank populations of haddock, the Grand Bank haddock having heavier otoliths, and between the inshore St. John's and offshore southern Grand Bank populations of cod, the St. John's cod possessing considerably heavier otoliths. In haddock from the Grand Bank area the otoliths of the males are heavier than those of females of the same length. In both cod and haddock the otolith length decreases greatly relative to the length of the fish with increasing size.

Vertebral Averages. The vertebral averages of haddock samples from St. Pierre Bank and the Grand Bank cover approximately the same range so that the vertebral averages are not a good weapon for studying the differences and migrations in schools of haddock in the Newfoundland area. The vertebral averages in the Newfoundland area are approximately one vertebra lower than that of the neighbouring Nova Scotian banks.

In cod the vertebral average is of very practical use in studying the distinctness or otherwise of the various cod populations and for indicating mixing and migration in the Newfoundland area. Differences in vertebral averages between 54.479 and 52.146 occur. High vertebral averages mostly above 54 are found in Labrador, on the east coast of Newfoundland, and to the north of the Grand Banks. The lowest vertebral averages, between 52.146 and 52.903, are found in cod populations on the south east tip of the Grand Bank. Averages are below 53.3 on the south west edge of the Grand Bank and below 53 on the southern part of the west coast of Newfoundland. Elsewhere in the area vertebral averages intermediate between the high and the low are found.

Survival of Haddock Year Classes. On the Newfoundland banks the dominating year class at present, providing in numbers almost seventy per cent of the commercial catch at St. Pierre Bank, is the 1942 year class. A new year class, the 1946, is showing promise. The 12 to 15 year old fish are numerous on St. Pierre Bank but very scarce on the Grand Bank. On these banks there are many extremes of survival, some years such as 1944 and 1945 on both banks and 1939 1940 and 1941 on St. Pierre Bank, showing a survival of only one to three per cent that of a very good year such as 1942.

The variations in year classes in the different areas are of use in showing migration or lack of migration between areas.

Nematodes in Cod Fillets. Studies of parasitic nematodes in cod fillets have shown the highest infestation, 42 to 45 per cent of the fish infested, near the middle of the west coast of Newfoundland. From the area of high infestation the rate of infection is reduced to the north and toward the eastern part of the south coast. Infestation is low 0 to 6.9 per cent on the east coast of Newfoundland and in Labrador still lower, 0 to 5 per cent on the Grand Bank, and lowest, 1 per cent at the south east tip of the Grand Bank and 0.5 per cent on Flemish Cap over 300 miles from the nearest land. The abundance of harbour seals, particularly of breeding colonies closely parallels the abundance of parasitic nematodes in cod fillets.

Tagging. A Belly tag has been used in cod tagging with better success in the second year than the more usual cheek tag. Over 4300 cod and 300 haddock have been tagged during the past three years. There have been no returns of haddock tagged from ordinary otter trawl catches. The general picture from the cod tagging is that these fish move little along the coast during the summer months and the great movement is off to deep water in the autumn to a spawning area for spawning in May and June and a considerable almost immediate dispersal after spawning. Many cod near the west coast of Newfoundland in the Gulf of St. Lawrence migrate out of the Gulf to banks off the western part of the south coast in the late autumn and early winter and back again in the spring. Many cod from the western side of the Grand Bank and from St. Pierre Bank migrate inshore but inshore migration would be quite unusual from the south eastern part of the Grand Bank.

Data and materials collected but not yet worked up. A large amount of data and materials, including sex, sexual maturity and spawning data for 4000 haddock and 7000 cod, stomach contents of 6000 cod, otoliths for 6000 cod, measurements of 64000 haddock and 51000 cod and length weight relationship of 3000 haddock and 3000 cod have not yet been worked up sufficiently for summary reports to be given.

Salmon Investigations

Recent investigations of salmon in Newfoundland under Dr. A. A. Blair have been chiefly concerned with increasing the river space available for salmon and with tagging. Four natural fishways, that is, series of pools blasted out of bedrock have been built. One of these appears to be quite successful, in two some salmon have passed up and in one the salmon have not yet been sufficiently directed to the mouth of the fishway.

Salmon tagging at Bonavista in the middle of the east coast of Newfoundland has given a 43 per cent recapture. Mainly

nine per cent of the tagged salmon and 7 per cent of the grilse were caught in Nova Scotia, New Brunswick and Quebec, entirely in the southern part of the Gulf of St. Lawrence and the entrance to the Strait of Canso. Salmon tagged at Cape Charles in Southern Labrador were caught mostly along the Labrador coast. Tagging at Cape Broyle near St. John's gave poor returns.

Trolling for salmon has been tried with the hope of obtaining salmon for tagging but with no success.

Vitamin A Value and Yield of Liver Oil

In 1947 to 1949 a study has been made of the Vitamin A value and yield of liver oil from the individual livers of about seventeen hundred fish from the inshore and offshore areas. Attention was concentrated especially on the cod and to a lesser degree the fishes caught in numbers in the area namely haddock, dogfish, thorny skate, American plaice and rosefish while some work was done on 25 other species mostly of groundfishes.

The cod still remains the best commercial source of Vitamin A oil in the area. The halibut has long been known as an excellent source of Vitamin A and D but the quantities of livers available in the area are limited. Of minor importance because of their lack of quantity but otherwise of commercial value are the livers of pollock, hake, large anglers, large barn door and spiny tailed skates. The extraction of oil from rosefish waste is definitely worth while, providing oil of relatively high Vitamin A values. Growing out of the laboratory investigation the extraction of oil from rosefish waste is being carried out on a commercial scale in Newfoundland. These researches on fish oils are being brought to a close.

ESTIMATES OF EXPENDITURE

PROJECT	1949-50	1950-51
Administrative - Office & Library	34,150.00	20,855.00
Groundfish	41,570.00	54,395.00
M/V Investigator II	80,620.00	45,985.00
Salmon	18,120.00	21,045.00
M/B Grilse	3,600.00	3,700.00
Hydrography & Fish Oils	7,350.00	9,190.00
Fish Inspection	7,130.00	0
Herring	4,350.00	4,350.00
	196,890.00	159,520.00

ORGANIZATION

(As of August 1, 1949)

1. Administrative - Office & Library

Director	W. Templeman, Ph.D.
Asst. Tech. Grade 1 (Acting Secty.)	Audrey S. Ralph
Stenographer Grade 1	Sheila T.M. Keough
Supervising Clerk	O. E. Wheeler

2. Groundfish

A. Scientific and Investigational Staff

Assistant Biologist	A. M. Fleming, B.Sc.
Assistant Biologist	G. L. Handrigan, B.Sc.
Asst. Tech. Grade 3	F. Brett
Asst. Tech. Grade 3	W. R. Hamilton
Asst. Tech. Grade 3	A. Kelland
Asst. Tech. Grade 3	F. K. Spencer
Asst. Tech. Grade 3	H. J. Squires
Asst. Tech. Grade 3	E. L. Rowe
Asst. Tech. Grade 2	B. Tibbo
Asst. Tech. Grade 1	N. D. Jean Winsor
Jun. Res. Asst. - Seasonal	T. K. Pitt

B. Crew M/V Investigator

Captain	W. Barbour
Mate	F. A. Winsor
Chief Engineer	C. R. Barbour
Second Engineer	B. Blackwood
Boatswain	W. C. Easton
Cook-Deckhand	L. J. Hurley
Deckhand	H. E. Hunt
Deckhand	C. Roberts
Deckhand	E. Easton

3. Salmon

A. Scientific and Investigational Staff

Principal Biologist	A. A. Blair, Ph.D.
Asst. Tech. Grade 3	F. A. Day
Asst. Tech. Grade 2 - Seasonal	C. G. Seymour
Asst. Tech. Grade 1 - Seasonal	E. Davidge
Asst. Tech. Grade 1 - Seasonal	T. J. Farrell
Asst. Tech. Grade 1 - Seasonal	J. S. Perham

B. Crew M/B Grilse

Skipper - Seasonal	J. J. Hull
Deckhand - Seasonal	S. Farrell

4. Hydrography and Fish Oils

Assistant Hydrographer	J. P. Hennessey, B.Sc.
Jun. Res. Assist. - Seasonal	E. D. Morgan
Jun. Lab. Assist. Grade 2	Shirley Wornell

5. Herring

Biologist (Seconded to A.H.I.C. at St. Andrews)	S. N. Tibbo, M.A.

STAFF

(Personnel employed during the period
April 1st to December 1st, 1949)

Scientific

W. Templeman, O.B.E., B.Sc., M.A., Ph.D.,	Director
A. A. Blair, M.A., Ph.D.,	Principal Biologist
S. N. Tibbo, M.A.,	Biologist
A. M. Fleming, B.Sc.,	Assistant Biologist
G. L. Handrigan, B.Sc.,	Assistant Biologist
J. P. Hennessey, B.Sc.,	Assistant Hydrographer

Non-Scientific

F. Brett	Asst. Tech. Grade 3	(Resigned Sept. 16th, 1949)
C. I. Barbour	Asst. Tech. Grade 3	
F. A. Day	Asst. Tech. Grade 3	
W. R. Hamilton	Asst. Tech. Grade 3	
A. G. Kelland	Asst. Tech. Grade 3	
E. L. Rowe	Asst. Tech. Grade 3	
F. K. Spencer	Asst. Tech. Grade 3	
H. J. Squires	Asst. Tech. Grade 3	
L. N. Cluett	Asst. Tech. Grade 2	
Jean Goodyear, B.A.,	Asst. Tech. Grade 2	
Elizabeth Scott, B.A.,	Asst. Tech. Grade 2	
B. Tibbo	Asst. Tech. Grade 2	(Resigned Sept. 16th, 1949)
Audrey S. Ralph	Asst. Tech. Grade 1	(Resigned Sept. 21st, 1949)
N.D. Jean Winsor	Asst. Tech. Grade 1	(Resigned Nov. 1st, 1949)
Shirley J. Wornell	Jun. Lab. Asst. Grade 2	
W. Barbour	Captain	
C. R. Barbour	Chief Engineer	
F. A. Winsor	Mate	
J. J. Hull	Skipper	
B. Blackwood	Second Engineer	
W. C. Easton	Boatswain	
L. J. Hurley	Cook-Deckhand	
E. Easton	Deckhand	
H. E. Hunt	Deckhand	
C. Roberts	Deckhand	
O. E. Wheeler	Supervising Clerk	
Sheila T.M. Keough	Stenographer Grade 1	

