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Excerpts from

FISHERIES RESEARCH BOARD OF CANADA

REPORT OF THE ATLANTIC BIOLOGICAL STATION FOR 1950-1951

by

A.W.H. NEEDLER, DIRECTOR.

Appendix No. 26

GENERAL SUMMARY OF GROUNDFISH INVESTIGATIONS

The groundfish catch varies sharply from year to year both in total quantity and in variety of species landed. Such variation is caused by the interaction of a number of controlling factors and the most important of these are landed price, fishing efficiency and abundance of available fish stocks. Expansion and stabilization of the groundfish industry depend on an understanding of these various factors and such is the aim of the groundfish investigation.

Market demand has an important bearing on the catch through its effect on landed price. Quality improvement, which affects market demand, is being attempted through reduction of the worm incidence in cod. Earlier investigations have demonstrated the role of harbour and gray seals as important hosts of adult cod worms. Worm incidence in cod is being closely followed in the Bras d'Or Lakes and an attempt to reduce the number of seals in the Lakes will be made. The experiment will measure the feasibility of large-scale reduction in cod-worm incidence. (Appendix 27).

Fishing methods must be both varied and efficient if our groundfish resources are to be fully exploited. Most groundfish are low-priced species and small changes in fishing technique can make the difference between profit and loss. A major part of the groundfish investigation is concerned with the study of fishing methods:

1. The advantages of powered haulers for line-trawl fishermen have been demonstrated. Many inshore fishermen have now accepted the "long-lining" method and three types of hauler are being used. Arrangements were made with two high-liner Lockeport fishermen to take their boats to Bonavista, Newfoundland, for the purpose of testing the Lockeport fishing method in this area. These commercial fishing experiments, which were financed by the Department of Fisheries, have demonstrated potentialities for improved fishing in that area. Operations of the M. B. "Cuddle", a Liverpool, N. S., long-liner, during bait experiments at Tignish, P. E. I., indicated that "long-lining" would not be profitable there. (Appendix 28). It is of intefest that the "Alfred D", a seven-man "long-liner", carried out profitable halibut fishing during the summer of 1950. M. B. "J. J. Cowie" operations in 1944-46 demonstrated this possibility.

2. Bait experiments conducted in the Gulf of St. Lawrence during 1949 and 1950 have shown large differences in the catch of cod and hake taken by different baits. Squid proved to be particularly good bait and clams, "shack" and flounders were very poor. Nova Scotia herring were consistently better than Gulf of St. Lawrence herring with differences possibly related to fatness. The work will be continued off western Nova Scotia. (Appendix 28).

3. Power haulers have been successfully adapted to hoisting long strings of gill-nets. The method has been highly developed in the Great Lakes and successfully used for groundfish in New England (Gloucester and Portland). Groundfish gill-netting, as conducted in the Maritimes, has been limited by the labour involved in hauling nets by hand. Experiments initiated in 1950 have shown the feasibility of mechanized gill-netting in Maritime waters but the method is costly. The low price of groundfish must be off-set by high abundance if this fishing method is to be profitable. The technique might be adapted to mackerel drift-netting. (Appendix 29).

4. "Danish seining" experiments have been postponed until trials can be arranged on a commercial boat. Preliminary commercial trials conducted in the late fall of 1949 were abortive and the vessel was sold before summer trials could be attempted.

5. Exploratory flounder dragging has led to the development of a growing commercial fishery in the Bay of Fundy. Further work was postponed in 1950 but is needed.

Abundance is of primary importance in the control of catch and a major part of the groundfish investigation is concerned with the assessment of this relationship. Such knowledge provides the basis for rational use of the various groundfish species. An understanding of abundance forms the basis for increased exploitation of underfished species and prediction of changes in abundance permits better utilization of the fishery. Catch fluctuations which result from natural causes must be distinguished from those which are due to fishing. In the event of "overfishing" these studies form the basis for recommending remedial action and the pending formation of a North-west Atlantic Commission has extended our responsibilities in this direction. Control of fishing operations must be guarded against until the need for restriction has been fully demonstrated.

Interpretation of abundance requires long-term collection of catch statistics (catch, effort and size and age composition data). The accumulation of five years' data for both inshore and offshore commercial fisheries is beginning to throw light on the abundance problem (Appendices 30 and 31) but these studies must be continued indefinitely in order to be of value as bases for prediction, increased exploitation or conservation.

The newly-developed winter flounder fishery has received special attention since 1947. The work has involved exploration for fishing grounds, tagging to measure movement and fishing intensity, catch and effort data, size and age composition studies, trawl-mesh experiments, a study of the life history of a trematode which affects the quality of flounder fillets, and experimental studies of the

factors responsible for seasonal movements of flounders. Mr. McCracken and Mr. Wolfgang are using part of the data for Doctorate theses. The winter flounder investigations will be reduced in 1951 to exploration, parasite and fishing intensity studies. (Appendices 32 to 34).

