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FISHERIES RESEARCH BOARD OF CANADA

REPORT

of the

ATLANTIC BIOLOGICAL STATION

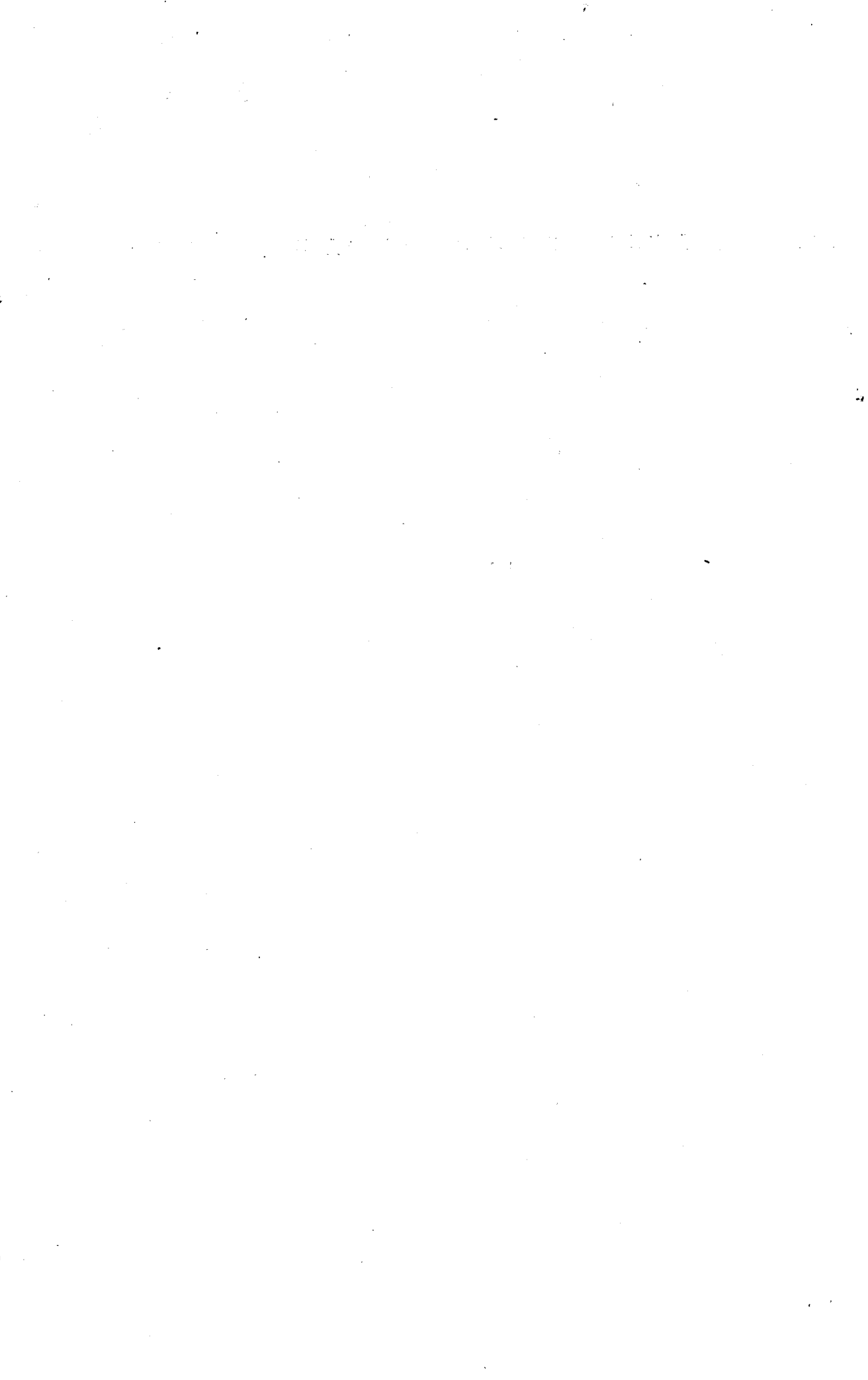
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A. W. H. NEEDLER, Director

With Investigators' Summaries as Appendices



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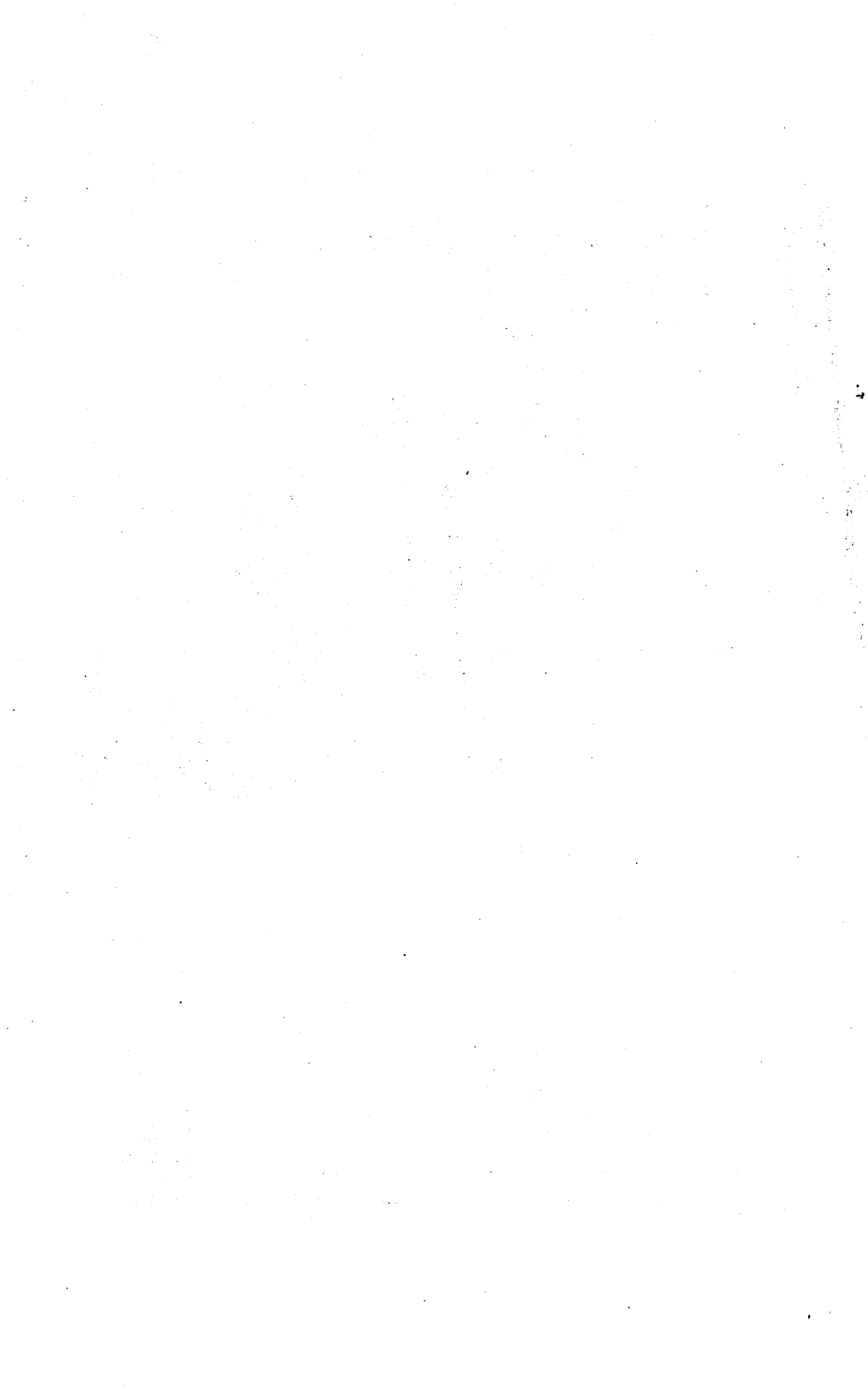
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REPORT FOR 1953 OF THE
ATLANTIC BIOLOGICAL STATION, ST. ANDREWS, N. B.

By A. F. B. Hessler, Director



BOTTOM TRAWLING FOR HERRING

Part of a single haul of 12,500 pounds of large, fat herring taken on July 10 in a French herring bottom trawl by the M. V. "Marion Crouse" in 30 fathoms off Margaree, N.S.

During the summer of 1953, a large-scale search for commercial quantities of herring in offshore areas of the Gulf of St. Lawrence was conducted by the Atlantic Biological Station for the Department of Fisheries to discover whether the present spring herring fishery could be extended throughout the summer months. Large bodies of herring were located in the southwestern portion of the Gulf of St. Lawrence and bottom trawls were successful in catching an average of 1,900 pounds per 90-minute tow.

REPORT FOR 1953 OF THE
ATLANTIC BIOLOGICAL STATION, ST. ANDREWS, N. B.

By A. W. H. Needler, Director

Note. In the 1952 report statements were made on the kinds of work carried on by the Station and the principles on which its program is based, and on the background of each investigation (the importance and history of the fishery and the course of the work to date). In this multigraphed report repetition of such statements is avoided; they can be found by reference to the printed report of the Board for 1952. It is hoped that the result - a statement of developments in 1953 - will be more valuable to Board members. If more background material should be included in the section on the Station in the Board's printed report, this can be added readily.

In 1953 the Station continued work on the following aspects of the problem of fisheries development.

Positive cultural measures. During the year the efforts of the Station and the oyster culture administration to develop oyster farming methods and policies were carefully reviewed; some aspects of this work were intensified. In the soft-shelled clam industry it appears that more intensive management or culture may offer the only hope of maintaining production in the face of increasing fishing and predation, and preliminary steps were taken in some new directions. No more work was done in 1953 on the means of increasing the numbers of smelt larvae by improving conditions in the spawning streams but the degree to which such increases are reflected in the commercial catches was still under investigation. In the case of trout work progressed on the promising combination of fertilization, predator control and stocking in small lakes, and on pond culture. The control of predatory birds as a means of increasing the production of salmon smolts has reached the pilot-plant stage and work is proceeding actively on its development as a practical procedure; some other aspects of the salmon investigations may lead to development of positive cultural measures.

Exploration. In 1953 active explorations were carried on for herring and scallops, the Station directing intensified work under the Department's Industrial Development Service vote. Drift-netting and bottom trawling have now revealed a supply of fat herring throughout the summer in the south-western Gulf of St. Lawrence which is exciting commercial interest; attention is being turned to the waters south of Nova Scotia and to other areas. Offshore scallop dragging on grounds east of Halifax discovered a very promising new ground on St. Pierre Bank and some of minor importance on the Nova Scotian banks.

Fishing methods. Work on the introduction of new fishing methods included further trials of Danish seining in the southern Gulf of St. Lawrence with only limited local success. The most important developments were the successful use of special

bottom trawls of Dutch and French design for herring fishing in the Gulf and continued success there with deep drift-nets. Testing of pelagic trawls for herring fishing is under way. Initial steps have been taken towards adapting hydraulic methods of handling silt and small shellfish to the needs of our oyster and soft-shelled clam industries. Some further study was made of the relative efficacy of various baits used in hook-and-line fishing for groundfish. A start was made at attempts to develop more durable and effective lobster traps.

Progress has been made in 1953 in a study of the pulls required to operate various towed gears, and the abilities of boats of various sizes, designs and powers to deliver these pulls. With the present rapid development of dragging by small vessels such information is very valuable both to fishermen and to those who formulate development policy.

Regulation of intensive fisheries. The long-term time-consuming investigations involved in the assessment of the need for restricting fishing to maintain the yield at its most profitable level have been continued in the case of a number of fisheries in which it seems that such restriction might be beneficial. In the important and intensive lobster fishery evidence of the value of size-limits is accumulating and it is hoped to arrange an experimental size-limit increase in one of the areas with good recruitment, high fishing intensity and low average size. Experiments still in progress are confirming the probable value of limiting the frequency with which stocks of soft-shelled clams are dug and attempts are being made to apply this principle through regulation. In the intensive Digby scallop fishery the savings gear developed by the Station has now been adopted by regulation. A forecasted natural increase in abundance is being realized and population dynamics are under study to extend and improve such forecasting. A great deal of the groundfish investigation is associated with Canada's share in the work of the International Commission for the Northwest Atlantic Fisheries. The Station conducts the study of the groundfish stocks and Canadian fishery in the Commission's Sub-area 4 (the Nova Scotian banks and the Gulf of St. Lawrence) and is taking an active part in a study now being made of the possible need for restrictions similar to those in Sub-area 5 (Georges Bank). Much of the Station's work on Atlantic salmon is concerned with development of knowledge of the movements, catches and population dynamics of salmon, all having a bearing on the need for changes in regulations to assure maximum use of the stock without impairing production. Work on the harp seal is leading to the conclusion that the present total take is at a dangerously high level, especially when the increasing kill of adults is taken into account.

Protection of public health. In this field, in which the Station has been very active in the past, active work in 1953 was limited to co-operation in a pilot-plant experiment in the cleansing of clams carried out in the main by the Fish Inspection Laboratory. Supervision of the control measures connected with paralytic shellfish poison has now at last been

turned over to the Fish Inspection Laboratory through its branch at St. Andrews. The Station continues to act in an advisory capacity in connection with various aspects of the control of the shellfish industry in the interests of public health.

Handling of live shellfish. Progress was made in 1953 in the intensive study of the physical and chemical factors influencing survival of lobsters, and steps were taken to apply the results through advice to the industry. Preliminary work is under way on a study of the factors involved in the storage of live oysters in water in the autumn and winter in the interests of better marketing.

Improvement of quality. Efforts were continued in 1953 to complete our knowledge of the life cycle of the round-worm which occurs in cod and to devise means of reducing the abundance of the worms or of removing them more easily from the fillets.