Seasonal

Georgina Gill	Junior Res. Assist.	(June 27th - Sept. 18th)
E. D. Morgan	Junior Res. Assist.	(May 10th - Sept. 22nd)

T. K. Pitt	Junior Res. Assist.	(May 11th - Sept. 22nd)
C. G. Seymour	Asst. Tech. Grade 2	(May 2nd - Aug. 9th)
E. Davidge	Asst. Tech. Grade 1	(July 4th - Oct. 1st)
T. J. Farrell	Asst. Tech. Grade 1	(May 18th - Oct. 1st)
J. S. Perham	Asst. Tech. Grade 1	(May 18th - Oct. 1st)
S. Farrell	Deckhand	(May 7th - Oct. 1st)

PUBLICATIONS 1948-49

Templeman Wilfred	The Life History of the Caplin (Mallotus villosus O. F. Muller) in Newfoundland Waters. Bull. Newfoundland Government Laboratory No. 17, Pages 1-151.
Templeman W.	Abnormalities in Lobsters. Bull. Nfld. Govt. Lab., No. 18, pp. 3-8.
Templeman W.	A Possible Substitute for the Plugging and Banding of Lobster Claws. Bull. Nfld. Govt. Lab., No. 18, pp. 9-11.
Templeman W.	Body Form and Stage Identification in the Early Stages of the American Lobster. Bull. Nfld. Govt. Lab., No. 18, pp. 12-25.
Templeman W.	Growth per Moult in the American Lobster. Bull. Nfld. Govt. Lab., No. 18, pp. 26-48.

INDEX TO SUMMARY REPORTS

Appendix No. 1

INVESTIGATOR II BOAT AND WORK

The Investigator II is the larger of the two research vessels of the Station, an 84 foot 120 gross ton boat of British Columbia seiner type. The boat carries a crew of nine and a laboratory staff of two, is powered by a - 250 H.P. Atlas Diesel Engine, and was built at Clarenville in Newfoundland in 1946. It has been operated by the Station to some extent for long lining but mostly for otter trawling. Hydrographic work has been carried on in connection with experimental fishing and other hydrographic work occupying about a month of the boat's time each year. The chief defects of the boat have been the difficulty in trawling successfully in deep water over a hundred fathoms, the lack of sufficient size and power to use heavy gear without which trawling over eighty per cent of the Grand Bank and St. Pierre Bank is impossible or unsuccessful, the difficulties of fishing in rough weather and of carrying on offshore fishing during the stormy fall and winter months. The difference in size, power and gear of the Investigator II and of the commercial vessels operating on the Grand Bank also render difficult a direct comparison of the results of fishing in the various areas where the commercial vessels do not venture. Since the Board is not familiar with the work of the Investigator II a review will be given of some of the operations of this boat in 1948 as well as 1949.

W. Templeman

Appendix No. 2

OPERATION INVESTIGATOR II 1948

Hydrography and Fish Concentration on Grand Bank early spring 1947 and 1948

The cruises of the Investigator II in March were hydrographic cruises to study the temperature and salinity of the water on the Grand Bank and St. Pierre Bank. Bottom temperatures in March 1948 were found to be considerably lower than they were in March 1947. In water of 40 fathoms or less over most of the Grand Bank with the exception of the south eastern tip temperatures were below zero centigrade, whereas in March 1947, the temperatures in 40 fathoms on the south western edge of the bank were as high as 2°C. Corresponding with the low temperatures on the rougher and shallower parts of the bank mostly fished by line fishermen, the haddock and cod were in much greater concentration than usual on the warmer southwestern slopes of the bank where between the 50 and 80 fathom mark there were huge catches by trawlers. The line fishermen fishing in the colder shallower water of the bank found very poor fishing in March. This was probably due to two causes, the concentrating of the fish in the deeper waters due to the low temperatures and the failure of the fish to digest and eat much in

below zero water so that they would not be caught in numbers by line fishermen. In dragging operations on the Grand Bank in the early spring it was necessary to go deeper than in 1946 and 1947, more large catches being made near 70 fathoms and less near 50 fathoms than in 1946 and 47.

W. Templeman
G. L. Handrigan

Appendix No. 3

OPERATION INVESTIGATOR II 1948

Haddock

The months from April to June were spent in studying the haddock populations on the Grand Bank and St. Pierre Bank. On the Grand Bank the large haddock were at first concentrated mostly in water of intermediate depth, 60 to 80 fathoms, on the south west slopes of the bank mainly between 51° and 53° 30' west longitude. As the water warmed up they entered shallower water until by the end of May large quantities were to be caught at 45 to 50 fathoms on the southern part of the bank between 51° and 52° west longitude. Later as the spawning of the haddock progressed in June and as water temperatures on the shallower parts of the bank increased the large spawning and spent haddock gradually disappeared from the deeper water area in which they had previously been concentrated on the south-west slopes of the bank and scattered over the shallower and rougher bottomed parts of the bank to the north-east bringing the commercial otter-trawl fishing for haddock on the Grand Bank to an end.

On St. Pierre Bank the Investigator II in April discovered haddock in quantity on the north-western edge of the bank in deep water at about 95 fathoms. Since the Grand Bank fishing in shallower water and on smoother and more level bottom was then producing large quantities of haddock this discovery was not at the time followed up by the commercial trawlers. Later, however, during the last part of May and in June when the Grand Bank haddock were scattering north-eastward the local trawlers took haddock in good numbers in the deep water on the western edge of St. Pierre Bank at first in the locality fished by the Investigator and later the fishing gradually moved southwards along the western edge of the bank. Successful fishing here lasted until the first week of July by which time most of these haddock had spawned and scattered to shallower water areas of the bank and inshore.

It is unusual for large haddock to be found in large quantities deeper than 80 fathoms. It is also unusual for large haddock to be found in quantity in water temperatures very near zero centigrade. On the Grand Banks, even in winter [illegible]

spring, temperatures of 3°C and higher can usually be found from fifty fathoms down, on the south western edge of the Grand Banks, and correspondingly at this time the greatest quantities of large haddock are usually found at 50 to 60 fathoms. The considerable depth - about 95 fathoms - in which the St. Pierre haddock were found in 1948 was due to the fact that temperatures below zero centigrade extended to almost 80 fathoms to the northwest of St. Pierre Bank and to 90 fathoms in the middle of the western edge, forcing the haddock deeper. The finding of these haddock by the Investigator II is a good example of the use of water temperatures in fishing. When the hydrographic cruises of the Investigator II were completed in March it was noticed that temperatures were below zero centigrade from the surface to about 80 fathoms on the north western edge of St. Pierre Bank and to about 110 fathoms in the middle of the western edge of the bank. It was presumed, therefore, that haddock would be found somewhere between 80 and 100 fathoms in the warmest water then to be found on the bank which was along the north-western edge. This proved to be the case. Later, the south western area warmed up by an inpushing of deep warmer water so that water above zero centigrade moved up to 80 or 90 fathoms and haddock were caught in numbers below these depths. By June, surface warming had brought the temperatures on the shallow 20 to 25 fathom parts of St. Pierre Bank up to one or two degrees centigrade and the hungry haddock after spawning were gathering on these shallower water parts of the bank. By the end of the first week of July, spawning and the transference of mostly spent haddock from deep to shallow water was almost complete. Some immature haddock and mature haddock not yet spent still remained, however, in deep water.

W. Templeman
G. L. Handrigan

Appendix No. 4

OPERATION INVESTIGATOR II 1948

Cod

The earlier Newfoundland trawlers the Cape Agulhas and the Imperialist were unsuccessful, partly due to the fact that they were salt fishing for cod and large haddock and partly for the reason that after the concentration of cod and haddock on the southern part of the Grand Bank broke up in June due to the scattering after spawning they did not know where to obtain good catches. During the summer of 1948 two regions where successful trawling for cod during the summer and fall can be carried on by local trawlers were studied during the operations of the Investigator II. The first of these areas investigated during the latter

part of July is about 120 miles north east of St. John's, on the northern edge of the Grand Bank between 49° 40' and 50° 15'W longitude. The best depths were from 105 to 120 fathoms and the catches of cod when the net was not torn usually ran between 3000 and 7000 pounds per hours drag. The distribution of water temperatures explained the concentration of cod in these deep waters. The whole northern area of the Grand Bank which is about 40 fathoms deep was covered with water one degree below zero centigrade. This layer of very cold water extended from about 25 fathoms to 80 fathoms with water of zero centigrade extending to about 90 fathoms. Below the layer of very cold water of zero centigrade or lower the water gradually became warmer with depth until at 120 fathoms it was 2.3 degrees centigrade. Temperatures of 0.5 to $2\frac{1}{2}$°C are quite favourable for codfish while very large concentrations of cod are more unusual, particularly during the summer time, in water below zero centigrade. The water of zero centigrade and lower, therefore, apparently formed a partial barrier concentrating those cod in deep water and preventing them from ascending and scattering to the neighbouring shallow water areas of the bank on which which the temperature of -1° centigrade was unsuitable in any case. In the neighbourhood of this northern Grand Bank accumulation of cod, also, caplin are present in quantity providing a plentiful food supply. The area described above is a favourite fishing ground of the French and Portuguese trawlers from spring to autumn. The bottom here is rather rough for small trawlers.

In two trips during the first part of June and about the middle of July to the eastern edge of the Grand Bank in the neighbourhood of 45° 35' north latitude fair numbers of cod and an unusual abundance of large plaice were found. Captain Blackwood in the trawler Blue Spray followed the lead of the Investigator into the area during the latter part of July and other local trawlers followed. In this locality the temperature distribution in June was very similar to that described above for the area to the north of the bank. Water of below zero centigrade temperature extended from above the 35 to 45 fathom eastern edge of the bank to 90 fathoms or more forming a partial barrier for the cod. Cod were plentiful from 95 to 120 fathoms in the slightly warmer water below the cold layer. There was also some cod in shallower water below zero centigrade. In this area the cod were feeding heavily on launce with some caplin and the abundance of these bait fishes was doubtless partly responsible for the concentration of cod and also plaice in the area. The fishing for cod and plaice on the eastern edge of the Grand Bank gave profitable fishing to local trawlers from July to September.