The personnel responsible for groundfish investigations during 1950 were twelve in number apart from boat crews. Messrs. Boyce, Fitzgerald and Fraser have collected field data from the commercial fishery at both offshore and inshore ports. Mr. Sollows acted as observer for experiments conducted on the M.V. "J.J. Cowie". Miss MacMorran was responsible for age determinations and Mrs. Cunningham for compilation of records used in abundance studies. Four summer workers were employed in groundfish work: Dr. Scott and Mr. Shapiro carried out cod-worm studies at Baddeck, N.S., Mr. Wolfgang is studying the flounder trematode and Mr. Murdock assisted with bait experiments.

Four boats have been used for groundfish studies during the year: (1) M.B. "Pandalus" in cod-worm investigations in Bras d'Or Lakes, N.S.; (2) M.B. "Cuddle" - chartered for bait experiments at Tignish, P.E.I.; (3) M.B. "Clupea H." in flounder parasite studies in Passamaquoddy Bay, N.B.; (4) M.V. "J.J. Cowie" in gill-netting experiments off Cape Sambro, N.S., flounder tagging in St. Mary Bay, N.S., and flounder mesh experiments in Passamaquoddy Bay, N.B. It is expected that a new inshore research boat will be available for flounder and bait studies during 1951, thereby releasing the "Cowie" for gill-netting and otter-trawling experiments.

Co-operation has been maintained with the groundfish investigations of the Newfoundland Biological Station, the U.S. Fish and Wildlife Service and the Economics Division of the Department of Fisheries. The work has benefited from visits by personnel from these units to St. Andrews and from trips by the writer to Ottawa, St. John's and Woods Hole.

W.R. Martin

Appendix No. 28

RELATIVE EFFICACY OF BAITS FOR GROUNDFISH

Comparison of the relative efficiency of different baits for the capture of groundfish was continued during the summer of 1950. The locale of the experiment was shifted from Souris, P.E.I., (base of the 1949 experiment) to Richibucto, N.B., and Tignish, P.E.I., in order to obtain catches which consisted mainly of cod.

The long-lining method of fishing was used throughout the experiment with a 42-ft. commercial fishing boat of the Cape Island type, the "Cuddle", chartered for three months' fishing operations (36 fishing days). The seven baits compared in the course of the experiment were: squid, mackerel, Gulf of St. Lawrence herring, Nova Scotia herring, flounders, clams and "shack" (waste fish caught during long-lining). With the exception of shack and clams, all the baits were frozen. The baits tested were alternated every other line or every two lines to reduce the possibility of bias caused from

concentrations of cod in a particular place. Either three or four baits and approximately 2,700 hooks, on 54 lines, were fished each day. Mr. G. A. Murdock acted as boat observer.

At Richibucto the results confirmed those obtained at Souris, P. E. I., in 1949 for hake. Mackerel caught one and a half times as much hake as Gulf herring. Clams, shack and flounders caught much less hake than either Gulf herring or mackerel. Nova Scotia herring was not used sufficiently to give definite results for hake.

At Tignish the catch of cod produced by clams, flounders and shack was far below any of the standard baits used by fishermen. Any of these three would have to be sold for almost nothing to produce the same net profit as the poorest of the standard baits (Gulf herring at four cents per pound).

The standard baits can be arranged according to the weight of cod caught in the following order: squid, Nova Scotia herring, mackerel and Gulf herring.

Table I

Average weight of cod caught per pound of bait used

Bait	Pounds of bait per line	Pounds of cod per pound of bait
Squid	3.0	11.9 to 1
Nova Scotia herring	4.0	3.7 to 1
Mackerel	4.0	2.8 to 1
Gulf herring	4.0	2.2 to 1

Squid produced much the largest catches. Differences in catch produced by the other three baits were smaller but consistent throughout all experiments.

Cod caught by squid were of larger average size in both day and night sets. For the day sets the other three baits listed in Table I caught fish of almost the same average size. For the night sets the average size of cod caught can be placed in the following order in relation to the baits used: squid largest, followed by Gulf herring, mackerel and Nova Scotia herring.

Over-night sets caught on the average about one and a half times the weight of cod caught by "flying sets".

From the data obtained in this experiment it appears that a boat such as the M. B. "Cuddle", using the long-line method of fishing at Tignish, would operate at a loss. At local prices the ratio of weight of fish caught to the weight of bait used is too low (with the exception of squid) to meet baiting costs. The advantage of handling more gear, as is possible with the long-lining method, is lost since operations at Tignish showed a net loss per line fished.

Local fishermen increase the ratio of catch to bait by setting trawl over night and "under-running" it. Using this method, baiting costs are reduced since the baits are cut smaller and any

baits on the line which are in good condition when the trawl is under-run can be returned to the water.

Apart from the low efficiency of the long-lining method, the results give useful information on the relative efficiency of the baits tested:

1. It is apparent that the substitution of clams, flounders or shack in place of any of the commonly used baits is not economically feasible.

2. Squid, even at a cost of twelve cents per pound, gave a higher net profit than either mackerel at five cents per pound or Gulf herring at four cents per pound.

3. Nova Scotia herring at six cents per pound would give the same net profit as Gulf herring at four cents per pound but it is unlikely that it could be made available in Prince Edward Island at this price. The comparison of the two herrings does, however, give information which may be useful at some future time if and when local shortages of herring occur.