Biological background for fisheries development. The above examples of the Station's activities include no mention of the broad background of hydrography and biology on which progress on the more specific and more practical projects depends. All the aspects of the work for which there is obvious need - whether development of positive cultural methods, exploration for new fisheries, improvement of catching methods, regulation of intensive fisheries, or any other - depend for success on a knowledge of how the species concerned live and react to their environment and how the latter varies from time to time and from place to place. In the long run the Station, in order to achieve practical results, will have to pay more attention to these more basic studies. They are not now forgotten, though difficult to list in a summary of this kind.

There is first the development of a broad and thorough knowledge of hydrographic conditions and how they vary, in which the Atlantic Oceanographic Group plays a leading part with the co-operation of the Station. There are also the many and various studies of life histories and movements associated with the major investigations. In 1953, too, there were broad biological studies of eel-grass (Zostera), valuable in itself but a hindrance to oyster culture, of the boring sponge Cliona, which seriously affects the quality of oysters, and of the annelid Glycera, which supports a new bait-worm industry. Experimental work is playing a growing part in improving our understanding of natural changes in abundance and of commercial practices. Such work included, in 1953, intensive study of factors affecting survival of lobsters and less extensive work of the same sort on scallops and certain groundfish; expansion in this field is needed and planned.

Progress of Investigations

The above is a brief listing of the principal projects according to the type of work. More detail is given below according to species.

Lobsters

Regulation of the fishery. In 1953 intensive studies of the lobster stocks and fisheries were continued at Grand Manan, N.B., Port Maitland, N.S., Fourchu, N.S., (with supplementary information from neighbouring Gabarus and L'Archeveque) and Tignish and Miminegash, P.E.I. In these areas for almost a decade sample catches have been measured, detailed records of catch and effort kept and lobsters tagged. From these data, combined with information on growth rates from work recently completed, estimates of population sizes and mortality rates can be derived. Thus it is possible to follow changes in abundance (whether natural or resulting from regulations) more reliably than from information on catches alone.

Information obtained to date indicates that the growth (close to 50% per year in weight) of the smaller lobsters now caught would more than compensate for natural mortality if they were left in the water and thus supports the value of size-limits as a means of increasing the yield. The protection of small lobsters, through size-limits supported by the wide-spaced traps or "savings gear" developed by the Station, is now the major activity of the Department to maintain the yield. An increase in size-limit at Fourchu from 7" total length to 3 1/8" carapace length (about 9" total length) in 1947 apparently resulted in about the same yield in weight but greater value due to the higher price for larger lobsters (Appendix 1). In this area, where the average size of lobsters was moderate and the regulation is well observed some reasonably good assessment of the effect of the increase in size-limit is possible but this is not true of the areas in western Prince Edward Island where lobsters are very small and observance of the regulation poor. The small size in these areas is apparently due to the very high proportion caught (up to 80%) and such intensive fishing can be attractive to the fishermen only by virtue of the very great numbers of lobsters, a condition confirmed by the observed high abundance of larvae.

It is in these areas with lobsters relatively abundant and small and with specially intensive fishing that a well-enforced size-limit might have its greatest value. It is, however, becoming increasingly clear that a reliable assessment of its value can be made only by intensive study of the effects of a well-observed experimental increase in the size-limit. This, in turn, would require full local support by a well-organized community of fishermen and special efforts to obtain full observance of the regulations. It is planned to arrange such an experiment, if possible. In association with this the Station's program of population studies would be adjusted: by (1) discontinuing those at Grand Manan while continuing those at Port Maitland where conditions are similar; (2) continuing those in the Fourchu area to observe the effects of past changes in size-limit; (3) continuing those at Miminegash to compare changes in population size with changes in production of larvae (Appendices 3 and 4) and (4) diverting effort from Tignish and Grand Manan to the area selected for the experiment.

The economic aspects of the problems of regulation of the lobster fishery must be borne in mind. It appears from our results that protection of small lobsters until they grow somewhat larger would increase the yield, in terms of poundage, from a natural production of small lobsters which may be little influenced by regulation, if at all. It is also probable that a reduction in fishing effort would increase the profit by reducing cost more than catch. The Station has co-operated with the Department's economists in a preliminary investigation of this problem and the economic aspects of experimental regulation should be followed closely.

Improvement of lobster traps. The recent institution of government insurance on lobster traps has brought to the fore the heavy losses caused by storms and other factors, and emphasized the need for more durable traps. A start was made in 1953 by testing traps of conventional shape but made of steel rods (Appendix 2). These traps have about the same weight in water as the conventional stone-ballasted wooden traps, although the steel traps are much lighter in air. They offer much less surface to current or wave action and are expected to be moved about less by storms. It is planned to test other modifications of traps and associated gear intended to improve stability and durability and also to study the relative efficiency of various designs.

Variations in abundance of lobster larvae and early bottom stages. Systematic towing for lobster larvae in the northern end of Northumberland Strait was continued in 1953 for the sixth consecutive year. During this period fourth-stage larvae (after three moults and about to settle on the bottom) have varied in abundance more (23:1) than have the first stage (6:1), indicating that the ultimate success of a year class is more dependent on survival during the free-swimming period than on the number hatched (Appendix 3). It is planned to continue this program, perhaps to a total of ten years, and to compare the variations in the abundance of larvae with variations in the abundance of marketable lobsters as indicated by the population studies at Miminegash. According to recent growth estimates the 1948 larvae should enter the catches in 1953 or 1954.

The newly-designed drag, which in 1952 caught 19 of that year's larvae after they had reached the bottom and were in stages six to eight, caught 8 more of this same group in the spring of 1953. No 1953 larvae were caught in the autumn of 1953 although 92 drags were made, suggesting some correlation with the unusual abundance of larvae in 1952 and relative scarcity in 1953. Although the drag has for the first time caught under-yearling lobsters in numbers useful for growth studies, further improvement is needed if sub-legal lobsters are to be taken in sufficient numbers to follow the relative abundance of year classes.

Commercial holding of live lobsters. The experiment in which upper lethal temperatures, lower lethal salinities and lower lethal oxygen concentrations were determined for lobsters

acclimated to 27 different combinations of temperature, salinity and oxygen concentration, was completed in 1953 (Appendix 5). The results show the interaction of the three factors. The upper lethal temperature is raised by an increase in acclimation temperature, lowered by a decrease in acclimation salinity and lowered by a decrease in acclimation oxygen. The lower lethal salinity is raised by an increase in acclimation temperature, lowered by a decrease in acclimation salinity and lowered by a decrease in acclimation oxygen. The lower lethal oxygen level is raised by an increase in acclimation temperature and by a decrease in acclimation salinity but is unaffected by the oxygen level to which the lobsters were acclimated.

The information gained in this experiment is being supplemented by smaller-scale experiments and provides the basis for a better understanding of the causes of mortalities among lobsters held commercially and for advice to the industry on how to avoid them. A preliminary survey of commercial holding conditions for lobsters was made in the Northumberland Strait area in August, 1953, and such work will be extended. Advice was given to those holding lobsters in pounds in southern New Brunswick (Appendix 6).

Further experiments with the small unit designed by the Station in 1952 for the holding of lobsters in inland areas in aerated artificial sea water emphasized the value of low temperatures in extending the time for which lobsters can be held satisfactorily. The unit was described in a circular distributed to the trade in January, 1953, and a number are now in commercial use (Appendix 7).

Experiments have shown that lobsters can be held without food for at least 7 months and remain active and apparently healthy. The meat yield is, however, reduced and, although no objectionable flavours developed, it was believed by a tasting group that the starved lobsters were less tasty. For periods up to 5 weeks feeding had no marked effect on the meat yield (Appendix 8).

Oysters

Oyster farming. Since 1930 the Station, through its sub-station at Ellerslie, P.E.I., has co-operated very closely with the oyster culture services of the Department in a program for the development of oyster farming. First confined to Prince Edward Island, the work was extended to Nova Scotia and certain areas of New Brunswick in the middle thirties. A small oyster-farming industry has been established using the methods and guided by the policies developed by this program. The growth of the industry was arrested during the second World War and has since been slow, perhaps partly because of the seasonal nature of oyster farming and the good opportunities for employment elsewhere but partly also because costs are high, risks relatively great and returns slow. In 1953 the joint program was carefully reviewed in an attempt to assure that policies and experimental farming were both planned in the best interests of the industry, and some aspects of the work have been intensified.

In the Bras d'Or Lakes, where spat collection had been demonstrated and is more consistently successful than elsewhere, the low salinities make quality relatively low and the use of cheap methods is imperative. A series of experiments has been started in 1953 in which oysters will be grown from spat to marketable size by a variety of methods including the cheapest as well as the most promising. Cost records will be kept and it is hoped that the result will be the demonstration of one or more methods which are both cheap enough and effective (Appendix 12).

At Malagash, N.S., in a region with wide, tidal flats and little firm ground below low tide in sheltered situations, the rearing of oysters inside dykes holding shallow water over the flats at low tide was tried about fifteen years ago and again recently. In both cases preliminary results indicated good growth and survival of spat or small oysters planted in the dykes but silting soon made them unusable (Appendix 11). Various means of controlling or removing silt were tried without success; preparations are under way for experiments in the use of pumps for removing both silt and oysters. If they solve the silt problem a cheap and effective means of rearing small oysters will become available; if the oysters are handled satisfactorily the use of pumps might have great value in other aspects of oyster farming.

Attempts to develop cheaper and more effective means of collecting spat and rearing small oysters were continued in a number of areas. The 1953 season was in general a poor year for spat production (Appendix 9) and some experiments in spat collection methods were consequently ineffective (Appendix 10). A better understanding of the factors governing the production of spat would improve the prediction of sets, which is now reasonably good as regards the time when they are to be expected but very poor as regards the numbers of spat.

As part of the extended oyster culture program it is planned to use echo sounders in 1954 to search for firm bottom in the areas on either side of the eastern end of Northumberland Strait where conditions for spat collection and rearing are good but deep firm ground for maturing oysters is scarce. The method was tested in 1952 in the Malpeque and Egmont Bay areas, P.E.I., and found promising. There is some doubt of the suitability of the conditions on the less sheltered areas for oyster growth and tests of this suitability will be needed in some cases (Appendix 14).

Sponges which riddle oyster shells. The damaging effects of the boring sponge, Cliona celata, continue to increase in the Malpeque Bay area, P.E.I. Shells are so riddled and weakened as to lessen the value of the oysters, and in extreme cases the health of the oysters is affected. In an attempt to find the basis for control, an intensive study of the biology of the sponge is being made (Appendix 16). This is largely a new field and many interesting points are emerging. Further observations are needed but the work in 1953 confirms that in 1952 in suggesting that there is no free-swimming stage, the eggs falling to the bottom when discharged and developing there. If this is

true, and it is confirmed by experiments indicating that the shells become infected mainly by direct contact with shells already infected, the removal of old shell from the surface of oyster grounds is a possible means of reducing the damage (Appendix 16). The problem is very important and it is planned to continue the investigation and extend it to include experiments in control.

Control of eel-grass on oyster grounds. The investigations of the biology of eel-grass and of the means of controlling it on oyster grounds are drawing to a close. The development of the plant has been followed and described from embryonic to mature stages. Observations of the growth of tagged and measured plants in nature and in constant-temperature tanks show that growth continues during falling temperatures and even at 5°C., it also continues actively throughout the periods of high temperature. Shallow-diving equipment was used to advantage in these studies (Appendix 83).

Covering by hard materials such as oyster or clam shells, gravel or concrete slabs results in an area free from eel-grass and highly resistant to recolonization because the plants are unable to establish root systems. Covering with tar-paper and sand is effective too, but permits slow recolonization both by seedlings and by vegetative growth along the edges. Treatment with Benoclor (in concentrations of 1 gallon or more per 1,000 sq. feet) kills eel-grass initially but leaves the bottom unaltered and permits more extensive and rapid recolonization. These findings constitute a substantial contribution to the solution of the problem. The methods may be too expensive for wide use but nevertheless valuable on small highly-productive grounds. (Appendix 82).

Oyster diseases. Studies over the past 24 years of the disease which decimated the Malpeque oyster stocks in the years following 1914 have given a clear picture of its spread throughout the Malpeque-Cascumpeque area and later through other areas in Prince Edward Island, and of the development of resistant stocks in each area in the course of about fifteen years. The continuation into 1953 of the rearing of native and Malpeque spat in the Enmore-Percival and Charlottetown areas has confirmed the latter (Appendix 15).

Experiments have shown that the causative agent of the disease is still present even in the Malpeque area after almost 40 years and that oysters from New Brunswick and Nova Scotia areas suffer high mortalities when held in that inlet. There is thus some reason for fearing that the recent heavy and sudden decline in the abundance of oysters in the Cocagne-Buctouche-Richibucto area of New Brunswick has resulted from introduction of the "Malpeque disease". A more intensive investigation of this possibility is planned and quarantine measures have been recommended.

The causative agent of the disease has not been identified. The same is true of the condition observed in oysters taken in West River, Charlottetown, P.E.I., in 1951 and again in

1952 which caused losses during storage in the succeeding winters, although most of the affected oysters recovered. The Station is co-operating in a study of the normal histology of the oyster at the University of Western Ontario which, it is hoped, will provide a better background for recognition of abnormalities. It is hoped, too, that studies by Mr. R. R. Logie at Rutgers University, supplemented by field work in the summers of 1954 and 1955, will make progress towards identification of the causative agents.

Quahaugs (Venus)

Recent high demand and heavy crops of small quahaugs led to some observations on recruitment and growth, associated with oyster investigations. The results, however, confirm the low growth rates found previously. The scattered distribution and great variations in reproduction cast doubt on the value of regulatory or cultural measures, especially when the high demand for small quahaugs and the slow growth are taken into account (Appendix 17).

Soft-shelled clams (Mya)

The decline in the total production of soft-shelled clams in the Maritime Provinces from its peak in 1950 continued in 1953. This was expected as a result of the continued high demand and intensive digging and the fact that all productive areas of any importance are now exploited. The decline, however, seems to be hastened by the appearance of a new predator, the Green crab Carcinides maenes, and by unexplained mortalities which are suggestive of disease.