W. Templeman
G. L. Handrigan

Appendix No. 5

OPERATION INVESTIGATOR II 1949

General Description

In 1949 the Investigator did not begin operations until June 28 owing to a delay caused by the installation of a new engine. By this time the commercial haddock fishery on the Grand Bank was over. The chief work of the Investigator for 1949 consisted of a series of trips to investigate the eastern and northern edge of the Grand Bank from the extreme south eastern tip up the eastern edge to the north western tip of the bank. The depths investigated by trawling and hydrographic studies on this eastern and northern edge were between 30 and 40 fathoms to 120 fathoms. A trip was also made to Flemish Cap and three trips to fishing grounds near the coast and between the coast and St. Pierre and Green Banks and for rosefish in the Gulf of St. Lawrence.

W. Templeman

Appendix No. 6

OPERATION INVESTIGATOR II 1949

Cod

In a trip during the latter part of July cod were found in quantity, 2000 to 5000 pounds per hours dragging, over the whole area of the eastern edge of the Grand Bank centering on latitude 45° 29' and extending from 48° 48' to 49° 06'W longitude. The bottom temperatures ranged from 0.1 to -0.9°C, most of the temperatures being between -0.2 and -0.5°C. Depths were from 39 to 78 fathoms.

In a trip during the first part of August to the part of the eastern slope of the Grand Bank between 46° 35' and 47° 08'N latitude and 47° 17' and 49° 07'W longitude and from 40 to 113 fathoms no large quantities of cod were found the best catch of 2500 pounds in a hours dragging being at 110 to 113 fathoms at a temperature of 2.2°C. In this voyage few cod were found at the minus temperatures which extended over the bottom areas fished from 40 to over 90 fathoms in most of the area.

Large quantities of cod were found by the Investigator about the middle of August, 3000, 9000 and 10,000 pounds in three one hour drags at the eastern side of the south east corner of the Grand Bank between 40 and 80 fathoms and with temperatures from -0.6 to -1.1°C. Local trawlers, led by Captain Blackwood of the Blue Spray, followed the Investigator into this area and have continued to fish cod and plaice successfully mostly in the same area

from August till the time of writing in November. They have taken at least five or six million pounds of cod and plaice from the area since that time the larger trawlers obtaining about two hundred thousand pounds of mixed cod and plaice in four days actual fishing.

In a trip to Flemish Cap during the latter part of August all bottom temperatures from 73 to 120 fathoms (there is no shallow water on this bank) were between 3.7 and 3.9°C. No large catches of cod were obtained the greatest catch per hours drag being 600 pounds. Some of these fish were most extraordinary in size, 16 fish, all females, in a sample of a hundred and three fish ranging from 97 to 134 cm. in length, 7 from 97 cm. to 120 cm. weighing 20 to 50 pounds and 9 fish from 123 to 134 cm. weighing from 41 to 70 pounds. Most of the cod caught on Flemish Cap however were small, of scrod size and smaller.

The occurrence of cod in numbers as during 1949 in water below zero centigrade temperature will need further investigation. The explanation may lie in the behaviour of the food fishes launce and caplin the former being common toward the southern and the latter toward the northern part of the bank. Doubtless when food is plentiful cod may remain in areas otherwise unfavourable.

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Appendix No. 7

OPERATION INVESTIGATOR II, 1947-1949

Rosefish

Several special trips and a number of additional exploratory drags have been made for rosefish during the years. Some large rosefish, 300 to 1000 pounds per hour and a half dragging, were caught in 90 to 110 fathoms on the northwestern part of St. Pierre Bank during the fishing for large haddock in April. In both 1947 and 48 the best catch of rosefish on St. Pierre Bank has been in essentially the same area on the southwestern edge of the bank. Here a catch of 3600 pounds was taken in one hours dragging on September 5, 1947 at 110 to 120 fathoms in 56° 49'W longitude and a catch of 3000 pounds in 45 minutes dragging in 82-83 fathoms on May 5, 1948 in 56° 45'W Longitude. On the Grand Bank several catches of about 5000 pounds of rosefish in a hours dragging were taken in 60 to 85 fathoms on the southwestern edge between longitudes 51 and 52° in May 1947 and in 1948 some small catches of about a thousand pounds per hours dragging were made further south on the south western edge in 80 to 140 fathoms between 50 and 51° 50'W longitude. Commercial vessels have made some good catches of

rosefish on the eastern edge of the Grand Bank between 43° and 43° 30' north latitude and occasional good drags as far north as 44° 30' north latitude on the eastern edge.

The deep water channel on the west coast of Newfoundland extending from Port aux Basques to Port Saunders was explored between 100 and 150 fathoms in 1947 and 1948 and the deep water north of Anticosti Island in 1948. The operation was not a commercial success but a few hundred pounds of large rosefish per hours dragging were usually found in all parts of the area. North of Anticosti the largest catch was 1000 pounds of large rosefish in one hours drag while several catches of 500 pounds per hours dragging were obtained.

The best catch in the area was off Port Saunders where one drag produced rosefish at the rate of 4000 pounds an hour. This latter area, only a few miles from shore has been tested by a local commercial trawler in 1949 whose skipper was advised of the Investigator's results and it is reported that a catch of a hundred thousand pounds of rosefish was obtained in one days fishing.

It must be emphasized that for depths over 100 fathoms the catch per hours dragging of the Investigator II ~~are~~ is probably not much more than twenty per cent of those of a commercial trawler and possibly not even as high as twenty per cent once 120 fathoms have been passed. We would therefore think it very likely that commercial fishing for rosefish can be established in many areas along the west coast of Newfoundland particularly off the Port Saunders area and possibly north of Anticosti Island especially near the western tip of the deep water pocket extending north of this Island. The rosefish in these areas are large.

In August 1947 the Investigator II discovered a rosefish area in Hermitage Bay on the south coast of Newfoundland from which during the remainder of 1947 and during 1948 over seven million pounds of rosefish were obtained by local trawlers. The best part of this area for fishing, at about 140 fathoms is inside the three mile limit for territorial waters and has been closed in 1949. It is apparent, however, that a quantity of rosefish per year exceeding in marketed value the whole cod catch of the Hermitage Bay area can be obtained inside territorial waters in Hermitage Bay if the local people of the area could be persuaded and allowed to use small draggers and if, which may be doubtful, these small draggers can fish these deep waters efficiently.

In August 1949 several hundred pounds of very large rosefish 45 to 55 cm. in length were caught in 109-116 fathoms, at 3.7°C near Flemish Cap in latitude 47° 11'N and longitude 45° 09'W. This may indicate the presence of quantities of large rosefish in water deeper than 120 fathoms in the Flemish Cap area and to the north east of the Grand Bank.

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Appendix No. 8

OPERATION INVESTIGATOR II 1948-49

New Fishery for Plaice

In 1948 and especially during 1949 the Investigator has explored populations of plaice, often called American Plaice, rough dab or flounder, with successful results all along the eastern slopes of the Grand Bank. The table below shows the areas of the eastern edge of the Grand Bank where catches per hours dragging of fifteen hundred pounds or more of plaice were obtained during the exploratory fishing operations of the Investigator II. In considering the commercial possibilities of these areas it must be remembered that a larger and more powerful commercial trawler with a larger net will catch several times as much per hours dragging as the Investigator. It must be remembered also that quantities of cod as well as plaice were often obtained in these drags. Plaice were found in quantity at temperatures ranging from -1.2 to +1.1° C. Water below zero temperature was as often as not quite favourable for their occurrence in numbers. In general large accumulations of plaice occupied water somewhat colder than cod and plaice were most numerous at intermediate depths of 60 to 90 fathoms on the eastern slopes of the Grand Bank.

The trawler Cape Agulhas when operated by the Nfld. Fisheries Research Laboratory at Bay Bulls in the early thirties had one or two successful drags for Plaice on the eastern edge of the Grand Bank. The details of these drags were apparently lost in the fire which destroyed the Bay Bulls Laboratory in 1937. No further information was available for the eastern Grand Bank area until the Investigator II found plaice fairly plentiful near the south eastern edge of the Grand Bank in 1946 and especially plentiful with some cod in June, 1948, at 60-75 fathoms near latitude 45° 33' and longitude 48° 44'. Some Newfoundland trawlers almost immediately after June, 1948, 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 Grand Bank toward the south and to a lesser degree to 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 fifty and a hundred fathoms, along the slope area of the whole eastern edge of the Grand Bank. More than ninety five per cent of these plaice were 40 cm. or more in length, most of them lying between 40 and 60 cm. and in many cases averaging 50 cm. or over in length. Several million pounds of these plaice have been caught by local trawlers during 1949 and we would think it probable that a catch of plaice up to fifty million pounds per year can be obtained in the area.