4. Using the long-line method of fishing, mackerel at five cents per pound gave a slightly lower net profit than Gulf herring at four cents per pound. In under-running trawl, however, mackerel would remain on the hooks for a longer time and might thus justify the difference in price.

Further work should compare the relative efficiency of baits for the capture of cod in a different region to see whether the relationship obtained at Tignish applies as a general rule.

F. D. McCracken

Appendix No. 29

EXPERIMENTAL GILL-NETTING FOR GROUNDFISH

Gill-netting operations were conducted from Ketch Harbour, Halifax County, N. S., with the M. V. "J. J. Cowie" from July 17 to September 27. Commercial gill-netting is conducted in this area and the facilities at the government wharf for net storage on reels and in a net shed were well suited to the work. A Crossley No. 125 net lifter and a 9 h.p. deck engine were installed to hoist the nets and a turn-table was set into the stern deck to eliminate net twists when setting. Six- and eight-inch-mesh nets were rigged on ¼" medium-lay cotton line or on six-thread steam-tarred rope with plastic floats and six-ounce split leads. Thirty-five six-inch-mesh nets (85 fm. long, 18 meshes deep of 12/3-thread linen) and 30 eight-inch-mesh nets (75 fm. long, 14 meshes deep of 16/4-thread linen) were rigged and cuprinol treated. The nets were hung on the half and rigged similar to two sample nets obtained from Gloucester. Two seven-inch-mesh, 210/3-thread nylon nets were also obtained.

A five-man crew and an observer carried out the experiments. Employment of additional shore hands to reel, box and repair nets

would be required in a commercial operation. The method of operation was similar to that used in the Great Lakes. Nets were boxed from reels ashore and set in a long string of about 15 nets from the port side of the "Cowie" stern. The nets were roped from the box by one man and spread by another as the boat moved ahead. The nets were lifted on the next fishing day by keeping the boat over the gear and by using the net lifter. The nets were passed along a picking table, where the fish were removed from the net, and boxed at the end of the table. Nets which were not badly fouled were reset and the fouled nets were replaced by dry nets. With light fishing only about three nets were replaced but with heavy fishing or after a storm most of the nets had to be replaced

The work benefited from the advice of two Lake Erie fishing captains, Ted Payne and George Macaulay. The latter gill-net captain was employed before and during fishing operations for two months to demonstrate gill-net techniques. The writer made trips on Lake Ontario and Gloucester boats as a background for the work.

The results of the gill-netting operations are summarized below and a number of observations are noted:

			July 16-31	August 1-15	August 16-31	September 1-15	September 16-30
Days fished			7	9	6	6	4
Number of nets hauled		6"	58	61	42	24	10
		8"	52	56	39	63	50
Catch (lb.)		Cod	1347	651	6361	3125	2825
		Pol.	1128	1390	730	381	188
		Total	2522	2095	7358	3669	3274
Catch per net (lb.)	6"	Cod	9.2	5.6	62.5	37.0	50.8
		Pol.	18.8	22.6	16.7	22.3	11.9
		Total	28.7	29.0	85.4	67.9	74.3
	8"	Cod	15.6	5.6	95.8	49.6	50.4
		Pol.	0.7	0.2	0.8	0.5	1.5
		Total	16.5	5.8	96.7	50.6	55.0

(1) The maximum number of nets hauled in a day was 20 and the maximum daily catch was 2.7 thousand pounds.

(2) Pollock were gilled, for the most part, in six-inch nets but since most cod were caught by the mouth the cod catch was comparable in the two meshes.

(3) The scarcity of cod was shown by fishing records of local fishermen and by catch statistics for the area (in thousands of pounds): 1948 - August, 410, September, 450; 1950 - August, 219, September, 117.

(4) Even in strong tides and stormy days the net lifter hauled nets quickly (15 nets in two hours) and efficiently (no parting of lines). Local fishermen take a comparable length of time to

haul three nets by hand.

(5) The fishing grounds were found to be small in size and the catches spotty so that a long string of gear was not well suited to this area. Local fishermen made larger catches per net by fishing short, deep, heavy nets on grounds where good catches could be expected.

(6) Capital cost of equipment is reduced by local fishermen by use of bottles and rocks rather than corks and leads. By using deep nets with no lead line, net fouling by fish or seaweed and "cable laying" of the net is reduced by local fishermen.

(7) Although the gear was not well hung and the corks were poor, the average catch per net was the same as that of Gloucester nets fished in the same string.

(8) The nylon net proved to be too weak for cod fishing. Only one dogfish was taken in two sets while linen nets on either side of the nylon net took good catches. The nylon net was filled with holes, suggesting that cod had gone on through the net. Heavier nylon should be tested.

An average day's fishing operations for Lake Erie and Gloucester boats, the "Cowie" off Ketch Harbour and local fisherman off Ketch Harbour is summarized below. The low efficiency of "Cowie" operations is readily apparent.