The Station in 1953 carried out no explorations for new areas and its experimental clam farming was limited to a single small-scale trial at Pocologan, N.B., where, alone among all the areas tried, the planting of small clams has given moderately promising results (Appendix 19). In spite of this exception clam farming, consisting of removing clams from areas where their growth and survival is poor and planting them in more favourable areas, is made unprofitable in our waters by slow growth and sometimes high mortalities.

Regulation of the fishery. The salient feature of the clam fishery is the fact that digging kills about half of the small clams which are left, while it takes only about 60% of the marketable clams, thus leaving enough to encourage repeated digging and repeated killing of half the small clams. Experiments were started in 1945 in three areas having differing types of soil, to compare the yield from semi-annual, annual, biennial and triennial digging. Results from digging of the experimental plots in 1953 confirm the trend already appearing in earlier results. In general the most frequently dug areas show a more rapid rate of decline in production and lower survival of clams remaining in the flats. There are local differences and the experiment has not continued long enough to show at what levels production will reach equilibrium but the general conclusion of higher take per unit effort and possibly higher total yield with

less frequent digging seems justified. An attempt has been made, with little success, to obtain agreement by the Charlotte County clam industry which would reduce the frequency of digging by about half.

How can the destruction of small clams be avoided? A more direct attack on the central problem of maintaining the yield would be to devise methods of removing clams from the soil without killing half of the small unmarketable clams. A start has been made at an attempt to develop mechanical or hydraulic methods which would remove all clams large and small without serious damage, permitting the replanting of the small. If such a method is found it is proposed to undertake a new set of experiments in systematic digging and replanting on a pilot-plant scale.

The Green Crab - a new predator. The green crab, Carcinides maenes, was first reported in Canadian Atlantic waters from Passamaquoddy Bay, N.B., in 1951. It increased in numbers in 1952 and in the summer of 1953 was abundant in this area and was appearing in small numbers elsewhere in the Bay of Fundy and St. Mary Bay (Appendix 22). The preliminary results of feeding experiments and observations on the clam flats confirm that this crab is a serious predator on clams (Appendix 21). The appearance of a serious new predator which may cause an important increase in natural mortality throws doubt on the advisability of restricting digging.

Is more intensive culture possible? The high value of clams (now about the same as that of oysters) makes costly culture more of an economic possibility than was the case ten years ago. It suggests the need to re-examine the question of whether means can be found of rearing clams protected from predators and other causes of mortality. We need to learn more of the conditions under which clams will survive and grow well.

Cleansing of sewage-contaminated clams. The Station co-operated in a pilot-plant experiment in the commercial cleansing of sewage-contaminated clams. In the experiment in 1953, which arose from earlier smaller-scale investigations, clams caught commercially were held for 96 hours in relatively pure water and marketed by the trade when cleansing was found to be satisfactory by bacteriological tests. The results are encouraging and suggest that, on a larger scale, the cleansing would not be prohibitive in cost and might be developed on a full commercial scale (Appendix 20).

Shipment of live clams in a refrigerated container. The Station co-operated in a trial shipment of live clams from Prince Edward Island in the new refrigerated container developed by the Canadian National Railways. In this insulated "Canex" container shields or liners containing an eutectic mixture maintain a temperature of about 29°F. for about 50 hours. The clams reached Montreal in good condition (Appendix 18). Further trial shipments of live clams and other shellfish are planned.

Bait Worms (Glycera)

The Station's explorations in 1951 and 1952 contributed to the establishment of a bait-worm industry centred mainly in Yarmouth County but with some shipments from the Lepreau area of Charlotte County, N.B. "Blood worms", the annelid Glycera dibranchiata, are packed in the seaweed Ascophyllum Mackaii and expressed to the United States for use as bait in sports fishing. The shippers paid a total of about \$50,000 to those collecting worms in 1953. Brief explorations failed to discover worms of commercially valuable size in the Minas Basin area (Appendix 23). A study is being made of the biology of the worms (Appendix 24). Preliminary results indicate a very low proportion of males, principal spawning season in the early summer and only about 20% of the worms large enough to be salable; a method of marking with silver nitrate has been developed.

Scallops

Forecasting production in the Digby scallop fishery.

In 1953 sampling of the scallop stocks on typical beds in the Digby area and collection of detailed statistics of catch and fishing effort were continued to follow fluctuations in the abundance of successive age groups and their effects on the yield. The yield is now increasing as predicted first in 1948 on the basis of correlation of annual yields with temperatures six years earlier and as later confirmed by sampling of year classes. The prospects for 1953-54 are even better than for 1952-53. The data being obtained should increase the accuracy and reliability of the predictions (Appendix 25).

It is too early to assess the effects of the adoption, near the close of the 1952-53 season, of the "savings gear" with rings having an inside diameter of 3 1/4" recommended by this Station.

Explorations. In 1953 the Station carried out off-shore scallop explorations for the Department under its Industrial Development Service vote. Dr. Chiasson supervised the work of two chartered offshore scallop draggers - the "Elaine W." (Capt. John Beck) for one trip to Middle Ground and the Sable Island area July 8 to 20 and the "Irish Patriot" (Capt. Jas. Himmelman) for four trips to Emerald Bank, Sable Island, Middle Ground, Banquereau and St. Pierre Bank August 6 to October 13.

The results justified the expectation that valuable concentrations would be found on the grounds east of Halifax. On the northern part of St. Pierre Bank an area of about 25 square miles was found on which 1,000 to 2,000 pounds of scallop meats could be taken per day - catches comparable to those on Georges Bank which supports a very valuable fishery. Small areas of more doubtful value were found on Middle Ground and Sable Island Bank, and preliminary exploration gives promise of a second valuable area on St. Pierre Bank. Further explorations are planned for 1954 (Appendix 26).

Brief explorations among the islands between Ecum Secum and Sheet Harbour, N.S., with light gear operated from a small boat failed to discover worthwhile quantities of scallops (Appendix 27).

Lethal temperatures of scallops. Experiments started in 1952 and continued on a small scale in 1953 have indicated that there is much seasonal variation in resistance of scallops to increases in temperature. For example, although scallops acclimated at 2° to 3°C. in January had 50% mortality in 48 hours at 22.3°C., those acclimated at 10° to 11°C. in July had 50% mortality in 48 hours at only 20.6°C. The latter finding supports the view that sudden increases in temperature may be responsible for the mass mortalities which have occurred frequently in the summer in the southern Gulf of St. Lawrence (Appendix 28).

Groundfish.

Assistance in development of the fishery. During the last few years much effort has been directed towards the development of the groundfish fisheries in the Maritime Provinces through exploration and through the improvement of fishing methods. The Station, for example, played major parts in the introduction of the use of powered haulers in long-lining in Nova Scotia and later in Newfoundland, in the discovery of flounder stocks and the development of inshore dragging, and in the demonstration of the value of Danish seining in limited areas. In 1953 work of this sort was limited to exploratory Danish seining on a small scale and to continuation of an investigation of the efficacy of various baits. It is expected that development work will play a still smaller part in the groundfish field in 1954, although investigations on dragging by small vessels (see below under "Operation of towed gear by small vessels") have their main application in the flounder fishery. Although much remains to be done efforts will be directed more towards studies of the effects of the fishery on the stocks.

Exploratory Danish seining. Earlier explorations by the Station had shown good prospects for the profitable use of Danish seining only in Chedabucto Bay, N.S. In 1953 the small vessel which has been using the method there was chartered for one month for exploratory fishing in the southern Gulf of St. Lawrence and arrangements were made for its use by the Quebec Department of Fisheries for a month in Chaleur Bay. Although areas in the eastern end of Northumberland Strait might be used, no really promising new areas were found. No further explorations by this Station are planned; it is hoped that the commercial use of the method, now established on a small scale, will explore suitable grounds adequately (Appendix 37).

Relative efficacy of baits. To supplement results obtained in 1949 and 1950 in the southern Gulf of St. Lawrence, where hake and cod predominated in the catches, experiments were carried out in 1953 at Lockeport, N.S., to compare the relative efficacy of various baits in catching haddock and cod. The

results confirm the very different effectiveness of different baits and stress the importance of quality and of ability to remain on hooks. Squid, if of good quality, is superior to mackerel or herring and could be twice as expensive and still give a better net profit (Appendix 36).

Effects of the fishery on the stocks and possible need for restrictive measures. The Station's groundfish investigations are being directed more and more to meeting the needs of the International Commission for the Northwest Atlantic Fisheries (ICNAF) for information on the groundfish stocks and fishery in its Sub-area 4 (which includes the Scotian Shelf and the Gulf of St. Lawrence) and to assessing the need for restrictive measures and their possible effects on the Canadian fishery in that area. The Commission, having started an experimental minimum-mesh regulation in Sub-area 5 (off New England), is now considering seriously the possible need for a similar measure in Sub-area 4. This requires a review of our knowledge of the stocks and of the fishery, and the Station is playing an important part in the development of the Commission's program in these two Sub-areas. To understand whether or not the groundfish stocks are overfished we must first know what divisions there are in the stock; we must then obtain, for each more or less separate population which is subject to intensive fishery, information on total catch, catch per unit of fishing effort, recruitment, growth rates and mortality rates both from fishing and from natural causes.

Redfish populations, movements and growth. The redfish fishery which started in the New England area about twenty years ago has been spreading northward and eastward and new stocks are showing the effects of intensive fishing. The Commission has stressed the need for better knowledge of redfish populations, movements and vital statistics, and for checking the validity of age estimations. Using the 65-foot "J. J. Cowie" a study of the horizontal and vertical distribution of redfish in the Gulf of St. Lawrence was started. The results suggest that redfish larvae liberated in the Gulf are carried outward towards Cabot Strait gradually moving northward again along the Laurentian channel after they grow to maturity. A preliminary picture was obtained of seasonal changes in vertical distribution which may be more important than horizontal movements in determining the size of the catch. Mature females tend to be off bottom at spawning time and redfish, especially the males, leave the bottom in the evening (Appendix 34).

Populations and movements of cod and haddock. The results of earlier work have already shown the main divisions of the cod and haddock stocks in Sub-area 4. In 1953 comprehensive reports were prepared on the results of tagging cod and haddock and extensive data on vertebral counts are being analysed. A summary of present knowledge of groundfish stocks in Sub-area 4 was presented to the Commission at its annual meeting in May.

Statistics of the fishery. The collection and analysis of statistics of the fishery were continued in 1953, the Departmental officers recording landings but the Station being responsible for the detail of fishing effort and area of capture offshore.

This arrangement may be adjusted as a result of a review now being made of the collection of statistics in the Maritime Provinces but the work must be continued over a long period. It now occupies a major portion of the time of four field men and a clerk on the Station's staff. In 1953 circulars were issued describing offshore fresh-fish landings in 1949 and 1950. ICNAF is bringing together for the first time statistics on the groundfish fishing by all countries.

There is, of course, too much detail to present here but certain trends may be noted. The abundance of large cod, as indicated both by total catch and by catch-per-unit-effort, became particularly high at the end of the war, probably because of reduced fishing, and has now fallen to the lowest level in the past fifteen years. Haddock, on the other hand, have been caught in larger quantities and there are indications that good recent and current recruitment are increasing abundance (Appendix 29). Canada is also paying more attention to redfish and flounders and making larger landings.

Sampling for size and age composition. This, too, is a long-term program to follow the effects of the fishery on the stocks and involves sampling of both landings and total catches at sea and age estimations by examination of otoliths. In 1953 sampling was carried out at Freeport, Whites Cove, Yarmouth, Lockeport, Lunenburg, Halifax, Canso, Queensport, Louisburg and North Sydney, N.S., Souris, P.E.I., Caraquet, Grand Anse and Maisonette, N.B., and Paspebiac, Grand River, Fox River and Grand Vallee, Quebec.

In the analysis of these data special attention has been given to the intensive year-round fishery of the relatively discrete stocks in the Lockeport area. Data on the cod stocks in this area show a close relationship between total landings and catch per effort, reduced abundance of large, old fish and a very high proportion of small immature fish, a growth rate seemingly in excess of mortality rate to an age of five years, high fishing mortality as shown by tagging (see below), increased abundance and catch during the war years and decreased abundance and catch since then - all indications of an intensive fishery in which less catching of small cod might increase landings. Data on haddock show, similarly, a close relationship between total landings and catch per effort, and growth rate exceeding total mortality rate to an age of five years but relatively high abundance and catch caused recently by good recruitment (Appendix 30).

Tagging cod and haddock to indicate proportion caught. In 1953 cod and haddock caught by hook and line in relatively low depths in the Lockeport, N.S., area were marked with a variety of tags in an attempt to develop tagging as an indication of the proportion caught ("fishing mortality"). Preliminary returns of tagged cod (18% to October 31 of fish tagged from May 27 to October 20) indicate that fishing is responsible for most of the total mortality; returns of tagged haddock were poor, apparently because of poor survival. Preliminary returns of

Petersen celluloid disk tags were somewhat better than those of Lea "hydrostatic" tags and much better than those of monel-metal strap tags. Further tests are being conducted in tanks at St. Andrews and tagging is planned in the southern Gulf of St. Lawrence in 1954 (Appendix 33).

Cod and haddock discarded at sea. A preliminary comparison of the sizes of haddock and cod in total catches and in commercial landings by line fishermen indicate that they discard considerable quantities at sea, dory fishermen discarding more small haddock than long-liners. Further sampling at sea in 1953 confirms the high proportions of haddock discarded by otter trawlers during the summer months (Appendix 31).