Catches of Plaice by Investigator II 1948 & 1949
Eastern Slopes of Grand Banks
(Catches of 1500 lbs. and over per hours dragging)

Date	North Latitude	West Longitude	No. of lbs. per hours dragging	Depth Fathoms	Bottom Temperature Degrees C
1948					
June 9	45° 33'15"	48° 43'30"	8500	63-75	
June 8	45° 32'30"	48° 44'30"	4000	60-75	-1.13
July 11	45° 24'00"	48° 49'30"	1500	50-60	-1.07
July 11	45° 04'00"	49° 08'45"	6000	35	-1.16
1949					
Sept.20	47° 49'30"	48° 50'30"	1600	118-126	0.16
Sept.20	47° 49'00"	48° 49'45"	2200	120-126	0.25
Sept.20	47° 48'55"	48° 50'30"	3900	122-125	0.29
Sept.18	47° 27'15"	49° 09'00"	1500	73-78	-0.60
Sept. 9	46° 36'45"	47° 32'30"	2500	82-88	0.62
Sept. 9	46° 36'00"	47° 32'30"	2000	82-88	0.77
Sept. 9	46° 36'00"	47° 32'15"	3000	86-90	0.63
Sept. 8	46° 35'15"	47° 36'30"	2000	75-78	-0.22
Sept. 9	46° 34'30"	47° 33'30"	3500	85-89	1.11
Aug. 3	46° 33'30"	47° 28'30"	6000	80	0.25
Aug. 3	46° 31'30"	47° 33'30"	5000	82-90	0.29
July 24	45° 51'45"	48° 07'00"	1500	84-96	-0.39
July 23	45° 49'00"	48° 14'00"	1800	75	-0.54
July 13	45° 46'45"	48° 20'30"	3400	73-75	-0.38
July 13	45° 41'45"	48° 12'00"	4500	95-98	-0.09

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Appendix No. 9

OTOLITH WEIGHTS AS INDICES OF DISTINCT POPULATIONS OF FISH

Techniques

A method, apparently new, has been developed for distinguishing between populations of fish by means of otolith weights. A comparison of length of otolith may often be of value also. To date only the information on cod and haddock otoliths collected in 1947 has been worked up.

Otoliths are removed from the fish, washed in fresh water, wiped on a clean cloth and placed in envelopes. The otoliths

are weighed in grams to the fourth decimal place 12 months after capture in the case of haddock and 18 months for cod. Crystallized broken or chipped otoliths are not weighed. Weighings of the same otoliths carried out monthly over a period of two years show that after the first four months the weights of cod otoliths were stable to within one milligram, varying slightly in the tenths of a milligram with changes in the humidity.

Haddock

In haddock in which it is impossible to distinguish the Grand Bank and St. Pierre Bank populations by means of the ordinary routine samples of 100 fish, the vertebral averages from the two areas overlapping completely, the otolith weights are very distinct except among the few largest and most migratory fish. The Grand Bank haddock possess heavier otoliths than those from St. Pierre Bank haddock of the same length.

The most likely reason for this difference is that the St. Pierre Bank haddock grow faster than the Grand Bank haddock and thus would have smaller heads at the same fish length. Corresponding with this the otoliths would be smaller. Our studies have shown that the St. Pierre haddock grow faster but we have not yet carried out head measurements on the two populations.

Cod

In the cod the St. John's inshore population possesses considerably heavier otoliths than cod from the southern part of the Grand Bank.

The following table shows the differences actually found in the 1947 samples:

Size Cms.	No.of Cod St.John's	No.of Cod Grand Bank	Average Otolith Weight St.John's Grams	Average Otolith Weight Grand Bank Grams
40,41		5		.2070
42,43	5	8	.2233	.2143
44,45	5	8	.2119	.2308
46,47	16	11	.2524	.2473
48,49	23	9	.2758	.2677
50,51	23	10	.2968	.2781
52,53	19	7	.3062	.3133
54,55	29	12	.3555	.3289
56,57	27	15	.3798	.3547
58,59	34	12	.4275	.3804
60,61	36	12	.4641	.3985
62,63	31	12	.5011	.4798
64,65	23	23	.5113	.4801
66,67	26	11	.5601	.4863

(Continued)

Size Cms.	No.of Cod St.John's	No.of Cod Grand Bank	Average Otolith Weight St.John's Grams	Average Otolith Weight Grand Bank Grams
68,69	26	16	.5833	.5205
70,71	16	16	.6105	.6037
72,73	22	9	.6460	.5609
74,75	18	14	.6723	.5992
76,77	11	39	.7744	.6314
78,79	11	18	.6869	.6578
80,81	13	33	.8191	.7116
82,83	15	24	.9018	.7840
84,85	8	24	.8565	.7607
86,87	4	31	.9071	.8263
88,89	5	29	.9487	.8502
90,91	6	34	1.0617	.9110
92,93	3	20	1.1491	.9152
94,95	5	23	1.0413	.9814
96,97	8	13	1.1298	1.0430

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Appendix No. 10

OTOLITH WEIGHTS IN MALE AND FEMALE HADDOCK

The relative weights of the otolith have been compared for male and female haddock of the Grand Bank area. At sizes from 36-37 cm. and upward the otoliths of male haddock are heavier than those of female haddock of the same size. We attribute these heavier otoliths of the male haddock to the fact that the males mature at a smaller size and earlier age than the females and that after maturity growth slows down so that the mature males of any size are older and presumably have heavier heads than females of the same size. This latter conclusion has not yet been checked.

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Appendix No. 11

DECREASE IN OTOLITH LENGTHS WITH INCREASING SIZE OF FISH

In both cod and haddock there is a considerable decrease in the length of the otolith relative to the length of the fish with increasing size of the fish. In the Grand Bank haddock the otolith length decreases from 4.3 per cent of the fish length at 35 cm. to 3.2 per cent of the fish length at 72 cm. In St. Pierre Bank haddock the otolith length decreases from 4.3 per cent of the fish length at 37 cm. to 3.1 per cent of the fish length at 72 cm. In the Grand Bank cod the otolith length decreases from 3.4 per cent of the fish length at 36 cm. to 1.7 per cent of the fish length at 138 cm. and in the St. John's cod the otolith length decreases from 3.2 per cent of the fish length at 39 cm. to 1.6 per cent of the fish length at 136 cm.

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Appendix No. 12

TECHNIQUES OF VERTEBRAL COUNTING AND CLEANING

The vertebral number used is the number of vertebral centra between but not including the occipital bone and the hypural. Three counts usually two by a technician and one by a biologist were taken on each vertebral column. Vertebral columns with fused centra were not included in the averages. A method has been developed of placing the lightly cooked usually filleted fish on a wire screen and cleaning the fish from the bone by using a stream of water from a nozzle on a pressure hose. For the larger fishes such as cod, haddock, flatfishes and rosefish this method results in a much quicker and cleaner operation than in the removal of the flesh by hand.

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Appendix No. 13

HADDOCK VERTEBRAL AVERAGES

In 14 samples of haddock from various localities of the Grand Bank and 8 samples from St. Pierre Bank mostly of about a hundred fish the vertebral averages of the Grand Bank area ranged

from 52.732 to 53.057 and in the St. Pierre Bank area from 52.701 to 53.133. The totals of all samples in the two areas have not yet been compared statistically but in the haddock there is little evidence on the basis of individual samples of a real difference in the populations of haddock on various parts of the Grand Bank or St. Pierre Bank or even of the populations on these two banks being distinct. All of these vertebral averages, however, on the Grand Bank and St. Pierre Bank are very distinct from those previously recorded by Vladykov for the northern Nova Scotian banks, the latter averages being about one vertebra higher. Vladykov also has some unpublished records of vertebral counts from St. Pierre Bank which are very similar to our own. Thus there would seem to be no doubt about the division of the haddock populations on the Nova Scotian banks from those on the Newfoundland banks. Within the Newfoundland area however the vertebral average is not likely to be a very practical weapon for the study of the distinctness of haddock populations.

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Appendix No. 14

COD. VERTEBRAL AVERAGES

Vertebral counts have been completed for 76 samples of cod, usually about a hundred fish per sample, from all of the chief fishing areas of Newfoundland and Labrador including the Grand Banks and St. Pierre Bank. The variations in cod vertebral count in this area are often very significant and show a number of relatively distinct cod populations.

Along the Labrador coast between Domino and Nutak in six samples the vertebral average ranged between 53.990 and 54.324. On the East coast of Newfoundland from Englee to Dildo in Trinity Bay in nine samples the average ranged from 54.114 to 54.479. At St. John's, monthly samples from July to November in three years have demonstrated vertebral averages between 53.346 and 54.245. On the eastern side of the Grand Bank the vertebral average declines gradually from an average of 54.039 to 54.265, very much like the east coast and Labrador average, at the north, to 52.146 to 52.903 at the south eastern tip. In the area near the eastern edge of this bank between Latitudes 45° and 46°N schools of cod from both north and south appear to be often present without losing their identity. Significantly different vertebral averages ranging from 52.825 to 54.275 have been found in samples of cod caught within a few miles of each other. The cod of the Flemish Cap have vertebral averages 53.667 to 53.701 very similar to those of the neighbouring eastern edge of the Grand Bank in the same latitude, 53.826

to 53.866. The cod on the central part of the Grand Bank are more closely related to the cod populations of the south rather than the north of the bank with vertebral averages between 52.612 and 52.854.

From averages of 52.146 to 52.903 at the south east tip of the Grand Bank the vertebral count gradually rises proceeding northward along the south western edge of the banks to averages between 53.320 and 53.634 on St. Pierre Bank. On the south coast of Newfoundland the area between Ramea and Burin has vertebral averages ranging between 52.750 and 53.439 while the St. Mary's Bay average to the east is intermediate between the typical south coast and east coast averages with vertebral averages of 53.600 to 53.958. Another Cod population with low vertebral averages exists on the west coast of Newfoundland with vertebral averages between Port aux Basques and Cow Head ranging between 52.738 and 53.009. Passing toward the Strait of Belle Isle the vertebral average gradually rises to the east coast type.

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Appendix No. 15

COD VERTEBRAL AVERAGES THROUGHOUT THE FISHING SEASON

At St. John's it has been possible to follow the vertebral averages by monthly samples throughout the fishing season.

	Vertebral Average at St. John's			Number of Cod in Sample		
Month	1947	1948	1949	1947	1948	1949
May			53.962			26
June			54.142			106
July	54.020	54.191		100	94	
August	54.019	54.217	53.769	103	106	52
September	54.245	54.019	53.755	49	108	49
October	53.927	53.621		96	103	
November	53.346	53.559		104	102	

In both 1947 and 1948 in which the fishery at St. John's was fairly good the vertebral average decreased below 54 in October and still further in November. In 1949 when the fishery at St. John's and neighbouring areas was extremely poor except for a brief period in late June and in July the vertebral average decreased considerably below 54 in August. No sample was taken in July.