	Lake Erie	Gloucester	"Cowie"	Local Ketch Harbour
Number of men	6	7	6	2
Net length - fm.	1200	1200	1200	200
Catch - lb.	700	3000	700	300
Price per lb. $	.40	.06	.03	.03
Value of catch $	280	180	21	9
Boat share $	140	90	10	3
Share per man $	23	13	2	3

With cost of operations comparable at Gloucester and Ketch Harbour and fish price approximately half as great in Nova Scotia as in New England, the catch per day should be of the order of 6,000 lb. to be profitable. Such fishing can only be expected with a much greater abundance of fish than that encountered and with a crew of seven, two of whom remain ashore to box and repair nets. Local fishermen obtained a higher share per man than that which would have been available from "Cowie" operations.

The gill-netting experiments demonstrated that a much larger quantity of gear than that fished by Ketch Harbour inshore fishermen could be handled by use of a net lifter and more efficient landling techniques. Operations comparable with those of the Great Lakes and Gloucester are feasible. The cost of gill-netting is high and these preliminary experiments suggest the method would only be profitable if fish were abundant or landed price was high. Mackerel drift-netting, using a net lifter, might well prove to be profitable.

Gill-netting is much more costly than line fishing and it may only compete in groundfishing when fish are not taking bait or when good bait is not available. Such are the times that gill-netting has been most vigorously pursued at Ketch Harbour. Experiments might well be continued in a new area where comparisons with line fishing and otter trawling can be made.

W. R. Martin
K. G. Sollows

Appendix No. 30

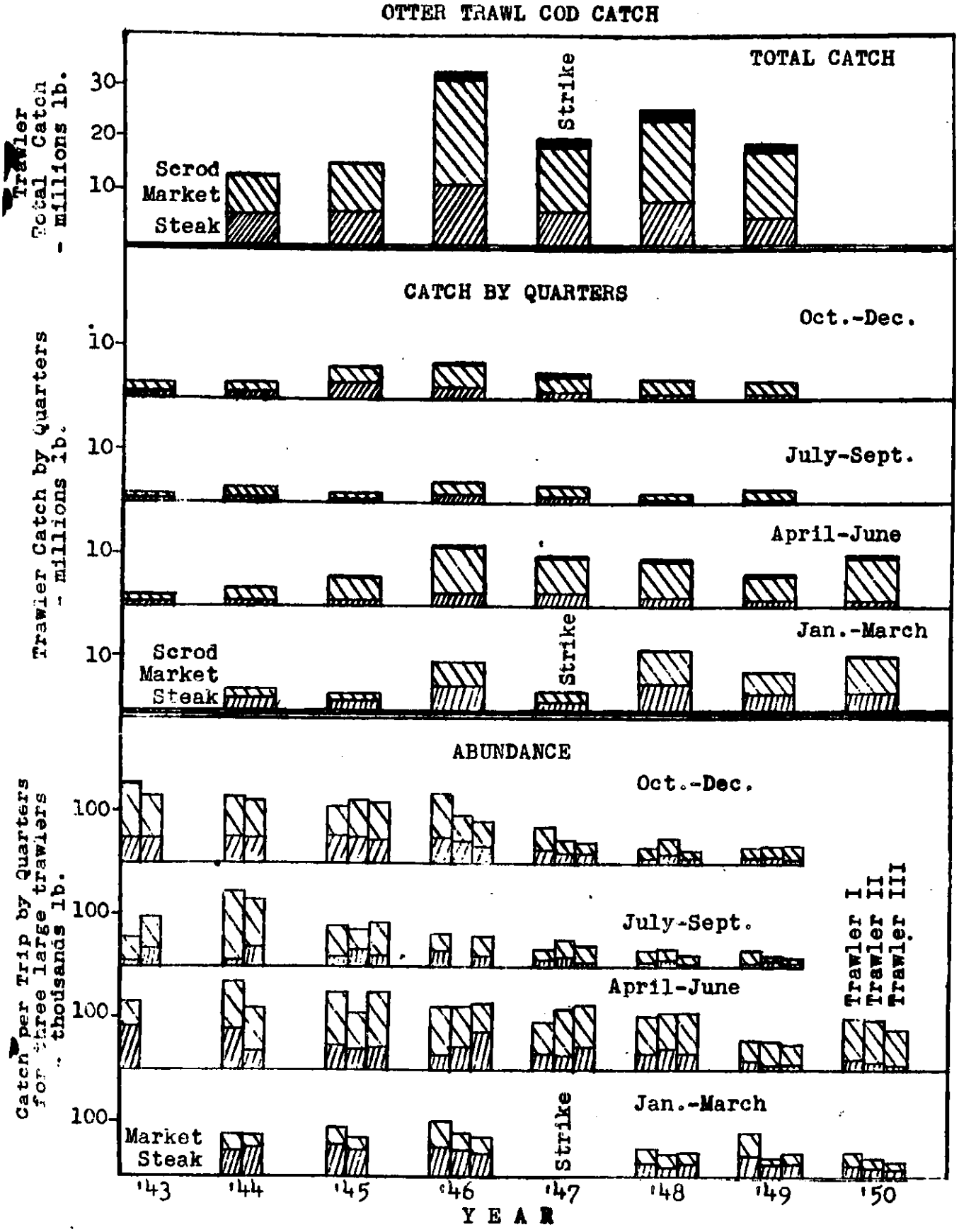
ABUNDANCE OF OFFSHORE GROUNDFISH

Current changes in the offshore fishery serve to illustrate the interaction of price, fishing efficiency and abundance in the control of catch.