Selectivity by otter trawls with cod-ends of various meshes. The serious consideration by ICNAF of the need for a minimum mesh regulation in Sub-area 4 similar to that already instituted in Sub-area 5 creates an urgent need for better knowledge of the effects of various mesh sizes on the sizes of fish caught. In 1953 experiments were carried out on three trips by a commercial otter-trawler which supplemented the results obtained elsewhere by getting information on the selective action of cod-ends with various meshes on the species and populations in our waters. Experiments were carried out in which the sizes retained by various meshes were compared in cod-ends both with and without smaller-meshed covers. The results showed that the covers used in the experiment and the commercial "chafing gear" used to protect the nets both hinder the escape of small fish. The sizes of fish at which 50% are retained were determined for some larger meshes than had previously been tried. The results confirm the effectiveness of larger meshes in permitting the escape of more small fish. The saving of small fish and reduction in work which resulted have led many members of the industry to adopt larger-meshed cod-ends (6" between knot centres or about 4 1/2" inside measure instead of the 2 7/8" inside measure which had been common) (Appendix 32).

Our information is not yet good enough to determine the best size at which to start catching cod and haddock in Sub-area 4. It seems, however, that there is little risk in reducing the number of small fish brought aboard which are not used. It is planned in 1954 to conduct experiments with smaller draggers catching other species (especially flatfish) in the Gulf of St. Lawrence so that the effects of a minimum-mesh regulation on our growing small-dragger fishery can be assessed.

Flounder fishery of western Nova Scotia. The fishery with small draggers in St. Mary Bay, Annapolis Basin and Minas Basin, which resulted from explorations by the Station starting in 1947, has now apparently approached its maximum level. In 1953 about 35 small draggers took a total of about 800,000 lb. each of winter flounders and haddock and about 200,000 lb. of other species. These catches are lower than the peak reached in 1950 and 1951, but similar to those in 1952. Tagging, continued in 1953, indicates the existence of local stocks with fishing mortalities up to about 20% per year. Experiments have demonstrated that large-meshed cod-ends (up to about 5" inside measure) release small unmarketable flounders and other trash

without reducing the catch of flounders of marketable size (over 12" long by present trade practices). The selection of the most suitable mesh will depend on determination of the optimum size for first capture of flounders (on the basis of data now being obtained) and on the effect of increased mesh size on landings of other species (Appendix 35).

Tolerance of groundfish to high temperatures. To learn more of the natural factors influencing the abundance and movements of groundfish, as distinct from the effects of fishing, there is need for an experimental study of physical and chemical factors and correlation of the results with field observations. As a start in this direction tests to determine upper lethal temperatures for four species were started in 1953. When acclimated at 16°C. 50% of cod, of pollock (Gadus virens) and of plaice (Hippoglossoides platessoides) were killed in 48 hours by temperatures between 20 and 22°C. while about 27°C was necessary to kill smooth flounders (Liopsetta putnami), a species living close inshore. (Appendix 39). It is planned to make a more thorough study of lethal temperatures and other factors, and to extend work in this field to include, if possible, a study of preferences.

Cod-worms and seals

To overcome the infestation of cod fillets with the round-worm Porrocaecum decipiens remains one of the most serious and urgent problems of the Canadian Atlantic fishery. In 1953 further attempts were made to complete our knowledge of the life cycle of the worm, the possibility of controlling the seals in which the worm matures was further explored and various physical stimuli were tried as a means of inducing the worms to leave the fillets.

Life cycle of Porrocaecum decipiens. Earlier work had shown that the immature worms which occur in fish mature in seals which eat the fish, and had suggested that the eggs leave the seals, develop first in mysids (small crustacea) or other invertebrates and are transferred to the fish which eat these invertebrates. Attempts were made in 1953 to infect invertebrates by feeding or injecting them with eggs obtained from mature worms in freshly-killed seals or with infective larvae obtained by culturing these eggs in sea water. The only success was apparent slight growth of Porrocaecum larvae in the shrimp Crangon vulgaris. Further attempts to complete the life cycle are planned (Appendix 38).

Control by reduction of seals. The possibility of reducing the abundance of Porrocaecum by reducing the numbers of the seals in which the worm matures remains extremely doubtful. It still appears possible to reduce the numbers of Harbour Seals, which breed in accessible places; the bounty has apparently increased the kill of adults and this effect might be intensified (Appendix 73). Further information has been obtained on the reproduction of this species indicating that they mate in late June or early July shortly after the whelping in May or June (Appendix 74). The Grey Seals, which also

harbour the cod-worm, present a more serious problem. They bear their young in January and February in areas which are difficult of access and not yet well known (Appendix 75). Furthermore the role of the numerous Harp Seals, which may shed cod-worm eggs in the Gulf of St. Lawrence in winter and spring, is not at all clear.

Stimulating the worms to leave cod fillets. Candling fillets and picking out the worms by hand is expensive and the removal may not be complete especially when the fillets are thick. In 1953 physical and chemical means of stimulating the worms to leave the fillets were tried.

Dr. R. W. Wolfgang of the Institute of Parasitology, who has taken an active part in the Station's cod-worm investigations, found that the nematodes in the fillets were remarkably resistant to dielectric high-frequency transmission, high-voltage electrostatic transmission and ultrasonic irradiation. High temperatures were tried and emergence was fair at 30°C. and good at 40 to 47°C. but drying produced a coating of coagulated protein through which the worms could not pass.

The most promising results were obtained by placing the fillets in cold water of low salinity, a treatment suggested by the emergence of worms from fillets held overnight in iced salt water. In some experiments suggested by this observation emergence was complete but more work is needed before either the factors at work or the effects on quality will be well understood. The preliminary results are promising enough to warrant further careful study (Appendix 38).

Herring

The outstanding feature of herring investigations in 1953 was the continued success of exploratory fishing in the southern Gulf of St. Lawrence. The discovery that fat herring can be caught with drift-nets or special bottom trawls throughout the summer in this area has excited commercial interest. It is planned to concentrate efforts in 1954 to the areas off Nova Scotia where less extensive work has as yet failed to find herring in commercial quantities in the summer but where interest is keen.

Exploratory fishing in the Gulf of St. Lawrence. In 1953 the explorations for herring were expended, under the Department's Industrial Development Service vote, to include trawling with special bottom trawls of French and Dutch design as well as a continuation of drift-netting. Using a chartered 98-foot dragger, the "Marion Crouse", and the M.V. "Harengus" exploratory fishing was carried on in the south-western area of the Gulf from Gaspé to Cape Breton. Drift-net catches averaged 358 lb. per net (37 1/2 yards long and 360 meshes deep) - more than twice as large as average commercial catches in the North Sea. Trawl catches by the "Marion Crouse", after July 10, when the first large concentrations of herring were found, averaged about 2,400 lb. per 90-minute tow in spite of unfamiliarity with the ground. The best trawl catches were made along the Cape Breton shore from Port Hood to Margaree but good catches were also made near Pictou

Island, off East Point, P.E.I., and on Le Fond George about 20 miles south of the Magdalen Islands. Sonic-sounder records, especially in the Gaspé area, indicated schools which, it is believed, could be purse-seined with equipment suitable for use in open water (Appendix 40).

In 1954 it is planned only to test the ability of a 60-foot dragger, of the size now so common in the south-western Gulf, to trawl herring in the more promising areas discovered in 1953. The results to date have excited commercial interest and it is felt that herring explorations may now be concentrated elsewhere.

Exploratory fishing off Nova Scotia. Drift-netting in the summer of 1950 at a number of stations covering the Scotian Shelf failed to catch any herring as did a few sets in May, 1951. In the summer of 1952 deeper North-Sea nets were used in a limited area off western Nova Scotia but again without success. In 1953, under the Department's Industrial Development Service vote, a dragger, the "Point Pleasant II", was chartered for exploratory trawling on the banks from Georges to St. Pierre but took a total of only about 12,000 lb. of herring in 275 tows, the best catch being 1,500 lb. and only four catches over 1,000 lb. (Appendix 41).

These results contrast sharply with the success of similar operations in the south-western Gulf of St. Lawrence. The established Nova Scotia industry using herring for food and bait has, however, suffered failures of present inshore fishing to supply the demand. The explorations to date have been in the summer only and deep drift-nets have been used only in a limited area. With these considerations in mind more thorough exploration is planned in 1954 using the M. V. "Harengus" in drift-netting over a longer season.

Relation of catches to temperature, light and plankton. In the above explorations no relationship was found between temperatures and herring catches. Light, on the other hand, strongly influenced both drift-net and bottom-trawl catches. As in 1950 and 1952 the best drift-net catches were made on clear star-lit nights and the poorest with bright moonlight. Catches with bottom trawls were almost negligible at night, fishing being best in the day-time in depths of from 28 to 34 fathoms.

Although the good herring catches in the Gulf of St. Lawrence were generally associated with an abundance of the copepod Calanus, this form varied greatly in the grounds off Nova Scotia with no indication of correlation with the poor herring catches (Appendix 42).

Herring population studies. Sampling of commercial herring catches, as well as of those made in exploratory fishing, was continued in 1953 to follow changes in year-class strength, etc., in the several divisions of the stock which can be recognized from differences in length and age composition, growth rate and vertebral counts. Two new bodies of herring, of which we had no previous knowledge, were discovered in exploratory fishing in

the Gulf of St. Lawrence; small herring 6 to 8 inches long were also sampled for the first time in that area (Appendix 43).

In the Charlotte County, N.B., sardine fishery in 1953, the catches and the average size of the fish were abnormally small. The yearling herring, usually an important part of the catch, were missing but large catches were made of herring about 3 inches long now considered too small to can although they would have been used as "sardines" in former years. The "pepper-spot" disease was less evident than usual (Appendix 44).

Methods of catching herring. In the exploratory fishing in 1953 in the Gulf of St. Lawrence, the Swedish mid-water "Phantom" or "Larsson" trawls were used with only moderate success. In one tow 1,125 lb. of herring were taken but in seven others a total of only 75 lb. On two occasions, when large schools were indicated by sonic sounder, trawls were torn beyond repair, suggesting that this method might be very successful if trawls can be made strong enough to handle large catches but light enough to tow easily (Appendix 40).

The successful trawling for herring with special bottom trawls has been noted above. It is planned to test trawls of this type, but of a size suitable for use by small vessels, in the winter "sardine" herring fishery in the Bay of Fundy where earlier experiments stimulated the successful use of ordinary groundfish trawls with small-meshed cod-ends. It is also proposed to test other mid-water and bottom trawls of local design (Appendix 45).

During the explorations in 1953 in the Gulf of St. Lawrence sonic sounders were used to advantage to find herring schools at or near the bottom as well as up in the water (Appendix 42).

Smelt

The only phase of the Station's smelt investigations in the Miramichi area, N.B., which was continued actively in 1953 was the comparison of the abundance of larvae with the subsequent yield of the same year class to the commercial fishery. It is planned to make no further collections of larvae for this purpose, continuing only the sampling of the commercial catch to discover the yield from year classes already sampled as larvae. Plans for further work, if any, will depend on the results of thorough analysis of the very extensive data already on hand on the populations, movements and reproduction of smelt in the Miramichi area.

Factors influencing the production of smelt larvae.

Since experiments have shown that extreme crowding on spawning grounds may reduce not only the proportion but even the total number of the eggs which hatch successfully, it is natural that no correlation can be found between the size of the smelt run as indicated by the commercial catch, and the size of the year class resulting from its spawning, as indicated by sampling of larvae and of subsequent commercial catches (Appendix 47). It has been shown that removal of obstructions in the streams will

reduce crowding on the spawning grounds. Observations also indicate that heavy freshets may force smelt to spawn in quiet water at high levels along the shores of the larger streams, leaving the eggs exposed when the freshet recedes. A review of the records indicates that high production of larvae is favoured by low spring freshets as well as by freedom of the brooks from obstructions (Appendix 48).

Production of smelt larvae and the commercial catch.

Estimates of the relative numbers of smelt larvae produced in the Miramichi River have been made by systematic collections since 1948. For comparison with these the numbers of individuals and the poundages contributed by each year class to the commercial catch in the Miramichi area in each fishing season since that of 1948-49 have been computed on the basis of extensive samples and rather complete statistics. Year classes contribute to the fishery mainly at the end of their second, third and fourth years and information on the complete contribution of year classes since that of 1949 is not yet available. It is too soon, therefore, to have any indication of the degree of correlation between the relative abundance of larvae and the contribution of the year class to the catch (Appendix 49).

An analysis shows that there is a good deal of variation in the proportions of the contributions by various year classes that are made at various ages, some making their biggest contribution at two years of age and others at three. These variations apparently reflect the degree to which the stock enters the fishing area during the fishing season. They are likely to lessen the degree of correlation between larval abundance and total contribution to the catch (Appendix 50). It has also been found that the earliness or lateness of the spawning time (influenced by the time of the spring break-up) affects the size reached by the smelts at subsequent fishing seasons; the earlier the spawning season the larger the smelt at any given age. This, too, might influence their tendency to enter the fishery most strongly at two or at three years of age (Appendix 51) and affect the above correlation.

Trout

In 1953 progress was made in investigations on the Eastern Brook Trout (Salvelinus fontinalis) along the three principal lines already under way. The combination of fertilization, control of predators and planting of hatchery stock continued to give outstanding success in producing trout for anglers in an unpromising area. Experiments in the production of trout in fertile ponds emphasized the importance of parasites as well as predators in influencing the yield. The study of the effects of pond formation on the population of trout on a stream and their movements between and sea entered a new phase following the completion of the dam in October, 1952.

Fertilization and control of predators in natural lakes. Two lakes in Charlotte County, N.B., which had long shown a low yield of trout associated with low concentrations of nutrient salts were fertilized in 1946-1947 and again in 1951.