The cod fishery on the east coast 100 to 150 miles north of St. John's was one of the best ever known. A number of the fish tagged in the St. John's area in the autumn of 1948 were caught in this more northern area in 1949. It may be that a successful fishery in the St. John's area depends on an influx of fish of high vertebral number following the caplin to shore from the north of the Grand Bank area. As the bottom water warms up during the late summer and in September these northern fish may retreat or they may retreat as in St. John's 1949 following the offshore movement of the caplin in July. The varying quantities of the southward incoming migration and the time of retreat may determine the success of the fishery. This matter is worth pursuing further by further vertebral counts and other studies and by tagging in the different months. The fish obtained during October and November are larger and the vertebral average is more closely related to that of the neighbouring Grand Bank area to the south east of St. John's and to the St. Mary's Bay area to the south west of St. John's. In a typical successful fishing year a great part of the inshore catch of fish is caught in late June and in July with declining amounts in succeeding months and only a small percentage of the catch is landed in October and November.

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Appendix No. 16

HADDOCK. SURVIVAL OF YEAR CLASSES

The table given below which is subject to slight review, shows the percentages of the various ages and year classes of haddock i various Newfoundland areas from 1947 to 1949. The age estimat... was carried out from the scales.

Grand Bank and St. Pierre Bank

Most of the Newfoundland haddock catch is taken on the Grand Bank, with a smaller amount on St. Pierre Bank and much smaller amounts inshore mainly on the south coast. On both banks the 1942 year class had a very high survival furnishing in the three years, 27 to 48 per cent of the unselected trawler catch on the Grand Bank and on St. Pierre Bank 40 to 49 per cent of the unselected trawler catch and 62 to 72 per cent of the commercial landed catch of haddock. Whereas on the Grand Bank there was fair survival of the 1941, 1940 and 1939 year classes, these three year classes were almost complete failures on St. Pierre Bank. There was more than average survival of the 1938 year class on both banks. On St. Pierre Bank the 1936 year class must have had a much higher rate of survival than the average while the 1937 and

1935 year classes had better than average survival also. These three year classes on the Grand Bank had by 1947 to 1949 very small numbers of fish. This may have been partly due to a greater fishing mortality on the Grand Bank which possesses only a very small percentage of fish over ten years of age while on St. Pierre Bank there is a large percentage of haddock over ten years of age. It does appear, however, in any case that the 1936 year class showed a far greater survival on St. Pierre Bank than on the Grand Bank. On both banks there was a low survival of the 1943 year class and an extremely low survival of the 1944 and 1945 year classes while the 1946 year class with individuals as yet too small to enter the landed commercial catch and not being fully subject to capture is showing promise of a good addition from this year class to the commercial fishery on St. Pierre Bank in two or three years and on the Grand Bank in three or four years.

Other Areas

The haddock from the neighbouring inshore Ramea area to the north of St. Pierre Bank shows considerable resemblance to the St. Pierre Bank population but the 1943 year class is larger than on St. Pierre Bank. Haddock from the Corbin area near the Grand Bank possess year classes very much like those of St. Pierre Bank whereas the sample from the channel between Green Bank and Grand Bank has only one very large year class the 1942 and a considerably smaller survival in each year from 1935 to 1941.

Haddock. Survival of Year Classes. Per cent of Total at each Age.

Year Class	Grand Bank Unselected			St.Pierre Bank Unselected			St.Pierre Bank Landed Catch (1)			Ramea Islands Unselected	Corbin Trap Catch Unselected	Gully S.E. of Green Bank Unselected
	1947	1948	1949	1947	1948	1949	1947	1948	1949	1947	1947	1948
1948			0.5									
1947			1.3		11.7	1.4						
1946	0.2	12.7	19.7		12.0	19.0						0.9
1945	—	0.5	0.4		—	—						—
1944	—	0.4	0.2		1.6	—				2.4		—
1943	1.2	3.9	4.0		4.7	7.2	5.3	3.7	8.7	18.8	0.6	1.8
1942	26.9	45.9	47.6	43.1	40.2	49.3	70.2	72.2	61.8	64.7	28.5	64.0
1941	24.8	16.4	12.9	2.0	0.9	1.8	1.8	2.8	2.3	4.7	0.6	5.4
1940	18.0	9.3	6.3	3.9	1.6	1.8	—	3.2	2.3	—	0.6	3.6
1939	14.8	5.2	3.5	3.9	0.9	1.4	3.5	—	1.7	1.2	3.4	7.2
1938	10.5	4.2	2.0	10.5	4.2	3.2	1.8	2.3	4.0	1.2	15.6	3.6
1937	2.9	1.2	1.1	9.2	5.4	4.5	3.5	1.4	5.8	1.2	8.4	3.6
1936	0.5	0.2	0.4	22.2	10.1	5.9	12.3	8.8	7.5	4.7	21.8	7.2
1935	0.1	0.1	0.1	4.6	4.7	4.1	1.8	3.2	5.2	1.2	14.5	2.7
1934	—	0.1		0.7	1.4	—		2.3	—		3.9	
1933	0.1				0.2	0.5			0.6		1.7	
1932					0.2						0.6	
Total Fish	1291	829	1046	153	426	221	57	216	173	85	179	111

(1) 1949 commercial calculated from unselected samples and measurements of landed samples.

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Appendix No. 17

YEAR CLASS DISTRIBUTION AS EVIDENCE OF MIGRATION AND OF RELATED OR SEPARATE POPULATIONS OF HADDOCK

Grand Bank and St. Pierre Bank

While in all the areas considered in the previous summary the 1942 year class showed good survival and while the 1946 year class was present in numbers on both Grand Bank and St. Pierre Bank throughout 1947 to 1949, three year classes of large mature haddock of the size and age well suited to migration, the 1941 to 1939 year classes have been relatively plentiful on the Grand Bank and exceedingly scarce on St. Pierre Bank. On the other hand the very large and relatively highly migratory fish of the 1935 and 1936 year classes have been forty to fifty times as plentiful on St. Pierre Bank as on the Grand Bank. It is indicated, therefore, that the populations of haddock on these two banks mingle very little.

St. Pierre Bank and Corbin

The sample of haddock from the inshore Corbin area to the north of St. Pierre Bank on the Burin Peninsula shows strong resemblances in age class distribution of the larger haddock to those of the neighbouring St. Pierre Bank area. The 1942 year class in this sample, 5 years old in 1947, is not as well represented as on the banks. The explanation is probably that many of the smaller haddock of the 1942 year class and of the immatures of this class did not migrate. On the other hand the more highly migratory older and especially the oldest year classes were relatively much better represented in the inshore catch. The 1936 year class so numerous on St. Pierre Bank but almost absent on the Grand Bank and the 1935 and 1937 year classes well represented on the St. Pierre Bank and present only in very small numbers on the Grand Bank are present in large numbers in the Corbin sample while the 1939-1941 year classes, relatively numerous on the Grand Bank but very scarce on St. Pierre Bank are also very scarce and with the same degree of scarcity at Corbin. Since the inshore catch only begins in July when the haddock have finished spawning and there are no haddock inshore during the spring these Corbin haddock have apparently migrated from St. Pierre Bank.

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Appendix No. 18

LOSSES OF YOUNG HADDOCK IN COMMERCIAL TRAWLING ON THE NEWFOUNDLAND BANKS

During the spring of 1949 observers were placed on board Newfoundland trawlers to take random measurements of a large quantity

of haddock as they were caught. When the catch was landed random measurements were taken of the landed catch.

In the Newfoundland fishery some haddock are thrown away up to a size of 48 or 49 cm. Using the ratio of total numbers of haddock in the 50 cm. and up sizes in the ship and in the shore samples in each case as a basis the numbers measured on shore were equated with those measured on ship.

On this basis in a commercial trip on March 5 to 9 to the Grand Bank, in which 6290 haddock were measured on board ship and 1513 on shore 47 per cent of the haddock caught were discarded. Haddock were caught down to 22 cm.; all haddock above 48 cm. were retained while 5 per cent of the 46 to 47 cm. 26 per cent of the 44-45 cm. 55 per cent of the 42-43 cm. 72 per cent of the 40-41 cm. and 99.8 per cent below 41 cm. were discarded at sea.

In a trip to St. Pierre Bank from March 31 to April 10 in which 4554 haddock were measured at sea and 1193 on shore 32 per cent of the haddock caught were discarded. All the haddock above 46 cm. were retained while 68 per cent of the haddock 44-45 cm., 64 per cent 42-43 cm., 91 per cent 40-41 cm. and all of the catch below 40 cm., were discarded at sea.

In a trip to the Grand Bank April 29 to May 2, in which 4938 haddock were measured on ship and 874 on shore 71 per cent of the haddock caught were discarded at sea. All haddock from 50 cm. up were retained while 39 per cent 48-49 cm., 68 per cent 46-47 cm., 87 per cent 44-45 cm., 96 per cent 42-43 cm., and all of the catch below 42 cm., were discarded at sea.

In a trip to the Grand Bank May 19-22 in which 3098 haddock were measured at sea and 1046 on shore 49 per cent of the haddock caught were discarded at sea. All haddock from 50 cm. up were retained and 34 per cent 48-49 cm., 52 per cent 46-47 cm., 75 per cent 44-45 cm., 94 per cent 42-43 cm., and all of the catch below 42 cm., were discarded at sea.

All these haddock discarded at sea were dead. In addition to those discarded at sea large numbers of small haddock below 50 cm. were discarded on shore as being too small to fillet.

If the fishery is lean smaller haddock will be retained but if the ship is catching more haddock than can be cut before the next catch is made few haddock below 50 cm. are retained since it is more profitable to keep on fishing and to cut only the large fish. It is usual on the Grand Bank during April and May to catch haddock faster than they can be put down, thus particularly in these months only large haddock are retained. In the winter months when small haddock are more numerous than large on the trawling grounds somewhat smaller haddock are retained.

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Appendix No. 19

NEMATODES IN COD FILLETS

Since 1947 the fillets from most of the cod used for vertebral studies, otolith collection etc. have been carefully examined for the presence of the parasitic nematode, Porrocaecum. Samples were usually over a hundred fish. The percentages quoted are those of fish with a total of one or more nematodes. In all about six thousand cod have been examined for this purpose.