Annual statistics of the cod catch since the first Great War show a correlation coefficient of +0.8 between catch and price. The 1950 landed value of cod was one cent per pound or 25% lower than that of the peak year, 1945, and the cod catch has fallen during the same period from about 300 to about 225 million pounds. The decrease in landed value of cod to about 6.5 million dollars in 1950 has been compensated by a sharp increase in halibut landings to a landed value of about 2.5 million dollars. The halibut catch during the past 30 years has varied with the relative price of halibut and cod. In 1950 this ratio reached a peak of eight to one and halibut landings attained a new peak of some 10 million pounds (well over half the British Columbia halibut catch). Changes in landed price affect the catch.

Increased use of otter trawls has improved offshore fishing efficiency not only by increasing fishermen's incomes but by providing increased variety of species and sizes landed. During 1950 ten large otter trawlers and thirty draggers operated on Nova Scotia banks and in the Gulf of St. Lawrence, apart from the fleet of smaller inshore draggers operating in the southwestern part of the Maritimes. Some twenty small "Gloucester" draggers, operating from northern New Brunswick, landed well over 10 million pounds of cod in both 1949 and 1950, more than half the New Brunswick cod catch. The increased otter-trawl fleet has been responsible for the attainment of a new peak in flounder landings of about 15 million pounds in 1950. The "Gloucester"-class draggers alone landed about 4 million pounds of plaice during the year. Opportunity for greatly increasing the rosefish catch is provided by otter trawls. The rosefish catch landed in the Maritimes remained low during 1950 but the expansion potential is shown by the annual New England landings of more than 100 million pounds, a large part of which is taken close to the Nova Scotia coast. The groundfish catch can obviously be greatly increased by diverting fishing from the traditional line fishery to the use of additional efficient fishing methods.

Changes in catch are related in part to fluctuations in abundance. As noted above, part of the offshore fishing effort was diverted from cod to halibut during 1950. Such conversion appears



Current changes in total Nova Scotia otter-trawl fresh cod catch and catch per unit effort of three large trawlers by sizes and by quarters, 1943-1950.

to be related to the relative price and relative abundance of the two species. Current fluctuations in the Nova Scotia otter-trawl catch of cod are shown diagrammatically in the accompanying figure. Statistics collected since 1943 have been broken down by quarters and years, by steak, market and scrod sizes and by catch per trip for the three largest otter trawlers. The otter-trawl catch of fresh cod increased at the end of the recent war to more than 30 million pounds but has fallen steadily since 1946 to less than 20 million pounds. A strike in the fishing industry in 1947 reduced the annual catch appreciably. The proportion of steak cod, by weight, has fallen steadily from 42% in 1944 to 25% in 1949 and the proportion of scrod has increased from 2% to 7% during the same period. Cod abundance as measured by catch per trip for the three largest otter trawlers has fallen steadily since 1945 and the decreased abundance of steak cod is particularly apparent.

The changes in catch per unit effort and in total otter-trawl catch are apparently related to the effect of the war on accumulated stocks of cod. Total fishing effort on offshore banks was tremendously reduced during war years with the disappearance of European fleets and the tendency for New England boats to fish close to home. Reduced fishing mortality, together with continued recruitment and growth, resulted in an accumulation of the cod stock. Good catches were made by the boats which continued to fish during the war but the total catch was very low. With the resumption of full-scale operations by 1946, the expanded Canadian otter-trawl fleet took advantage of the high availability of cod to land a large total catch. By cleaning up on the accumulation of war years the catches have fallen to a level commensurate with annual production. Trip reports for part of the otter-trawl fleet extend back to 1931 and it is clear from these records that present catches of cod are comparable with those of the "thirties".

More detailed catch, effort and size- and age-composition data are being collected in order that the factors involved in catch fluctuations may be more precisely measured. With the disappearance of the 1936 year-class those of 1939, 1941 and 1943 continue to make up the greater part of the offshore catch. The 1946 year-class is beginning to appear in large numbers in the catch. With about ten year-classes involved in the cod catch and little more than 100% variation in the relative size of year-classes the cod fishery tends to remain stable. There is no evidence that the fishery for cod is too intensive.