Predatory birds and mammals were controlled at Crecy Lake (50 acres; mean depth 8 feet) commencing in 1949 and steps to reduce the numbers of eels (the only predacious fish, other than trout) were started in 1950; no such controls were carried out on Gibson Lake (59 acres; mean depth 13 feet). In Crecy Lake the first fertilization caused increased growth of planted fingerling and yearling trout and somewhat better survival to the anglers' catches which, however, soon declined again as predators were attracted; the second fertilization associated with predator control produced excellent survival of both fingerlings and yearlings, planted in 1951 and in 1952. In 1953 it was found that 13% of the fingerlings and over 85% of the yearlings planted in 1952 reached the anglers' catches, and the yield reached 16.2 lb. per acre. Results were much poorer in Gibson Lake where fertilization was not accompanied by predator control (Appendix 57).

The combination of fertilization, predator control and the planting of hatchery stock achieved unusually good success in creating good angling in infertile waters. The results are being applied in pilot-plant operations by the Fish Culture Branch of the Department with the co-operation of the Station; combinations of removal of competitors and predators by poisoning with subsequent fertilization, planting of hatchery stock and predator control are being applied in Tedford Lake, N.S., and Cook Lake, N.B.

The bottom fauna of Crecy Lake has been sampled three times a year since 1945 and the effects of fertilization of the lake in 1946 and 1951 have been followed. In general fertilization stimulated increase in the bottom fauna although the effects on different forms differed widely (Appendix 58).

Control of eels in Crecy Lake has been attempted by trapping them in the lake and by preventing the entrance of young elvers. The trapping has apparently not reduced the numbers of eels greatly although 864 have been taken in four summers. It is too soon to judge the effectiveness of preventing the entrance of elvers by building a dam in 1951 which channels all of the outflowing water over a sluice and drops it about two feet (Appendix 59).

Production of trout in fertile ponds. In 1953 the yield of trout to anglers from a 23-acre pond at Montague, P.E.I., was recorded for the eleventh consecutive year. During this period the take by anglers varied between 2,400 and 4,700 trout and the yield per acre between 22 and 45 pounds. There is no evidence of the influence of one season's catch on that in the next season. Suggestions that the yield would be increased by raising the size limit from 6 to 8 inches and by permitting only fly-fishing are not supported by the facts that, with no evidence of over-fishing, 51% of the trout caught are less than 8 inches in length and 77% are caught with bait. Such restrictions would apparently merely lead to less effective cropping (Appendix 53).

Experiments were continued in three two- to three-acre ponds in Prince Edward Island to discover their maximum carrying capacities for trout of angling size and how these maxima can be reached. Varying densities of yearling trout have been planted and their survival and growth over one season determined by draining the ponds. Results have been very varied, being influenced by predation and parasitism. The net production of trout over one season has varied from 0 to over 50 lb. per acre, and the survival from 40 to 95%. The results suggest that more complete control is needed if maximum production is to be assured (Appendix 54).

Populations and movements of trout in a Prince Edward Island stream. Because the formation of ponds on Prince Edward Island streams has appeared to provide good angling and because, consequently, many ponds are being built or re-built a program of observations and experiments was started on Ellerslie Brook to discover the effects of pond formation on the movements of trout between stream and sea and on the trout population as a whole. Since 1946 movements of trout between stream and sea have been observed by operating a two-way trap near the head of tide and since 1950 a two-way trap has also been operated immediately above the head of the 7-acre pond which was restored in 1952 by re-building an old dam near the head of tide.

The results to date indicate that the pond retains trout, acting somewhat as the estuary did before. Since the formation of the pond many times as many trout have entered it from above than have passed on into the estuary. In 1953 about 90% of the angling catch was made in the pond and population estimates in the brook above the pond show fewer trout of angling size, suggesting that more of the larger trout have moved to the pond than formerly moved to the estuary. It is, of course, too soon to assess the effects on the population as a whole. It is planned to transfer all trout entering the trap from the estuary into the pond for at least two years after which they will be barred (Appendix 55).

Population estimates of trout and salmon in Ellerslie Brook and in its small tributary, Hayes Brook, have been made since 1948 and 1947 respectively. Especially in the latter, which is about three feet wide, the numbers of older trout (mainly yearlings) have remained relatively constant although there have been wide variations from year to year in the number of fingerlings. This suggests that there is a relatively constant capacity to carry older trout and that it is fully used regardless of the production of fingerlings. The conditions are believed to be typical of small brooks in Prince Edward Island and suggest the futility of planting fingerlings as a means of increasing the production of older trout (Appendix 56).

Salmon

In 1953 progress was made in the many phases of a research program on Atlantic salmon which has been intensified, in co-operation with other branches of the Federal fisheries service and with the Quebec Department of Fisheries as a result

of a special meeting of Federal and Provincial representatives in the summer of 1952. In the following summary of the Station's salmon investigations in 1953 those items concerned with the development of means of increasing the production of smolts are presented first; these are followed by studies of the migrations of salmon and of their utilization by the commercial and sports fisheries, which have a bearing mainly on development of sound administration.

Planting of hatchery-produced fingerlings in varied densities. In 1953 an experiment in the Pollett River, N.B., to assess the value of giving fingerlings wide dispersal at planting was completed. In 1950, 1951 and 1952 4,000 fingerlings were distributed in each of three separate sections of the river, at rates of 5, 50 and 500 per yard of stream length, each section receiving each degree of dispersal at some time during the three-year period. The smolts, differently marked in each section, were counted as they passed a fence farther down stream as 2-year-olds and 3-year-olds, the last smolts from the experiment migrating in 1953. The experimental sections were relatively free from eels and merganser broods were removed. The over-all survival from fingerlings to smolts was unusually good (30%); the degree of dispersal had no effects (Appendix 61).

In an 11-mile stretch of the Pollett River between an impassable dam and an impassable fall various numbers of fingerlings (from 16,000 to 250,000) yielded a maximum of only 4,000 smolts and an average of only 2,500 when unprotected from bird predation. Attention was diverted to a test of the value of bird control which was shown to increase smolt production many times in this area. An experiment to discover the optimum number of fingerlings to plant has been resumed with the predatory birds controlled. In 1950, 1952 and 1953 plantings of 246,000, 925,000 and 65,000 respectively have been made and the results are being assessed by estimating the abundance of parr by seining and electro-fishing and by counting the migrating smolts. Preliminary results indicate that the parr produced from the largest planting were not much more numerous than those from the medium planting. A full comparison of the results of these three plantings will not be possible until 1956 when the 3-year-old smolts from the 1953 planting are counted (Appendix 61).

Smolt production from natural spawning of various densities. Although many restrictions on salmon fishing are intended to assure that enough adults survive and spawn to make full use of the capacity of streams to produce smolts, there is little information on how many parent salmon are needed. An experiment was started in 1953 in which parr and smolt production from known and varied numbers of parents will be determined. The first run of parent salmon was counted through the fishway over the dam at the lower end of the 11-mile experimental section of the Pollett River. The production of smolts from these salmon will not be known until 1957.

Control of predatory birds to increase smolt production. The removal of fish-eating birds, especially mergansers, from the experimental stretch of the Pollett River resulted in a ninefold

increase in smolt production from plantings of hatchery fingerlings and control of predatory birds is the most promising means of increasing salmon production which is emerging from the Station's investigations.

In the Miramichi area the effectiveness of bird control is being tested as a practical procedure under conditions making control somewhat more difficult and less complete than in the Pollett River experiments. In co-operation with the Canadian Wildlife Service and the Conservation and Development Service of the Department of Fisheries mergansers have been controlled since 1950 on the Northwest Miramichi but not on the Dungarvon River (another Miramichi tributary) and changes in parr and smolt production in the two streams have been compared. Results to date indicate that the merganser control has increased the production of large parr, and probably of smolts, about two to four times (Appendix 62). This confirms the view that bird control is a promising means of increasing smolt production from natural as well as from hatchery-produced stock.

On the St. Mary River, N.S., experimental bird control was started in 1953 by the Conservation and Development Service, with guidance from the Station. In this instance an attempt is being made to carry out the control economically and results will be judged mainly from the production of adult salmon, for which relatively good records are available in this area. The technique of bird control was demonstrated (Appendix 64) to those who will carry it out, with special attention to taking advantage of the birds' habits when driving the river to remove broods. Results of seining in 1952 and 1953 suggest that the control has already had some effect in increasing the abundance of parr (Appendix 65).

Study of the food and habits of mergansers has continued in preparation for a general account of their natural history and effects on fish production (Appendix 66).

Do salmon inherit a tendency to run early or late?

The usefulness of planting offspring of late-run salmon in streams where early-run fish are desired by anglers has been doubted, and the question of whether or not the tendency is inherited has a bearing on attempts to protect early-run stocks by regulation. Supposedly early-run Restigouche River stock when planted in Apple River behaved like the latter's late-run stock but the identity of the planted stock was not well established. A new experiment was, therefore, started in 1953 by the Fish Culture Branch in co-operation with the International Paper Company and the Station. Only early-run fish were allowed to enter Rocky Brook, a branch of the Southwest Miramichi and their eggs will be hatched and reared in the hatchery at River Philip, N.S. The resulting fingerlings will be marked and planted in that river which has a very late run. Their time of return as adults will be compared with that of native River Philip stock (Appendix 66).

Annual production of smolts by the Miramichi River. In the Pollett River, N.B., for some years and in the Port Daniel River, P.Q., starting in 1953 smolt runs are being counted. In the Miramichi River, too large to fence completely near its mouth,

smolt runs have been estimated in 1952 and 1953 by marking smolts on two tributaries and catching smolts in the estuary to determine what proportion of the smolts are marked. In 1953 25,218 smolts were marked in the Northwest Miramichi and 19,966 in the Dungarvon; of 17,615 smolts caught in the estuary 989 were marked, about the same proportions of the marked smolts from the two tributaries being recaptured there. The total smolt production of the river is calculated at 805,000 with a standard deviation of about 25,000. In 1952 a similar estimate, but based on the recapture of only 77 marked smolts was 1,650,000 (Appendix 67).

Movements of salmon as indicated by recaptures of marked smolts. In the years 1950 to 1953 about 103,088 smolts have been marked on two branches of the Miramichi River (67,442 on the Northwest Miramichi and 35,646 on the Dungarvon) and 68,313 on the Pollett River. In 1953 the Quebec Department of Fisheries, in co-operation with the Station, marked 4,063 on the Port Daniel River. It is hoped to expand the program to include a river in Newfoundland and possibly others. In 1953 an intensive search for marked fish was made by examining large samples of the commercial catch, by observing salmon caught in research programs, by enlisting the aid of fishery officers and by enquiries at angling camps.

The returns indicate the contribution of the various rivers to various sports and sea fisheries. Miramichi marked smolts, for example, were caught in 1953 by commercial fishing in Newfoundland in considerable numbers (201) as well as by the Miramichi drift-nets (183), shore nets (238) and anglers (48) and by shore nets in Baie Chaleur (9). Similarly marked smolts from the Pollett River were reported from Newfoundland (79), the Miramichi area (31) and Saint John Harbour (5). The recaptures of marked smolts in traps operated for salmon research indicate a strong degree of homing, the marked fish being recaptured almost exclusively at the traps at which they were marked.

The continuation and extension of this program will give information on the contribution made by various rivers to the different commercial and sports fisheries and on mortalities between the smolt stage and capture as grilse or older salmon (Appendix 67).

Salmon runs and the factors affecting them. In the Miramichi area the passage of salmon through counting fences on the Northwest Miramichi and Dungarvon Rivers has been observed since 1950. There is in general remarkable similarity year after year in the counts at the same trap for any particular month. Runs of grilse in the summer of 1953 were higher than in 1952, indicating that a change in fishing regulations, to permit commercial capture of grilse down to 3 lb. instead of 5 lb. did not reduce the supply of grilse for the angler. Day-by-day catches are strikingly correlated with water levels.

In 1952 and 1953 special small-meshed trap nets were operated in the Miramichi estuary from early summer to late autumn so that samples of salmon passing through the estuary can be examined and recorded. It is planned to operate such nets throughout the open-water season. The catches in 1952 and 1953

did not confirm the popular belief that lifting of drift-nets in the outer bay is reflected immediately in greater abundance of salmon in the estuary. Records of daily catches in the Miramichi drift-net fishery itself show that they reached a maximum in 1953 about June 23 and fell off markedly by July 10 when the season is closed for a fortnight; resumption of fishing in the second open period led to very small catches indeed. Neither the reasons for the concentration of these fish off the Miramichi in June nor their subsequent fate is at all clear (Appendix 68).

Factors affecting salmon angling success. The great concern of salmon anglers over the number of fish available to the sportsman (which, in fact, stimulated the recent expansion of the salmon program by Board and Department) and the apparently greater value of salmon to the community when angled than when caught commercially, make it important to examine the problems of the angling itself. A start has been made in an examination of detailed records of angling efforts and catches for evidence on the various factors affecting angling success. It is clear that there are great differences between the results of angling in various areas, even in the same river system. It is also clear that the skill of the angler and the methods he uses are important. In some areas, at least, it appears that methods other than the fly-fishing, which alone is now legal in Canada, would lead to better use of the salmon for sport (Appendix 69).

Recapture of salmon tagged as kelts. Data on the 722 salmon recaptured as a result of the tagging of 18,498 kelts by the Fish Culture Branch from 1913 to 1944 were analysed in 1953. Most of the recaptures, outside of the areas where the kelts were tagged, were made by the commercial sea fishery in Newfoundland. The recaptures are distributed in a manner consistent with the distribution of the recaptures of marked smolts from the same areas; for any one area fish tagged as kelts and marked as smolts showed much the same pattern of movement (Appendix 70).

Growth and migration of Pollett River salmon. Search for young salmon taken in weirs for salmon and herring in the vicinity of Halls Harbour, N.S., in the years 1951 to 1953 revealed 236 marked as smolts in the Pollett River and 55 in Maine rivers. These "post smolts" with 2 1/2 months in the sea had reached an average length of 11.7 inches, as compared with averages of 6.3 inches for Pollett River smolts and 25 inches for salmon re-entering the Pollett after 1 1/2 years in the sea.