The heaviest infestation was near the middle of the west coast of Newfoundland, (Cow Head just north of Bonne Bay 45 per cent, Lark Harbour in Bay of Islands 42 per cent). Port aux Basques near the southern tip of the west coast with 26 and 36 per cent infestation in two samples and the neighbouring area of Ramea on the western part of the south coast with 23 and 28 per cent infestation in two samples also showed high infestation. Port Saunders, to the north of Cow Head on the west coast with 11 per cent and Eddie's Cove at the southern entrance to the Strait of Belle Isle with 12 per cent show the infestation tapering off to the northern part of the west coast, and Burin with 8 per cent shows the reduction of infestation toward the eastern side of the south coast. There is a local centre of infestation with 13, 15 and 20 per cent respectively for three samples in and near St. Mary's Bay on the southern part of the Avalon Peninsula. Along the whole east coast of Newfoundland and Labrador from St. John's to Nutak, Labrador, the infestation is low, averaging in the various areas from 0 to 6.9 per cent with the highest infestation in 27 samples of 10 per cent in one sample (the other 4 per cent) at Hopedale, Labrador, the next highest 9 per cent at St. John's (out of 14 samples). Ten samples in this St. John's to Nutak area were below 3 per cent infection.

On the Grand Bank infestation is low over almost the whole area ranging from 0 to 5 per cent in 17 samples. The area with the least nematode parasites on the Grand Bank is at the extreme south eastern tip over two hundred and fifty miles from the nearest land. Here the infection is only one per cent. On Flemish Cap to the east of the Grand Bank and over 300 miles from the nearest land the infestation in two samples was only 0.5 per cent only one nematode being found in 214 fish.

A small area of the western edge of the Grand Bank about 70 miles from St. Mary's Bay with an infection of 16 per cent shows the probable effect of migration of cod from the inshore St. Mary's Bay area and another area with 6 per cent on the south western tip of the Grand Bank area about a hundred miles south of St. Mary's Bay with 6 per cent infection probably demonstrates some but a lesser migration of fish from the St. Mary's Bay area.

Whereas a sample from the south western part of St. Pierre Bank shows only 2 per cent infection another sample from the northern tip about 40 miles south of the more heavily infested Ramea area shows 14 per cent infection. Again some migration of the Ramea cod population to the northern tip of St. Pierre Bank is probably indicated. There is, however, a seal colony and probably a high nematode infestation in the cod in the equally nearby Miquelon area.

If the infestation is shown in terms of number of parasitic nematodes per hundred fish the differences are still more extreme since where the percentage infestation is high the number of worms per fish is also high whereas along the east coast of Newfoundland and on the banks where the infestation is low it is only rarely that one encounters more than one worm per infested fish. Thus the Cow Head on the west coast fish with 45 per cent infestation possessed 99 worms per hundred fish while to take an east coast example St. John's with 4 per cent infection possessed 5 worms per hundred fish.

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Appendix No. 20

HARBOUR SEALS AND NEMATODE INFESTATION OF COD FILLETS

Newfoundland

Because of the relation thought to exist between the harbour seal and the larval nematode Porrocaecum in cod flesh, data on harbour seals was collected from all areas visited during the past three years by field men.

On the eastern section of Newfoundland, harbour seals are apparently scarce, except in Notre Dame Bay, where it is evident that they are not as plentiful as in past years. However a small colony does exist in Dildo Run and nearby Horwood and Gander Bays, with scattered seals seen during the ice free season at various points among the islands in the bays, and extending along the shore toward Cape Freels.

To the north an occasional harbour seal is seen in Canada Bay, rarely coming outside to the cod grounds.

South of Cape Freels an occasional wanderer may enter Bonavista Bay, but they are unknown on the southern side of the bay. South of this, to Cape Race we have heard no account of the presence of harbour seals.

The scarcity of these seals along our east coast, and especially the southern section of the east coast may be attributed to the fact that these are the regions most thickly populated and seals having been constantly hunted and disturbed have moved to quieter sections of the coast.

In St. Mary's Bay on the south of the Avalon Peninsula a small colony, fifty to one hundred seals exists on the uninhabited western side of the bay. Again in Placentia Bay a small colony has been reported near Petit Forte at N.E. Nonsuch with occasional seals seen around Merasheen Island. On the eastern section of the Burin Peninsula in Mortier Bay, harbour seals have been seen around the rocks off Creston, but not in large numbers.

Near C. Miquelon on Miquelon Island a small colony of harbour seals has been reported while nearby a colony of much larger seals, presumably gray seals is known to exist.

In Fortune Bay on the south coast of Newfoundland harbour seals are reported around Belleoram during the herring season in the spring, with an occasional seal seen at other points around the bay. These may be seals from the small Miquelon Colony.

Occasional seals are seen at various points along the south coast, especially in the estuaries. They are found in Grey River, and are known to ascend the river for a distance of six or seven miles. Similarly in White Bear River harbour seals are known to enter in pursuit of salmon.

Near Burgeo the Big Barachois has a colony of about a hundred harbour seals. These wander eastwards about 9 miles while hunting, and sometimes ascend nearby Grandy's Brook pursuing salmon. They are known to eat launce and herring.

On the west coast at Long Ledge off Long Point on the Port au Port Peninsula a small colony exists, young being born here early in June. Scattered seals, presumably from this group are seen at various points in the Bay of Islands during the summer and fall.

The largest colony we know to exist around Newfoundland is in St. Pauls Inlet near Cow Head. This shallow inlet, with a narrow opening to the sea has a colony reported as 200 to 250 seals. They remain in here during the ice free season, giving birth to young around the rocks in June. They are known to eat smelt, herring, and trout, ascending brooks in pursuit of the latter. In late autumn before the freeze-up they leave the inlet. They are not reported in numbers outside the inlet, only an occasional seal being seen along the open coast. Sometimes small numbers are seen at Parsons Pond, but this area does not support a colony.

One other small colony exists around the rocks in St. John's Bay during the ice free season, and these seals are known to ascend Castor River in search of food.

Labrador

Reports from fishermen and residents from Labrador indicate that some harbour seals exist during the short ice free season in sheltered bays along the entire length of the coast. Among the numerous islands off the coast they may be seen singly, or in small numbers from time to time. They are known to ascend rivers in pursuit of salmon and trout, and during the salmon season in July they are considered as pests by fishermen because they eat the soft parts from entrapped salmon rendering the fish unsaleable.

Summary

It will be seen from the above that allowing for some mixing and migration of infested fish from the areas with many harbour seals the distribution of the nematode infestation closely parallels the distribution of the harbour seal. Of particular note is the relative absence of the parasite and the harbour seal on the east coast of Newfoundland, the extreme scarcity of the parasite on Flemish Cap and the south eastern tip of the Grand Banks, the local increase in the infestation in the St. Mary's Bay area where a fairly large seal population exists, the very high infestation at Cow Head and Lark Harbour on the west coast and at Ramea on the south coast all in the immediate neighbourhood of large harbour seal colonies.

It is also evident from these results that the intermediate host between the seal and the cod is unlikely to be migratory to a major degree.

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Appendix No. 21

GENERAL TAGGING TECHNIQUES AND SUCCESSFUL USE OF BELLY TAGS FOR COD

General

During the past three years 4300 cod and 300 haddock have been tagged. In the haddock tagging cheek tags were used and while the fish were vigorous on release, in common with experiences elsewhere there were no returns from 247 haddock tagged from ordinary otter trawl catches at 50 fathoms. On the other hand there were 6 recaptures from 48 haddock tagged inshore from cod traps. Cod on the other hand were tagged successfully from ordinary trawl catches.

Use of Belly Tags

It was found possible to use belly tags successfully in cod tagging. The red celluloid 2" by 3/8" tags were inserted through a small slit in the wall of the body cavity several inches anterio-dorsally from the cloaca. When a vertical cut was made across the muscle fibres the cut often was not healed a month after the operation while when a lengthwise slit, parallel with the muscle fibres was made the cut healed much more quickly.

The table following shows the returns from cheek tags of the bachelor button type developed by Herrington and from belly tags in comparative tests.

The belly tags gave considerably better returns in the second year and were at least as good as the cheek tags in the first year. Since the recaptures during the year of tagging usually show very little migration and the greatest migration occurs in the fall and winter to a spawning ground and with the dispersal from the spawning area to the feeding areas the following spring and early summer the belly tags are considerably more effective.

The chief defect of the cheek tag appeared to be the tendency for rotting of flesh and bone to occur in the operculum during the first few months and thus the tag would drop out. After the wound heals the tags may be retained for long periods but sometimes these tags in the operculum are overgrown in the process of healing or later.

The belly tags may penetrate organs such as the liver and the gonads and thus pass unobserved. Also, in some areas such as Labrador where livers are so lean that they are not usually collected, all the viscera will be dragged out at once and the tag very often not be observed. As far as we know these tagging experiments mark the first practical and successful use of belly tags for cod or haddock. Doubtless we can improve on the belly tag that has been used in these experiments.

Locality	Dates of Tagging 1948	No. of Cod Tagged		Per Cent Tags Returned					
		Cheek	Belly	Cheek Tags Year of Tagging	Belly Tags Year of Tagging	Cheek Tags Second Year	Belly Tags Second Year	Total Cheek Tags	Total Belly Tags
Nutak, Labrador	Aug.12-20	166	60	5.4	10.0	0	0	5.4	10.0
Domino, Labrador	July 12-20	397	108	13.6	6.5	2.0	4.6	15.6	11.1
Corbin	July 5-10	106	219	28.3	37.9	2.8	0.5	31.1	38.4
Lark Hr.	Oct. 7-20	231	230	6.5	5.2	6.5	10.4	13.0	15.6
St. John's	Oct. 5 - Nov. 4	291	286	6.2	4.5	6.2	9.8	12.4	14.3
Total Number		1191	903	126	121	44	58	170	179
Total Per Cent				10.6	13.4	3.7	6.4	14.3	19.8

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Appendix No. 22

MIGRATIONS OF TAGGED COD. INSHORE TAGGING

Since 1947, 3100 cod caught by hand line, long line or trap have been tagged in inshore waters.