W. R. Martin
A. R. MacMorran

Appendix No. 31

SIZES AND AGES OF INSHORE GROUNDFISH

The accumulation of data on catch, effort, sizes and ages for the inshore groundfish catch are beginning to contribute an understanding of population dynamics. They provide on the one hand a measure of the discreteness of groundfish populations and on the other

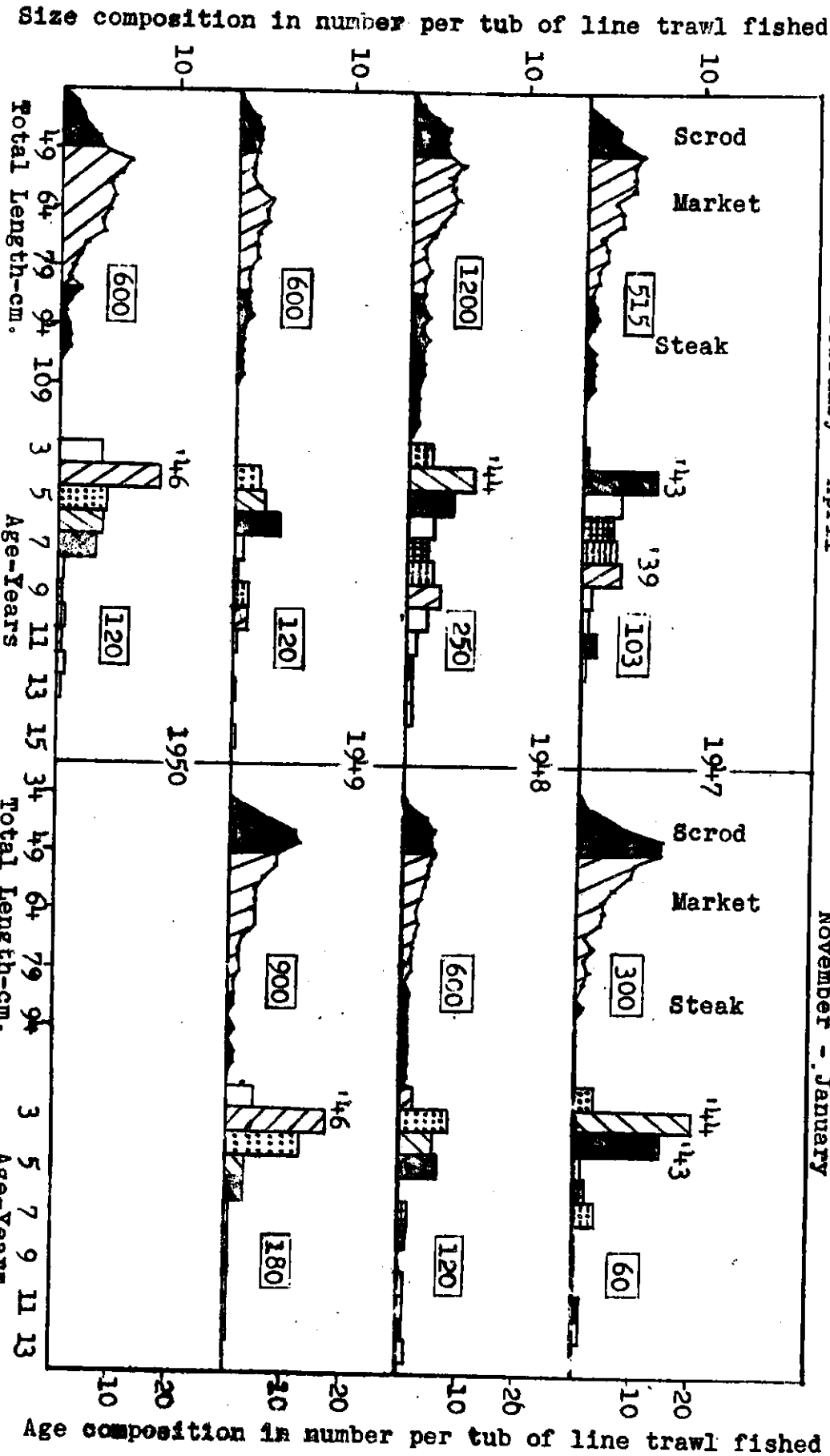
quantitative data on growth, recruitment and mortality.

Large differences in growth rate and cod-worm incidence support the conclusions, reached by tagging and vertebral count studies, that the Maritime cod fishery depends on a large number of discrete populations. The cod of western Nova Scotia grow rapidly and contribute most to the fishery during their third and fourth years. The inshore cod have a higher cod-worm infection than those from offshore. Western Nova Scotia cod may be contrasted with those of eastern Nova Scotia where, because of slower growth, cod contribute most to the fishery during their sixth to ninth years and where a much higher cod-worm infection is found.