Only a very small proportion of the smolts marked in the Pollett return to the experimental section although many have been recaptured elsewhere. The marked smolts are all from fingerlings introduced from other areas and Mr. H. C. White is arranging for the planting of fingerlings from eggs taken from salmon caught when entering the experimental area to discover whether a higher proportion of these native fish will return (Appendices 71 and 72).

Harp seals

The population estimates, which were made in 1950 and 1951 by photographing the whelping concentrations from the air, were not repeated in 1953 but knowledge of the biology of the harp seals, on which to base assessment of the need for restricting the kill, was greatly improved. Further samples and field observations were obtained, more seals were tagged and analysis of the material was carried farther.

Age estimation based on rings in teeth. Examination of sections of teeth taken from seals at various seasons has given further evidence of the validity of the rings in the dentine as an indication of age. The annuli of dense dentine are apparently laid down between the moult in the spring and the southward migration in the autumn - a period spent in the Arctic during which the seals are reported to be thin.

The technique of preparing sections of teeth for this purpose has been developed to the stage where a section can be made in a minute. It is now possible to apply the method on a large scale (Appendix 76).

Moulting and northward migration. During the latter part of the 1953 sealing season, in late March and April, direct observations were made on the moulting gatherings or "patches" of seals and on the early stages of the northward migration. Shortly after mating in late April or early March the seals gather in groups on the ice starting with adult males which are later joined by females and immatures. These groups, which are sometimes of immense size, form progressively farther north as the season progresses, the main concentrations moving in 1953 from between Cape Bonavista and the Funks at the end of March to off Bulldog Island, Labrador, by the end of April.

Age-composition of the kill by vessels in 1953. In 1953 there was a high proportion of one-year-olds which were scarce in 1952 (perhaps because of the very high kill in 1951). In 1895-1911 only 8% of the seals killed were one year old or older, the remainder being pups. The proportion of these older seals rose to 16% in 1912-1940, and 35% in 1946-1953, the kill of pups remaining high. In 1953 the kill was 157,000 pups and 62,000 older seals. The heavy kill of the older seals since the war is a cause for concern as they are less valuable than the pups and it takes a number of pups (perhaps four or more) to produce one adult. It seems desirable to consider protection of the older seals by some such measure as prohibition of hunting after April 15 (Appendix 77).

Reproduction and sexual maturity. Determination of the age at first maturity of larger numbers of females indicates that the seals mature on the whole somewhat later than previously reported. The age and reproductive condition were determined for 86 specimens collected in 1953. These seals had ovulated for the first time at ages varying from 3 to 8 years with 5 and 6 years being the most common.

Examination of reproductive tracts of females indicates that the mating season begins about two weeks after the peak of the pupping which was at March 10 to 12 in 1953 (Appendix 78).

Birth, growth and pelage of pups in 1953. In 1953 whelping east of Newfoundland appeared to commence on March 4 and continue to March 14. Pups, apparently only one day old, weighed 22 lb. on March 5. Weight of individuals increased rapidly, the average apparently reaching a peak of over 70 lb. about March 20 to 25 when weaning occurred after which the average decreased for a fortnight (to about 60 lb. on April 12) until feeding became active. Loosening of hair commenced about March 15 and moulting was complete by the end of the month (Appendix 79).

Feeding. Of 242 stomachs examined between March 10 and April 22 the majority were empty; three adults (March 14) contained fair quantities of shrimp and a few small bottom fish; six immatures on April 22 were filled with small decapods; 6 pups of the year on April 1 contained small quantities of amphipods and one on April 20 was filled with small decapods. Of the stomachs of 105 northward migrants collected late in June in the Strait of Belle Isle only 14 contained food (small quantities of herring, shrimp or squid).

Age and pelage pattern. A review of the pelage pattern of seals of known age indicates that the change from the spotted coat of the "bedlamer" to the black saddle and face mask of the adult male takes place quite abruptly at the end of the fourth year, although maturity is not usually reached until two years later. In females the change to black saddle and mask is more gradual and somewhat later and may not occur at all in some individuals. Many females with "bedlamer" markings are mature and bear young. As the commercial categories of "young" (pups), "bedlamers" (immatures) and "old" (adults) are based on pelage patterns it seems that part of the catch listed as "bedlamers" is composed of sexually mature females (Appendix 81).

Mechanics of fishing with towed gear

There have recently been rapid changes in fishing methods and equipment used in the Canadian Atlantic fishery. Many small craft have been converted to dragging of various sorts; others have been built for the purpose. Lack of knowledge has led to much waste effort and expenditure. To lay the basis for sound development a study was started in 1953 of the tensions required to pull various types of gear at various speeds and of the performance of small vessels of various size, power and design in delivering these pulls. Progress was made in both phases.

The pulls measured in towing warps varied from less than 500 lb. (total for both warps) for small flounder drags to almost 9,000 lb. for an "Iceland" trawl (commonly used by larger Nova Scotian trawlers). The area and weight of the otter-boards or "doors" seem to have a marked effect on the tension, suggesting the importance of selecting doors big enough to spread the net

but no bigger. Some basis is already being laid for selecting the appropriate gear for boats of known towing ability.

The problems of performance of small vessels are, of course, very complex but progress is being made towards assessing their ability to handle gear. It seems that fuel consumption of engines of different make doing the same job can differ so greatly as to constitute a major factor in determining profits.

It is planned to continue this study and develop it in a number of directions. An attempt will be made to devise an easy test of dragging ability. The effects of various factors (e.g. ratio of warp-length to depth, door size and weight, various riggings and designs of nets, etc.) on towing tensions will be studied. It is hoped eventually to test experimentally the effects of various factors (especially towing speed) on the efficiency of various types of gear (Appendix 84).

New or Unusual Records of Occurrence

Again in 1953 a number of new forms were reported in the Maritime Province area including some new visitors from the south, such as the White Shark (Carcharodon carcharias) and the Tarpon (Tarpon atlanticus) and some little-known forms from deep water.

Hydrography

The hydrographic investigations of the Atlantic Oceanographic Group, with headquarters at the Station, continued to lay the basis for a better understanding of the natural factors causing changes in the abundance and movements of the species with which we are concerned. The work of the Group is presented in the report of the Joint Committee on Oceanography part of which, including a general summary, is attached as Appendix 86.

The long-term program of quarterly cruises, making representative hydrographic sections in the Bay of Fundy, Scotian Shelf area and Gulf of St. Lawrence, remains the most important item in the program of the Group. Year by year a better picture is being obtained of the hydrographic conditions and how they vary. As it proceeds and is related to other investigations this work gathers importance.

It is not possible to present the results of the hydrographic work in detail but some developments might be mentioned. The general upward trend in water temperatures in the past 13 years has been followed closely. There is no definite indication yet of any change in this as a long-term trend, although minor fluctuations occur. The trend has been associated not only with the appearance in our waters of more southern forms (e.g. Green Crab and White Shark) but also with changes in distribution and abundance of important groundfish species. This study is based largely on regular frequent observations at coastal stations, at one of which (St. Andrews) they have been continuous for thirty years. The same trend is, however, in evidence elsewhere as indicated by finding maximum

bottom temperatures on the Scotian Shelf as much as 2°C. higher than those recorded in pre-war years.

A better appreciation has been obtained of the rapidity with which major changes can occur. In November, 1952, for example, a large-scale replacement of Bay of Fundy waters took place in three weeks. Bottom temperatures on banks on the Scotian Shelf can change several degrees in a few days and such changes are reflected in catches of groundfish.

An important study has been made of the "slope water" lying between the coastal waters of the Scotian Shelf area and the Gulf Stream. Incursions of this water are responsible for the sudden changes, noted above, in conditions on the banks. Its rather sharp boundaries may have an important effect on concentrations of pelagic fish such as herring. Such studies form the background for explorations for new fisheries.

CO-OPERATION WITH OTHER BODIES

In addition to very close co-operation with other branches of the Federal fisheries service in many fields (herring and scallop explorations, development of regulations for lobster and other fisheries, salmon investigations, oyster culture, etc., etc.), the Station has worked closely with a number of other bodies.

International Commission for the Northwest Atlantic Fisheries. The Station gave the Commission space and facilities until it moved to more permanent quarters at Halifax, N.S., in the late summer. The Station's groundfish investigations have been planned to satisfy the Commission's needs. Station personnel, especially Dr. Martin and the Director, have taken a very active part in the work of the Commission, especially through its working committees. Drs. Martin and Hachey attended meetings of committees at Copenhagen in October.

Provincial Government Departments. The Station has worked closely with Provincial bodies in a number of instances. Important examples are the part played by the Quebec Department of Fisheries in the salmon research program for which the Station has major responsibility and co-operation between that department and the Atlantic Oceanographic Group in hydrographic investigations in the Gulf of St. Lawrence. There are, however, numerous examples of exchange of information and active co-operation which benefit both the work and its application.

Public Health. Although active investigations by the Station in the field of the public health control of shellfish were only on a minor scale in 1953, the Station continues to act in an advisory capacity to an important degree. In 1953 the local aspects of administration of the controls concerned with protecting the public from paralytic shellfish poisoning were finally taken over completely from the Station by the Fish Inspection Laboratory. The Station co-operated with that Laboratory in pilot-plant trials of commercial cleansing of clams.

Prince Edward Island Fisheries Development Committee.

The Director continued to represent the Dominion Government on this Committee, and the Station assisted in bringing together information for its use.

ASSISTANCE TO OTHER SCIENTISTS

Dr. Arthur G. Humes of Boston University was provided with desk space and collecting equipment while a guest investigator interested in parasitic copepods of invertebrates, from July 27 to August 12.

Mr. E. Bousfield of the National Museum of Canada was provided with plankton material in connection with his research on the barnacle.

Mr. Derry Ellis, graduate student of McGill University, spent some time at the Station during late spring becoming familiar with the littoral fauna and collecting-gear as a background for work in the Arctic during the summer months under a grant from the Arctic Institute.

Tunicates were supplied to Dr. J. Kelvin Hamilton, Department of Agricultural Biochemistry, University of Minnesota, for work on paper chromatography of extracts.

Salmon fry, which were sampled and preserved at different stages of development, were supplied to Dr. V. D. Vladykov by Mr. H. C. White throughout the late winter and spring.

About twenty pounds of fresh herring testes were supplied to Professor F. J. Toole of the Department of Chemistry of the University of New Brunswick for the extraction of clupeine picrate.

Two large halibut heads were preserved and sent to Dr. Grace E. Pickford, Bingham Oceanographic Laboratory, for research on the pituitary gland.

Specimens of fresh marine algae of different species were provided for a Botanical Conversazione at the University of Toronto.

Shipments of sea water in carboy lots have been made regularly to the Biology Departments of Queen's, Toronto, and McGill Universities.

Field trials were conducted on behalf of the National Research Council on a recently developed semi-diesel engine for small fishing boats at Chatham, N.B., during the summer.

Specimens of lobsters, which had growths of, at least, three species of marine algae on their carapace, were shipped to Miss Constance MacFarlane, algologist with the Nova Scotia Research Foundation.

Many specimens of the littoral flora and fauna at the Station were shipped to McGill University for display at an "Open House".

Table space and opportunities for collecting bottom organisms were provided from June 11 to July 24 to Miss Anne Cockeram, assistant to Dr. V. Englebert, who is conducting research on the evolution of tissues.

PERSONNEL

The personnel of the Station to December 1 and organization as of September 1 are presented in the appended statements.

Dr. J. C. Medcof, on April 19, 1953, commenced a year's leave of absence to take part in fisheries work in Ceylon under the Colombo Plan. Dr. L. M. Dickie, returned to the Station as a full-time employee on April 19 to take charge of clam and scallop investigations during Dr. Medcof's absence.

Educational leave with half pay was granted to D. W. McLeese from October 13, 1952, to May 1, 1953, at the University of Toronto, to H. D. Fisher from October 20, 1952, to February 23, 1953, at McGill University and to R. R. Logie from September 25, 1953, to May, 1954, at Rutgers University.

MAJOR CHANGES IN PHYSICAL PLANT

The old salt-water reservoir, now beyond repair, was replaced with a concrete reservoir 25' x 32' x 5'. On this foundation, and acting as a cover for the reservoir, a building for storage of fishing gear was built at moderate additional expense.

A 50-foot tunnel-stern dragger of a type designed by Walter McInnis for the P.E.I. Fishermen's Loan Board was purchased from that body to replace the M. B. "Pandalus" a former R.C.A.F. Harbour Craft now declared surplus.

Cumbersome concrete tanks, supplied with salt water, in the basement of the main building were replaced with more flexible wooden tanks giving more space for experimental work. Cold rooms, refrigerated by ice and salt, and accessible only by trap-door from the top, were altered to permit entrance by door and were provided with mechanical refrigeration. These two items improve the facilities for experimental work considerably.

ACKNOWLEDGMENTS

The members of the staff of the Station are grateful for the continued co-operation of industry, of universities and of agencies of both Federal and Provincial governments, and especially that of other branches of the Dominion fisheries service. They wish also to thank the scientists in other countries from whom they have received assistance.