Tagging at Burin and Corbin in July 1948 showed very little migration, mostly 10-12 miles on each side of the tagging point, for the remainder of 1948 and spreading to a maximum distance of about 60 miles east and 100 miles west of the tagging point by 1949. The tagged fish appeared to be spread fairly at random over the area of recapture in 1949, that is the original school had apparently broken up. No tagged fish were recaptured in 1949 in the area near the tagging point where 30 per cent of the tagged fish were caught in 1949. Ten tagged fish were recaptured in 1949 and 266 in 1948. One of the ten fish recaptured in 1949 was captured on the channel between St. Pierre Bank and Green Bank all remaining captures being near the shore.

From tagging of 577 cod at St. John's Oct. 5 - Nov. 4, 1948, there were 42 returns from the inshore grounds and 2 returns from the offshore banks in 1949, the most distant recapture inshore being 115 miles and the farthest migrant offshore being 180 miles from the tagging point.

The tagging of 461 cod at Lark Harbour, Bay of Islands in October 1948 gave 11 recaptures mainly in the Rose Blanche Bank area, 10 during the following winter and early spring and one during the summer. This showed a definite migration out of the Gulf of St. Lawrence in the late fall and early winter and afforded an explanation of the good winter fishery off the Rose Blanche area during the winter and spring while the summer fishery is relatively poor. In the spring of 1949 there were 6 recaptures in the Port au Port area presumably of fish migrating back into the Gulf.

Recaptures from tagging of 529 cod at Englee on the north east coast of Newfoundland in 1947 indicated a winter migration into deep water over a hundred fathoms and a maximum migration of 110 miles north and 210 miles south of the tagging point in 1948. There was very little tendency for the fish to migrate into the Gulf of St. Lawrence through the shallow 30 fathom deep Strait of Belle Isle.

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Appendix No. 23

MIGRATIONS OF TAGGED COD. OFFSHORE TAGGING

Since 1947, 1077 cod caught by otter trawling on the Grand Bank have been tagged with only 3 per cent return of tags. Of 116 cod tagged on June 8, 1947 on the southern part of St. Pierre Bank one migrated inshore to the Burin Peninsula, a distance of 100 miles, a month later, and one inshore to Trepassey Bay the following year while two were caught in 1948 near the southern part of the Halibut Channel between Green Bank and St. Pierre Bank. Of 158 cod tagged near the south-eastern tip of the Grand Bank 8 recaptures were made, all to the northward or westward of the tagging areas, all on the Grand Banks and none inshore. The fastest migrating fish moved 150 miles in 48 days or 3.1 miles per day. Of 72 cod tagged on the Grand Bank south east of Whale Deep near longitude 52°W and latitude 44° 15' north 4 were recaptured, two inshore in Placentia and St. Mary's Bays on the eastern part of the south east coast and 2 on the Grand Bank. The fastest moving fish migrated 160 miles in 48 days or 3.3 miles per day.

Two hundred and forty two cod were tagged on the north-western edge of the Grand Bank about 40 miles from Cape Race June 4-5, 1948. These cod were spawning or spent and were feeding heavily on caplin. Several weeks later when the caplin came to shore to spawn a number of these tagged fish were caught probably having followed various schools of caplin to shore. In all seven fish were caught inshore all but one on the Avalon Peninsula while three others were caught on the Grand Bank.

The general picture at the moment is that the cod on the western side of the Grand Bank and on St. Pierre Bank may migrate inshore. Such migration would be unusual in fish from the south-eastern part of the Grand Bank.

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Appendix No. 24

DATA AND MATERIALS COLLECTED BUT NOT YET AVAILABLE FOR REPORT

Sex Ratios, Sexual Maturity and Spawning, Haddock and Cod

During the past few years about 4000 haddock and 7000 cod from many bank and inshore areas have been examined for sex, evidence of sexual maturity and condition with respect to spawning. This data is now being worked up.

Stomach Contents

Data on the stomach contents of over 6000 cod has been collected and is being summarized.

Cod and Haddock Otoliths

A collection has been made of about 3000 sets of haddock otoliths and about 6000 sets of cod otoliths covering all the main areas of Newfoundland, Labrador and the banks. These still await examination.

Measurements of Cod and Haddock

In the course of comparisons of sizes and numbers of cod and haddock found in various localities and different depths and temperatures and to provide a background of measurements of the commercial catch to compare with future sizes, a total of over thirty two thousand haddock and over eighteen thousand cod have been measured in 1949. The following measurements have been taken over the past four years.

Measurements of Cod and Haddock
1946, 1947, 1948 & 1949 to Trip 11

	HADDOCK			COD			
Year	Shore	Bank	Total	Shore	Bank	Total	Total Haddock and Cod
1946	—	5417	5417	—	2883	2883	8300
1947	692	9308	10000	8163	3778	11941	21941
1948	102	15932	16034	10236	7198	17434	33468
1949		32565	32565	6662	12245	18907	51165
	794	63222	64016	25061	26104	51165	115181

Length Weight Relationships Cod & Haddock

Lengths and round and gutted weights have been taken for about three thousand haddock and for more than three thousand cod in different seasons and localities both bank and inshore.

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Appendix No. 25

SALMON INVESTIGATIONS IN NEWFOUNDLAND

The earliest study of Newfoundland salmon was conducted by the Newfoundland Fishery Research Laboratory at Bay Bulls which operated from 1931 to 1936. The material collected in 1931 was published but later material was lost when the laboratory at Bay Bulls burned. In 1936 Belding did some work on the growth of parr in several of the west coast rivers. The Quebec Salmon Commission tagged adult salmon at Port aux Basques, Cabot Strait, in 1937 and 1938 and at St. Anthony, east coast of Newfoundland, in 1938. In 1937 the Newfoundland Commission of Government established the Fishery Research Institute (since known as Fishery Research Laboratory and Government Laboratory) on a permanent basis and salmon investigations have been carried on continuously since 1939.

From 1939 to 1944 the investigations were mainly concerned with coastal salmon and from 1945 to 1949 river obstructions were inspected and fishways constructed. The next phase should be a study of the rivers as to type of runs, productivity, and relationship to the commercial fishery. Anglers' catches from most of the Newfoundland rivers are composed mainly of grilse. Similar catches were obtained in several rivers which were netted. The main commercial fishery is on the east coast of Newfoundland and Labrador and the catch is made up mainly of 2-sea-year fish. The limited tagging of adult salmon in this area tends to show that many of these salmon are not returning to Newfoundland rivers. It is believed that restrictions on the capture of grilse should be relaxed. There are no catch statistics to show the state of the salmon fishery but whenever the catches are low there is always the fear of depletion. Because of this uncertainty and the fact that production was low in many rivers due to natural barriers to the ascent of salmon it was felt that the wisest policy was to embark on the river improvement programme which was started in 1946.

A. A. Blair

Appendix No. 26

NATURAL FISHWAYS FOR SALMON

A most pressing problem in Newfoundland salmon rivers is the provision of fishways. The country abounds in rivers and lakes but unfortunately falls are plentiful many of which are impassable. As the opportunity provided as many falls as possible were inspected and it was thought that in most cases a natural fishway, i.e. a series of pools blasted out of bedrock, could be

provided at considerably less expense and with less upkeep than the usual wood or concrete fishway. Since 1946 four such fishways of various sizes have been built. These were considered experimental so the usual precautions about white water and easy slope etc. were largely ignored. The policy was to keep down the initial cost and to make changes later if and when found necessary. Only in this way will it likely be possible to provide salmon with unobstructed passage in every river in Newfoundland and Labrador which should be the ultimate aim. A brief description of the fishways follows.

Northwest River, Bonavista Bay

Two miles from the mouth of the river there is a vertical fall 25 feet high. The fishway is 20.6 feet high and 317 feet long giving a general slope of 1 in 15. It was built in 1948 from July 20 to August 21 by a six man crew, the number of man hours being 1740 and the cost $1329.00. The mouth of the fishway is quite a distance from the foot of the fall but the river is narrow and salmon had no difficulty in finding the mouth as they were attempting to go up the fishway before it was completed. Forty-seven salmon used the fishway during construction but after that no record was kept. In 1949 a trap was operated and 62 salmon were counted. This seems very low but the river was blocked with logs until September and presumably the salmon went elsewhere. Apparently all the salmon that got through the wood block went up the fishway since salmon are usually seen jumping at the fall and this year none were seen.

Lomond River, Bonne Bay

The fishway is around 3 miles from the sea and is the steepest one constructed. It is 155 feet long and 22 feet high having a general slope of 1 in 7 while the greatest slope is 1 in 3. It was built in 1948 from August 23 to September 27. The man hours were 1830 and the cost $1,530.00. Sea trout were seen in the top pool right after it was completed. A trap was operated in 1949 and the count consisted of 29 trout and 4 salmon. The salmon went up in September. The warden reported that there was a fairly good run of salmon this year on East Brook which enters the main river about a mile below the fishway. The dam on this stream was wide open around the middle of July when the gate of the dam on the main river was raised only 4 inches. In this way the salmon may have been attracted to the East Brook since the river was abnormally low and the water warm. Whatever the reason only a few salmon reached the fall this year. The few that did go up the fishway show that it is suitable in spite of the steep gradient and white water.

Bay du Nord River, Fortune Bay

A large fishway was constructed at Smokey Fall which is 56 feet high and is situated 9 miles from the mouth of the river.

The fishway follows a brook and a valley, then cuts across a barren, follows a flood channel, and cuts across a wooded area. It is 2048 feet long and 84.5 feet high. There are three large pools (250 x 40 x 6, 50 x 30 x 5, and 20 x 20 x 4 feet) while small pools around 6 x 4 x 4 feet were made at the bottom and top of any appreciable rise. The overall gradient is 1 in 24 so salmon should have little difficulty in ascending the fishway but getting them to enter it is going to be a problem judging from this summer's experience. The fishway proper was finished in June of this year and salmon were at the fall by the 15th of July and were seen on the side of the river opposite the fishway but not on the fishway side. During the month of August the river bed was altered to divert more water to the side of the river where the mouth of the fishway is situated but to no avail. It may be that we were too late in diverting the flow or that the work near the mouth of the fishway kept salmon away. Careful observation will be required next year to determine what or if any remedies are necessary. The cost of the fishway up to last year was $11,124.82 and with this year's expenditure the total cost will be in the vicinity of fifteen thousand dollars.