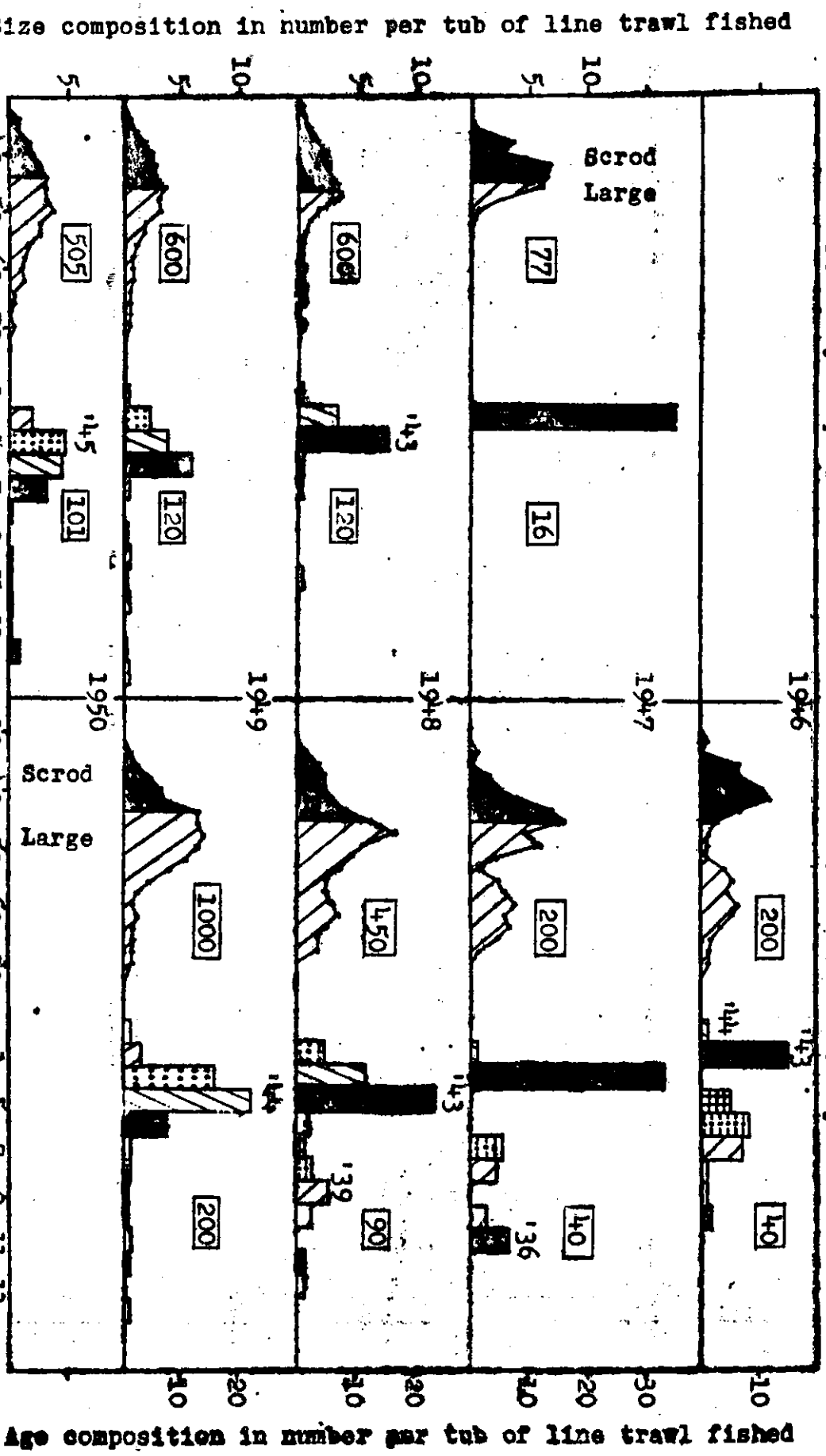
Vital statistics for the Lockeport cod population are shown in the accompanying figure as an example of the information which is becoming available for the inshore fishery. Data on catch per tub fished and size and age composition have been combined by quarters for a four-year period. Data for the other half year conform with those presented for the two cold quarters. It is assumed that catch per tub is closely related to abundance and that otoliths give reliable age determinations. Useful information on recruitment and mortality is apparent. Each year-class contributes a comparable amount to the fishery with largest numbers contributed at the end of the third and the beginning of the fourth years. The percentage of large cod in the catch has been reduced by the disappearance of age groups older than seven. A similar change has been noted for the offshore cod (Appendix 30). The reduced numbers of steak cod and the abundance of small market and scrod cod, resulting from good recruitment, have combined to reduce the average size and age of cod landed. Continued investigation will measure more completely the total contribution of individual year-classes to the fishery and the mortality rate of each.

Similar data for Lockeport haddock are shown in a second diagram. In contrast to the cod, large differences are found in the contribution of year-classes to the fishery. The 1943 year-class was dominant for a three-year period. In contrast to the more stable cod fishery, large variations in the annual haddock catch result from the greater variation in year-class strength. The catches of 1946 and 1947 were bimodal in size composition with large numbers of scrod and large haddock but small numbers of intermediate size. The older year-classes have now disappeared from the catch and the large 1943 year-class has grown from scrod to medium size. The cull size for scrod appears to depend on the size composition of the catch. The catch of the past year differs from that of 1946 in that a unimodal size distribution of medium-sized haddock makes up the bulk of the catch. Good recruitment of young haddock since 1943 will result in a continuing abundance of medium-sized haddock in the area fished by Lockeport boats.

W. R. Martin
A. H. MacMorran



Current changes in abundance of inshore Cod landed at Lockeport, N. S., by sizes and ages, for first and last quarters, 1947-1950.


Size composition in number per tub of line trawl fished
HADDOCK - LOCKEPORT
February - April
November - January
Scrod
Large
Total Length-cm.
Age-Years
Age composition in number per tub of line trawl fished
1946
1947
1948
1949
1950
'43
'44
'45
'36
'39
77
16
200
40
600
120
505
101
1000
200
450
90
Current changes in abundance of inshore Haddock landed at Lockeport, N. S., by sizes and ages, for first and last quarters, 1946-1950.