ORGANIZATION

(as of September 1, 1953, except that all seasonals are included)

Director

Scientific Assistant to Director

A. W. H. Needler, Ph.D.
L. R. Day, M.A.

A. Scientific and Investigational Staff

1. Lobster

Sen. Scientist in charge
Assist. Scientist
Technician II
Technician I
Assist. Tech. III
Student Assistant - Seasonal

D. G. Wilder, Ph.D.
D. W. McLeese, M.Sc.
R. C. Murray
L. G. Kervin
U. J. Walsh
Marjorie A. Myers, B.Sc.

2. Oyster

Assoc. Scientist in charge
(also in charge of Prince
Edward Island Biological
Station)
Technician I
Maintenance Supervisor II
Student Assistant - Seasonal
Student Assistant - Seasonal

R. R. Logie, M.A.
S. E. Vass, B.Sc.
P. C. MacCaul
Joan E. Mortimer
F. E. Warburton

3. Clam and Scallop

Assist. Scientist in charge
Technician II
Assist. Tech. II
Assoc. Scientist - Term
Student Assistant - Seasonal

L. M. Dickie, Ph.D.
J. S. MacPhail
Esther I. Lord
L. P. Chiasson, Ph.D.
W. L. Klawe, B.A.

4. Groundfish

Sen. Scientist in charge
Assoc. Scientist
Technician II
Technician II
Technician I
Technician I (Capt.)
Assist. Tech. III
Assist. Tech. III
Assist. Tech. II
Stenographer IIB
Stenographer IIA
Assist. Scientist - Term
Student Assistant - Seasonal
Student Assistant - Seasonal
Student Assistant - Seasonal
Student Assistant - Seasonal

W. R. Martin, Ph.D.
F. D. McCracken, M.A.
G. J. W. Sullivan
D. N. Fitzgerald
M. F. Fraser
C. J. Bayers
R. M. MacPherson
A. C. Kohler, B.A.
Jean M. Stuart, B.Sc.
Shirley B. Cunningham
Catherine A. Morrison
D. M. Scott, Ph.D.
C. J. McFarland
L. H. Roberts, B.Sc.
D. H. Steele
H. G. Baer, B.Sc.

5. Herring

Assoc. Scientist in charge
Assist.-Tech. III
Assist. Tech. I

S. N. Tibbo, M.A.
E. G. Sollows
Phyllis J. Gibson

6. Smelt
Assoc. Scientist in charge
Technician I
Assist. Tech. II
R. A. McKenzie, M.A.
I. M. Jones
Evelyn R. MacMillan
7. Trout
Sen. Scientist in charge
Assist. Scientist
Assist. Tech. III
Assist. Tech. II
Assist. Tech. II
Student Assistant - Seasonal
1 Labourer - Prevailing Rates
M. W. Smith, Ph.D.
J. W. Saunders, M.Sc.
C. R. Hayes
C. Williams
Lorna M. Guiou, B.A.
J. D. Levine, B.Sc.
8. Salmon
Sen. Scientist in charge
Assoc. Scientist
Assoc. Scientist
Assist. Tech. III
Assist. Tech. III
Assist. Tech. III
Stenographer IIA
Assist. Tech. III - Term
Assist. Tech. III - Term
Student Assistant - Seasonal
Student Assistant - Seasonal
Student Assistant - Seasonal
3 Labourers - Prevailing Rates
3 Netmen - Prevailing Rates
C. J. Kerswill, Ph.D.
P. F. Elson, Ph.D.
H. C. White, B.A.
R. J. Wiley, B.Sc.
H. W. Coates
P. R. Graves
Hazel L. Grant
G. W. Cooper
W. S. Curtis
J. K. Lowther
W. S. Huestis
R. E. Lemon
9. Seals
Assoc. Scientist in charge
Technician I
Student Assistant - Seasonal
H. D. Fisher, M.A.
B. A. Mackenzie, B.Sc.
Mona H. M. Blair, B.A.
10. Fish taxonomy and distribution
Senior Scientist
A. H. Leim, Ph.D.
11. Eel-grass
Assist. Scientist - Term
A. R. A. Taylor, B.A.
12. Miscellaneous (including Tuna, Museum,
Library, Photography and Drafting)
Assoc. Scientist
Assist. Tech. II
Clerk IIB
Student Assistant - Seasonal
L. R. Day, M.A.
P. W. G. McMullon
M. Beryl Stinson
Lucy J. Connell
13. Hydrography
Assoc. Scientist
(see also Atlantic Oceanographic Group below)
L. M. Lauzier, D.Sc.
14. Engineer
Assist. Scientist
C. E. Petite, B.Sc.
15. General Laboratory Assistance
Assist. Tech. I
Mary Holmes

B. Administration and Maintenance Staff

1. Director's Secretary and Office

Stenographer III
Stenographer IIA
Stenographer IIA
Stenographer I

Winifred E. Dougherty
Lois G. McMullon
C. Ruth Garnett
Joan K. MacNichol

2. Accounts, Stores and General

Administrative Officer II
Clerk III
Stenographer I

J. A. Rogers, A.C.B.A.
Frances L. Stinson
Marjorie H. Ruddock

3. Buildings, Grounds and Boats

Technician II
Main. Super. I
Assist. Tech. III
Main. Helper
Caretaker IV
Caretaker III (Groundsman)
Caretaker III
Caretaker III (Watchman)
3 Carpenters - Prevailing Rates
1 Labourer - Prevailing Rates

H. Y. Brownrigg
F. E. Purton
W. G. Carson
R. A. Greenlaw
K. W. Johnston
D. A. Stinson
C. S. Tucker
H. E. Lee

"J. J. Cowie"

Technician II (Capt.)
Engineer
3 additional crew

H. H. Butler
B. W. Hart

"Mallotus"

Technician I (Capt.)
Engineer
1 additional crew

R. H. McDonald
F. G. MacIntosh

"Gulf Explorer"

Assist. Tech. III (Capt.)
2 additional crew (one for short period only)

L. I. Cross

Atlantic Oceanographic Group
(responsible to Joint Committee on Oceanography)

Principal Scientist (Chief Oceanographer JCO
and Oceanographer-in-Charge AOG)

Assoc. Scientist
Assist. Scientist
Assist. Tech. III
Assist. Tech. II
Assist. Tech. II
Assist. Tech. II
Stenographer IIB
Assist. Scientist - Term

H. B. Hachey, M.Sc.
H. J. McLellan, M.Sc.
W. B. Bailey, B.Sc.
J. A. Sullivan, B.A.
J. H. Hull
G. B. Taylor
C. C. Cunningham
Madelyn M. Irwin
D. G. MacGregor, M.A.

Employees under Industrial Development Vote (Herring Explorations)

Technician II - Term
Assist. Tech. II - Term
Assist. Tech. II - Term

L. Vanderzwan
M. Daneau
G. M. Greek, B.A.

STAFF

(To December 1, 1953)

(Total full-time staff as of December 1 numbered 83, including 8 AOG,
12 positions being vacant at that season)
(Staff other than seasonals classified as of December 1)

A. W. H. Needler, O.B.E., M.A., Ph.D., F.R.S.C.	Director
A. H. Leim, B.A., Ph.D.	Senior Scientist
D. G. Wilder, M.A., Ph.D.	Senior Scientist
M. W. Smith, M.A., Ph.D.	Senior Scientist
J. C. Medcof, M.A., Ph.D.	Senior Scientist (on leave of absence from April 19)
C. J. Kerswill, M.A., Ph.D.	Senior Scientist
W. R. Martin, M.A., Ph.D.	Senior Scientist
P. F. Elson, M.A., Ph.D.	Associate Scientist
S. N. Tibbo, M.A.	Associate Scientist
L. M. Lauzier, M.Sc., D.Sc.	Associate Scientist
R. R. Logie, M.A.	Associate Scientist (on educational leave from Sept. 26)
R. A. McKenzie, M.A.	Associate Scientist
H. C. White, B.A.	Associate Scientist
L. R. Day, M.A.	Associate Scientist
H. D. Fisher, M.A.	Associate Scientist (on educational leave to Dec. 24, 1952, and from Jan. 15, 1953, to Feb. 15, 1953)
F. D. McCracken, M.A.	Associate Scientist
J. W. Saunders, M.Sc.	Assistant Scientist
C. E. Petite, B.Sc., B.E.	Assistant Scientist
L. M. Dickie, M.Sc., Ph.D.	Assistant Scientist (on educational leave from Jan. 15 to April 15)
D. W. McLeese, M.Sc.	Assistant Scientist (on educational leave to Dec. 24, 1952, and from March 1, 1953, to May 1, 1953)

Seasonal and Term

L. P. Chiasson, Ph.D.	Associate Scientist (June 16 - Sept. 28)
D. M. Scott, Ph.D.	Assistant Scientist (June 29 - July 31)
A. R. A. Taylor, B.A.	Assistant Scientist (May 26 - Sept. 23)
L. Vanderzwan	Technician II (from May 12)
G. W. Cooper	Assist. Tech. III (April 8 - Nov. 30)
W. S. Curtis	Assist. Tech. III (April 17 - Nov. 20)
M. Daneau	Assist. Tech. II (May 25 - Sept. 15)
G. M. Greek, B.A.	Assist. Tech. II (June 4 - Sept. 21)
H. G. Baer, B.Sc.	Student Assistant (May 4 - Sept. 16)
Mona H. M. Blair, B.A.	Student Assistant (June 20 - Sept. 15)
Lucy J. Connell	Student Assistant (June 1 - Sept. 12)
W. S. Huestis	Student Assistant (May 22 - Aug. 29)
W. L. Klawe, B.A.	Student Assistant (May 8 - Sept. 22)
R. E. Lemon	Student Assistant (May 15 - Aug. 22)
J. D. Levine, B.Sc.	Student Assistant (May 15 - Sept. 14)
J. K. Lowther	Student Assistant (May 8 - Sept. 6)
C. J. McFarland	Student Assistant (May 19 - Sept. 19)
Joan E. Mortimer	Student Assistant (June 3 - Sept. 10)
Marjorie A. Myers	Student Assistant (May 19 - Aug. 31)
L. H. Roberts, B.Sc.	Student Assistant (April 28 - Nov. 30)
D. H. Steele	Student Assistant (May 13 - Sept. 15)
F. E. Warburton	Student Assistant (May 14 - Sept. 21)

Verna Z. Smith, M.A.

Volunteer Investigator

P. C. MacCaul
F. E. Purton
R. A. Greenlaw
K. W. Johnston
D. A. Stinson
C. S. Tucker
H. E. Lee

Maintenance Supervisor II
Maintenance Supervisor I
Maintenance Helper
Caretaker IV
Caretaker III (Groundsman)
Caretaker III
Caretaker III (Watchman)

J. A. Rogers
Nina M. Parker
Winifred E. Dougherty
Frances L. Stinson
Catherine A. Morrison
Shirley B. Cunningham
M. Beryl Stinson
Lois G. McMullon
C. Ruth Garnett
Mary E. Johnston
Hazel L. Grant
Jean E. Cunningham
Joan K. MacNichol
Marjorie H. Ruddock

Administrative Officer II
Clerk IV (to March 20)
Stenographer III
Clerk III
Stenographer III
Stenographer IIB
Clerk IIB
Stenographer IIA
Stenographer IIA (from May 1)
Stenographer IIA (to May 22)
Stenographer IIA
Clerk IIA (from Sept. 16)
Stenographer I (to Sept. 14)
Stenographer I (from July 2)

G. J. W. Sullivan
H. Y. Brownrigg
J. S. MacPhail
R. C. Murray
D. N. Fitzgerald
M. F. Fraser
B. A. Mackenzie, B.Sc.
I. M. Jones
L. G. Kervin
S. E. Vass, B.Sc.
C. R. Hayes
U. J. Walsh
E. G. Sollows
R. J. Wiley, B.Sc.
W. G. Carson
A. C. Kohler, B.A.
R. M. MacPherson
L. P. Thibault, B.A.
H. W. Coates
P. R. Graves
Evelyn R. MacMillan
Jean M. Stuart, B.Sc.
Esther I. Lord

Technician III
Technician II
Technician II
Technician II
Technician II
Technician I
Technician I
Technician I
Technician I
Technician I
Assist. Tech. III
Assist. Tech. III
Assist. Tech. III
Assist. Tech. III
Assist. Tech. III
Assist. Tech. III (from July 2)
Assist. Tech. III
Assist. Tech. III (to July 13)
Assist. Tech. III
Assist. Tech. III
Assist. Tech. III
Assist. Tech. II
Assist. Tech. II (to Sept. 30)
Assist. Tech. II ($\frac{1}{2}$ time to March 31 and full-time from April 1)
Assist. Tech. II (from April 1)
Assist. Tech. II (from June 15)
Assist. Tech. II (to Jan. 31)
Assist. Tech. II (from June 15 to Sept. 25)
Assist. Tech. I
Assist. Tech. I

C. Williams
P. W. G. McMullon
Colleen C. Carten, B.Sc.
Lorna M. Guiou, B.A.
Mary Holmes
Phyllis J. Gibson

H. H. Butler	Technician II (Capt.)
C. J. Bayers	Technician I (Capt.)
R. H. McDonald	Technician I (Capt.)
L. I. Cross	Assist. Tech. III (Capt.)
B. W. Hart	Engineer
F. G. MacIntosh	Engineer (from Jan. 1, 1953, to Oct. 31, 1953)
I. A. Cottreau	Twinehand
D. W. Hart	Twinehand (from June 8, 1953, to Nov. 5, 1953)
G. R. Young	Cook-Deckhand
G. R. Zwicker	Cook-Deckhand (approx. 8 months)
R. N. Hardy	Cook-Deckhand (approx. 8 months)
W. McKinnon	Deckhand (approx. 3 months)
W. J. Ross	Carpenter - Prevailing Rates
J. F. Johnston	Carpenter - Prevailing Rates
H. C. Hillman	Carpenter - Prevailing Rates
W. G. Irving	Netman - Prevailing Rates
W. H. MacLean	Netman - Prevailing Rates (approx. 8 months)
E. C. Tucker	Netman - Prevailing Rates (approx. 8 months)
M. W. Collicutt	Labourer - Prevailing Rates (approx. 8 months)
A. G. Steeves	Labourer - Prevailing Rates (approx. 8 months)
H. P. Barchard	Labourer - Prevailing Rates
G. F. Wentworth	Labourer - Prevailing Rates
H. Smith	Labourer - Prevailing Rates (6 months)

Personnel of Atlantic Oceanographic Group with
headquarters at Atlantic Biological Station