Bay d'Est River, Hermitage Bay

The obstruction on this river, one of the largest rivers on the south coast, is a 14 foot fall situated half a mile from the head of tide. The fishway is 122 feet long and contains only one pool which was made by placing a dam on the river side of a depression about 7 feet from the face of the rock cliff. The runway above the pool is 51 feet long with a slope of 1 in 26 and the runway below the pool is 47 feet long with a slope of 1 in 6. The fishway was finished in the fall of 1947 but the crib dam was washed out by spring floods in 1948. It was not replaced until August of this year when a concrete dam was constructed which should be strong enough to withstand the tremendous pressure of water during floods. The total cost of the fishway will be around seven thousand dollars which is excessive for a fishway of this size. The replacement of the dam drove up the cost but the initial cost ($3849.64) in 1947 was high due to the use of hand drills instead of a portable jack hammer and a crew which should have had constant supervision. A counting trap was operated for a few days only before the crew left the job. Nine salmon went up the first day but none the remaining few days. On September 20 the warden noticed 6 salmon in the pool of the fishway and they went on up when disturbed.

A. A. Blair

Appendix No. 27

ADULT SALMON TAGGING

The movements of salmon around the shores of Newfoundland is one of the most important salmon problems. An extensive

tagging programme would seem to be in order but this is not possible with a small staff. Consequently tagging is being attempted at one place only each year but as experienced taggers are available the number of places will be increased to two or more per year.

The results of all the tagging operations to date give a general idea of the picture but significant gaps are left to be filled in by future work. Salmon have been tagged at Port aux Basques (1937) and St. Anthony (1938) by the Quebec Salmon Commission and at Bonavista (1940), Cape Charles (1948), and Cape Broyle (1949) by the Newfoundland Biological Station. The returns from all of these tagging stations show a wide distribution. Of the salmon tagged at Port aux Basques 13.3 per cent were recaptured. The areas where they were caught are: south and west coasts of Newfoundland, Labrador, Nova Scotia, New Brunswick, and Quebec. Forty per cent were taken in Newfoundland and Labrador and 60 per cent in Nova Scotia, New Brunswick, and Quebec. The recaptures from the Bonavista tagging showed a somewhat similar distribution but a higher percentage of recapture, 42.6. The percentage reported from Newfoundland and Labrador was 60.7 and from Nova Scotia, New Brunswick, and Quebec 39.3. Grilse were also tagged at Bonavista and although there was a greater concentration of recaptures on the east coast of Newfoundland than for salmon, the distribution was still widespread namely, east, south, and west coasts of Newfoundland and 7.3 per cent from Nova Scotia, New Brunswick, and Quebec.

The returns from the tagging at Cape Broyle (near St. John's) were low for no apparent reason. Four were caught at Cape Broyle, one on the south coast of Newfoundland, one on the west coast of Newfoundland, and one in a drift net off Tracadie, New Brunswick. Recaptures from the tagging at St. Anthony on the northeast coast of Newfoundland near the Strait of Belle Isle were reported from the following areas: east coast of Newfoundland (few salmon) as far south as White Bay, the west coast of Newfoundland as far south as Bay of Islands, the east coast of Labrador, and the north shore of the Gulf of St. Lawrence as far west as Natashquan which is directly north of the eastern end of Anticosti Island. Salmon tagged at Cape Charles, the south-eastern tip of the Labrador, were caught all along the Labrador coast as far north as the fishery extends and one was taken about half way down the west coast of Newfoundland.

From these results then it appears that the salmon fishery on the east coast of Newfoundland is concerned with a mixture of salmon with far distant destinations. Some of them make their way south and west through Cabot Strait to the southern section of the west coast of Newfoundland, Nova Scotia, New Brunswick, and the western section of the North Shore of the Gulf of St. Lawrence while others go north to Labrador and west through the Strait of Belle Isle to the northern section of the west coast of Newfoundland and the eastern section of the North Shore of the Gulf of St. Lawrence.

A. A. Blair

Appendix No. 28

TROLLING FOR ATLANTIC SALMON

As far as is known this method of fishing has not been tried on Atlantic salmon commercially although it has been in use some time now for catching spring and cohoe salmon on the Pacific Coast. Even if Atlantic salmon can be taken by trolling it might not be practical on this coast due to weather conditions but it would be a useful research tool in learning more about salmon off the coast. The present state of our knowledge consists of four records of salmon being taken by trawlers on the southwestern edge of the Grand Banks about 125 miles from the coast. Two were taken in 1947, one by the trawler "Zibet" around June 1 and the other by the trawler "Zebu" on June 8. Two were taken in 1949 by the trawler "Blue Spray", one on May 31 and the other on June 6.

Some trolling was tried this year along shore near Cape Broyle whenever tagging operations permitted. This meant that we could not troll early in the morning which is supposed to be the best time. Our efforts were not successful except for the experience gained. The boat used in this work had a heavy duty engine which could not be idled down to correct trolling speed. Later when a sail was tried the salmon run was over but three herring (lengths 32-34 cm.) were caught. They were hooked through the cheek.

A. A. Blair

Appendix No. 29

STUDY OF VITAMIN A VALUE AND YIELD OF LIVER OIL MATERIAL AND TECHNIQUES

During the period from 1947 to 1949 a study was made of the Vitamin A value and yield of oil from the individual livers of about seventeen hundred fish that were obtained from the inshore and from the offshore bank fisheries. Of those livers studied about seventy per cent were cod livers and these were taken from fish of definite length ranges, usually groups of five centimetres, viz., 38-42, 48-52, 58-62, etc. Lesser numbers of all available fishes particularly the Groundfishes common to the Newfoundland area were examined. The Vitamin A value and yield of liver oil in each species was related to size, sex, stage of maturity, season and locality.

The procedure followed for the extraction of oil from the livers was taken from the "Report of the U.S. Joint Government and Industry Technical Committee on Vitamin A" (Method B)

Briefly, the extraction was done as follows:-
A homogenized, weighed sample of liver is extracted with five separate portions of 30-40 ml. of petroleum ether and made to volume in a 250 ml. volumetric flask. Aliquots are withdrawn, the petroleum ether evaporated and the per cent of oil and the vitamin A determined. A Beckman Spectrophotometer is used for the latter, employing isopropanol as solvent and a conversion factor of 2,000 to give spectrophotometric units of Vitamin A.

In a percentage of those examined the Vitamin A of the whole oil was compared with that of the unsaponifiable portion. A table is given showing the numbers of fish of various species examined.

Number of Individual Fish Livers Examined for Vitamin A Value and Yield of Oil

Common Name	Scientific Name	Individual Livers Examined
Cod	Gadus callarias	1127
Haddock	Melanogrammus aeglifinus	147
Common Hake	Urophycis chuss	13
Silver Hake	Merluccius bilinearis	5
Pollock	Pollachius virens	19
Dogfish	Squalus acanthias	34
Great Blue Shark	Prionace glauca	2
Mackerel Shark	Isurus tigris	1
Barn-door Skate	Raja stabuliforis	12
Smooth Skate	Raja senta	5
Spiny-tailed Skate	Raja spinicauda	3
Spotted Skate	Raja diaphanes	2
Thorny Skate	Raja scabrata	73

Halibut	Hippoglossus hippoglossus	7
Greenland Halibut	Reinhardtius hippoglossoides	1
American Plaice	Hippoglossoides platessoides	100
Witch Flounder	Glyptocephalus cynoglossus	27
Yellowtail Flounder	Limanda ferruginea	12
Angler	Lophius piscatorius	4
Argentine	Argentina silus	4
Arctic Eel-pout	Lycodes reticulatus	3
Gaspereau	Pomolobus pseudoharengus	2
Smooth-spined Grenadier	Macrourus berglax	2
Rosefish	Sebastes marinus	61
Long-horned Sculpin	Myoxocephalus octodecimspinosus	5
Short-horned Sculpin	Myoxocephalus groenlandicus	5
Sea Raven	Hemitripterus americanus	6
Sturgeon	Acipenser oxyrhynchus	1
Broad-head Wolffish	Anarhichas latifrons	7
Spotted Wolffish	Anarhichas minor	13
Striped Wolffish	Anarhichas lupus	7

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Appendix No. 30

GENERAL OBSERVATIONS FROM WORK ON VITAMIN A AND OIL YIELD OF FISH LIVER OILS IN NEWFOUNDLAND AREA

The work of this Station on fish liver oils is being brought to a close, the results are being worked up and an account of the results will be presented in a later report.

As a general conclusion it may be stated that after the liver oil of all chief species in the Newfoundland area has been tested, the cod is far and away the best source of Vitamin A oil in the area. This is due to its numbers, the size, general high oil content, relatively good Vitamin A and D content of the liver and the fact that the fish must be split in any case and the liver is thus a by-product of the operation.

The Greenland Shark if it could be caught in numbers would be another prime source of Vitamin A oil but these sharks usually occur considerable distances offshore and their numbers in the area are as yet very much in doubt.

Other fish available in limited numbers whose livers could be used commercially on a small scale are the halibut, pollock, hake, large anglers over 3 feet long, the barn door skate, at least those over 3½ feet in length and the spiny tailed skate, Raja spinicauda, over 4 feet in length.

In large rosefish over 30 cm. in length, even though the livers will average only about fifteen grams, and the oil content is low there is an average of over 2 million units of Vitamin A per pound of livers. In fact if the livers are taken only from the fish of 35 cm. and up the livers will often average four to five million units of vitamin A per pound of liver with vitamin A values in some seasons and localities averaging over one hundred thousand units per gram of oil.

Rosefish waste, that is the remainder of the round fish after the fillets are taken off is definitely worth processing so as to separate the oil. After several laboratory tests of oil from this waste in 1947 had run 7600 and 12000 units of vitamin A respectively with 5 per cent oil we informed a local operator with the result that he immediately began collecting this oil which had previously run away with the stick water from the meal plant and the following year set up a special plant to process rosefish waste so as to obtain as much high Vitamin A rosefish oil as possible.

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