Appendix No. 32

DEVELOPMENT OF COMMERCIAL DRAGGING FOR WINTER FLOUNDERS

Commercial inshore flounder dragging, a new fishery resulting from Fisheries Research Board exploration, is being followed closely with a view to assessing the potentialities for expansion. Detailed records of catch and effort are collected from all flounder-dragger captains and samples are taken regularly to measure changes in the size and age composition of the catch. Winter flounders have been tagged in St. Mary Bay (the area in which the largest development of inshore dragging has taken place) as a means of studying fish movements and as a measure of fishing intensity.

St. Mary Bay

By October, 1950, over a million pounds of flounders were landed from St. Mary Bay in comparison with a total landing for 1949 of approximately 875,000 lb. Twenty-four small draggers were operating in St. Mary Bay during 1950 as compared to 13 in 1949.

Samples of the commercial catch show no apparent change in the age composition of the commercial landings since the inception of the fishery in April, 1948. The catch per unit of effort, however, decreased in 1950 to approximately one-half that in 1949.

Tagging. During October and November, 1949, 2,616 winter flounders were tagged in St. Mary Bay. A further 1,523 flounders were tagged during May, 1950.

All recoveries to date (with the exception of one return which may be classed as doubtful) have come from St. Mary Bay, indicating that the population is relatively discrete. During April tagged flounders were recovered in relatively deep water (15-19 fm.). Later in the season (May and June) the majority of recoveries came from shoaler water (5-9 fm.) and in the immediate neighbourhood of the point of release. During July and August recoveries were made in both deep and shoal water and tagged fish appeared to be distributed throughout the bay. The number and percentage recoveries to date are shown in the following tables:

October-November, 1949, Tagging

No. tagged	Recovered, 1949		Recovered, 1950		Total percentage
	No.	Percent	No.	Percent	
2616	114	4.4	499	19.9	23.4

May, 1950, Tagging

No. tagged	Recovered within two weeks		Recovered later, 1950		Total percentage
	No.	Percent	No.	Percent	
1523	125	8.2	387	27.4	33.6

These percentage returns are comparable with those obtained from the tagging of winter flounders in Long Island Sound, New York,

(1938-1941) where the fishery is believed to be intensive.

Such a high percentage tag return indicates that much further expansion of the inshore flounder-dragging industry in St. Mary Bay cannot be expected on a long-term basis.

Minas Basin

During the spring of 1950 five boats dragged for winter flounders in Minas Basin landing over a third of a million pounds. This is in contrast with 1949 when three boats (two of which landed flounders incidentally to the haddock catch) landed 150,000 lb. of flounders and 120,000 lb. of haddock.

The catch per unit of effort in 1950 decreased sharply to approximately one-quarter of that in 1949 but still remained somewhat higher than that of St. Mary Bay. Since it was high at the cessation of the fishery in July, 1949, and low at the resumption of the fishery in May, 1950, the decrease may have no relation to the removal of the 1949 catch.

Samples of the catch during 1950 show that a higher proportion of young fish were taken than in 1949.

Annapolis Basin

Dragging was sporadic here during 1950 as was also the case in 1949. This is related mainly to the seasonal variation in availability of winter flounders in Minas Basin and St. Mary Bay. The total catch to date is approximately 120,000 lb. as compared to 187,000 lb. in 1949.

Exploration

Significant expansion of the inshore flounder-dragging industry can only be anticipated through the discovery of new grounds. Further exploration, which is required particularly at the head of the Bay of Fundy, has been postponed pending the procurement of a new inshore research boat. It is expected that this exploration will be continued in 1951.

F. D. McCracken

Appendix No. 33

EXPERIMENTAL WINTER FLOUNDER STUDIES

Further experimental work relating to the distribution and movements of winter flounders was carried out at St. Andrews during 1950.

Size and lethal temperature. An attempt was made to determine whether a relationship existed between size and the temperature at which death occurs. Three experiments were performed in which flounders ranging from 10-35 cm. were exposed to increasing water temperatures (approximately 1°C increase every 10 minutes

starting at 18°C which is below the upper incipient lethal temperature) and the time to death noted. Air was bubbled into the tank to stir and oxygenate the water.

No correlation between size and the temperature at which death occurred could be demonstrated. The correlation coefficients, their t value and the t value required for P = 0.05 are listed for each of the experiments in the following table:

Experiment	Correlation Coefficient	t Value	t Value for P = 0.05
1	0.443	1.48	2.26
2	0.188	0.563	2.26
3	0.114	0.459	2.12

Temperature preferences. Further attempts to obtain a reaction from winter flounders when exposed to a temperature gradient were unsuccessful.

Reactions to light. Winter flounders placed in a tank where one half the bottom was covered with sand and the other half with rocks showed no preference for type of bottom while remaining in darkness. Exposed to light, however, the flounders tended to remain on the sand partially covered. This appears to be a cover reaction rather than a direct reaction to the type of bottom.

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