H. B. Hachey, M.B.E., E.D., M.Sc., LL.D., F.R.S.C.	Prin. Scientist
H. J. McLellan, M.Sc.	Assoc. Scientist
W. B. Bailey, B.Sc.	Assist. Scientist
R. W. Trites, B.Sc., M.A.	Junior Scientist (on educational leave to March 31; transferred to P.O.G. April 1)
J. A. Sullivan	Assist. Tech. III
G. B. Taylor	Assist. Tech. II
J. H. Hull	Assist. Tech. II
C. C. Cunningham	Assist. Tech. II
Madelyn M. Irwin	Stenographer IIB

Term

D. G. MacGregor, M.A.	Assist. Scientist (June 16 - Sept. 28)
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- Battle, Helen I. A Morphological and Physiological Study of Developmental Processes in the Three-spined Stickleback (Gasterosteus aculeatus, L.). Accepted.
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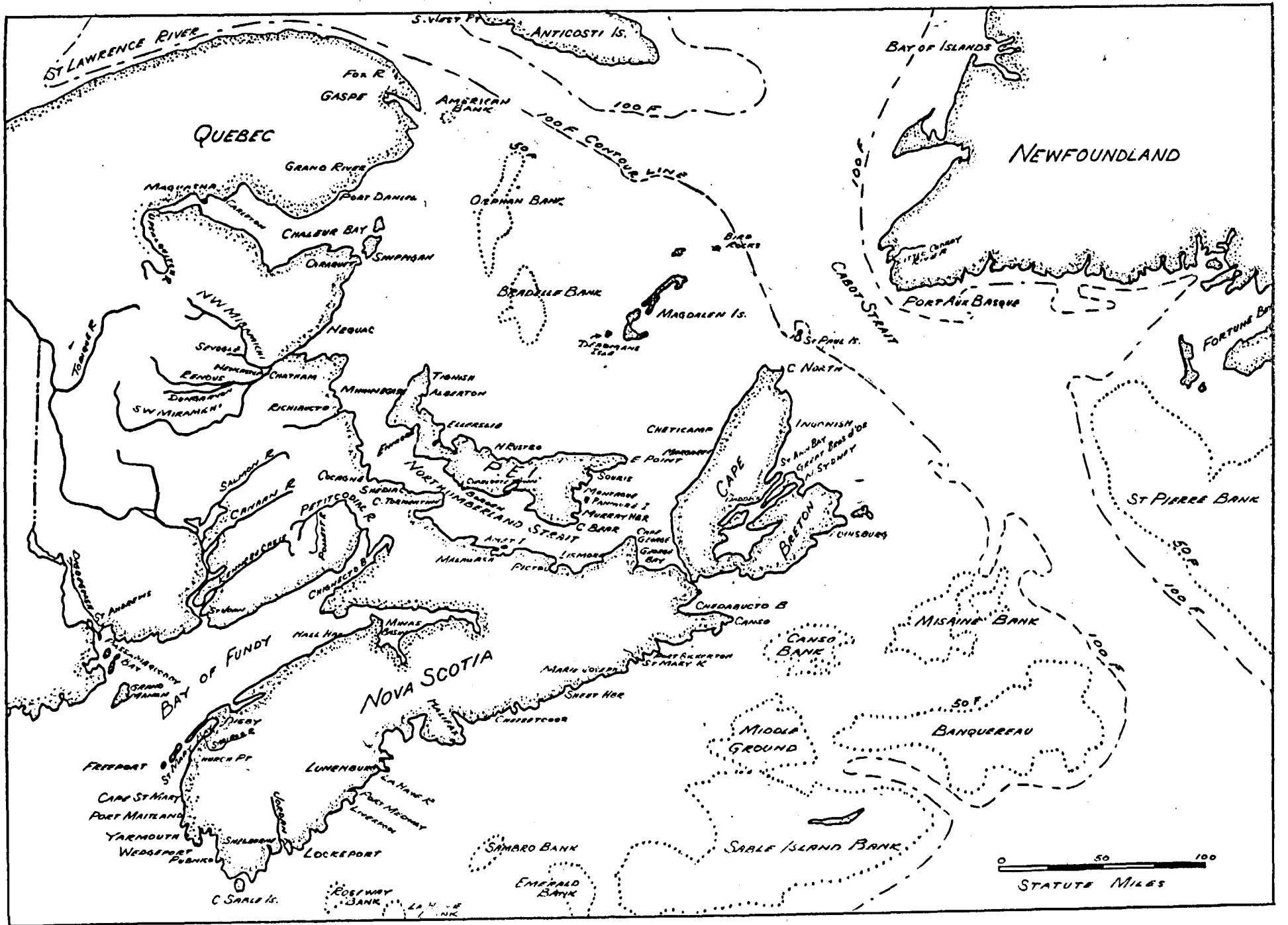
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- No. 535 Atlantic Oceanographic Group. Temperature Distribution on the Scotian Shelf from August, 1951, to November, 1952. (Restricted).

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RECENT CHANGES IN THE SIZE LIMITS FOR LOBSTERS

Since 1944 about half the time of the lobster investigation has been spent on a detailed study of the lobster fishery in six typical fishing areas. Each year in each area lobsters have been tagged, sample catches measured, and detailed catch and effort statistics collected. From these data estimates of population size and mortality rates can be derived which, together with growth estimates based on marking experiments, provide a biological basis for regulating the fishery. The information available to date indicates that the growth of lobsters below legal size more than compensates for natural losses. This provides strong support for the contention that greater sustained yields could be obtained from the fishery if present minimum size limits were well enforced or in some cases increased.

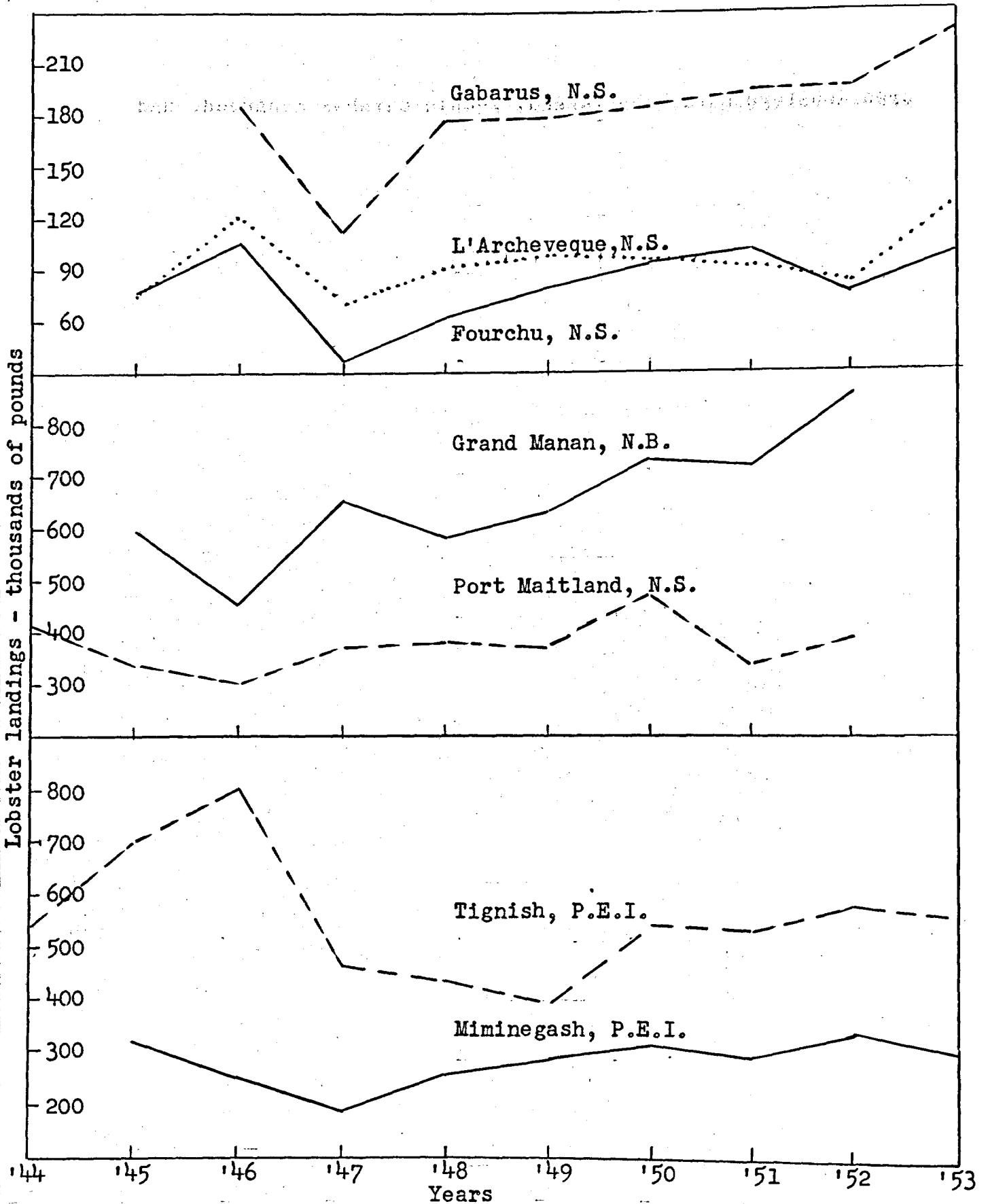
During recent years several changes have been made in the size limits and attempts have been made to measure the effect of these changes on the fishery. As an index of abundance the total landings at seven ports since 1944 or 1945 are shown in the accompanying figure.

Fourchu, N.S., L'Archeveque, N.S., and Gabarus, N.S. These three adjacent ports on the outer coast of Cape Breton Island are of particular interest. In 1947 the size limit at Fourchu was raised from 7" total length to 3 1/8" carapace length (about 9" total length). This coincided with a generally poor year and production dropped more than was expected (from 106,000 pounds of canners and markets in 1946 to 37,500 pounds of markets alone in 1947). From 1947 to 1951 the production of markets alone climbed steadily to a peak of 102,000 in 1951. In 1952 the size limit was further increased to 3 3/16" carapace length. This resulted in a slight drop in production in 1952, followed by an increase in 1953. Since market lobsters are normally worth more per pound than canners the value of market lobsters alone during recent years at Fourchu has exceeded the previous combined value of canners and markets.

L'Archeveque has been a market-lobster area throughout the period of observation with only one minor change in the size limit, an increase from 3 1/8" to 3 3/16" carapace length in 1952. This increase is reflected in the landings which dropped in 1952 and recovered in 1953. From 1947 to 1951 when the catch of markets in the Fourchu area was rising, production at L'Archeveque was relatively constant.

Gabarus has remained a canning area throughout the period of observation. In 1952 the size limit was reduced slightly from 7" total length to 2 3/8" carapace length and in 1953 increased to 2 1/2" carapace length. Neither of these changes had any noticeable effect on the landings. This is not surprising since in this area a relatively small proportion of the stock was affected by the changes.

At these three ports observance of size limits, of closed seasons and of protection of berried lobsters is exceptionally good.



Annual lobster landings at seven typical ports

Port Maitland, N.S., and Grand Manan, N.B. The 3 1/8" size limit was in effect at Port Maitland until 1951 when the limit was increased to 3 3/16". On the basis of extensive measurements it was predicted that the immediate effect of this increase would be to remove about 8% by weight of the lobsters from the legal-size range. Actual landings during the 1951-52 season were only 8.5% less than the average for the previous seven years, but were 25% below 1950-51, which was an exceptionally good year. In the 1952-53 season landings exceeded the 1944 to 1950 average by 3%.

At Grand Manan a 3 1/4" size limit was in effect until the spring of 1953 when it was reduced to 3 3/16" to correspond to all other market-lobster areas. In this area catches have been increasing since 1946, a trend that was continued in the 1952-53 season. Although landings in 1952-53 were about 19% higher than in 1951-52 not more than one quarter of this increase could be attributed to the smaller size limit.

Miminegash, P.E.I., and Tignish, P.E.I. In these two canning areas which are characterized by exceptionally small lobsters a 7" total-length size limit was in effect from 1942 to 1951. In 1952 the size limit was changed to 2 3/8" carapace length - a slight reduction which is reflected in the slightly greater landings at both ports. In 1953 the size limit was increased to 2 1/2" and landings dropped slightly. In small-lobster areas such as these, the 1953 increase removed up to 25% of the lobsters by count from the legal-size range. This increase was actively opposed by the fishermen in some areas and at Miminegash and Tignish observance of the fishery regulations suffered in 1953. In such areas where reasonably reliable figures on annual landings and the size composition of the catch cannot be obtained it is virtually impossible to assess the effect of any regulatory measures.

The field work referred to in this report was carried on by R. C. Murray, L. G. Kervin and U. J. Walsh.

D. G. Wilder

Appendix No. 2

EXPERIMENTS TO IMPROVE THE CONSTRUCTION AND DESIGN OF LOBSTER TRAPS

Lobster fishermen in the Maritime Provinces fish almost two million lobster traps valued at over six million dollars. Normal annual losses are reported to be of the order of 25% and in recent years much heavier losses have occurred in certain areas following severe storms. If these losses, which constitute an appreciable part of the cost of fishing, could be reduced by using a more durable trap greater profits could be realized from the fishery.

Conventional lobster traps are made of laths and netting built around a wooden frame. Even when heavily ballasted with rock or concrete and well soaked such traps are relatively light in the water. With their large surface area and high, rounded design they are readily affected by wave action.

To be acceptable to the fishermen a trap of different material or design must fish as well as the conventional trap. In the experiments to date only the question of material has been considered, the experimental traps being patterned after and tested against the wooden traps most popular in the experimental areas. If the experimental traps can be shown to fish as well as wooden traps further experiments may be necessary to discover the design that is least susceptible to storm damage.

During August and September, 1953, two iron-framed, wire-covered traps, as illustrated in the accompanying figure, were fished off Miminegash, P.E.I. The weight of these traps in air and in water as compared to the standard well-soaked, heavily-ballasted, three-foot Miminegash traps was as follows:

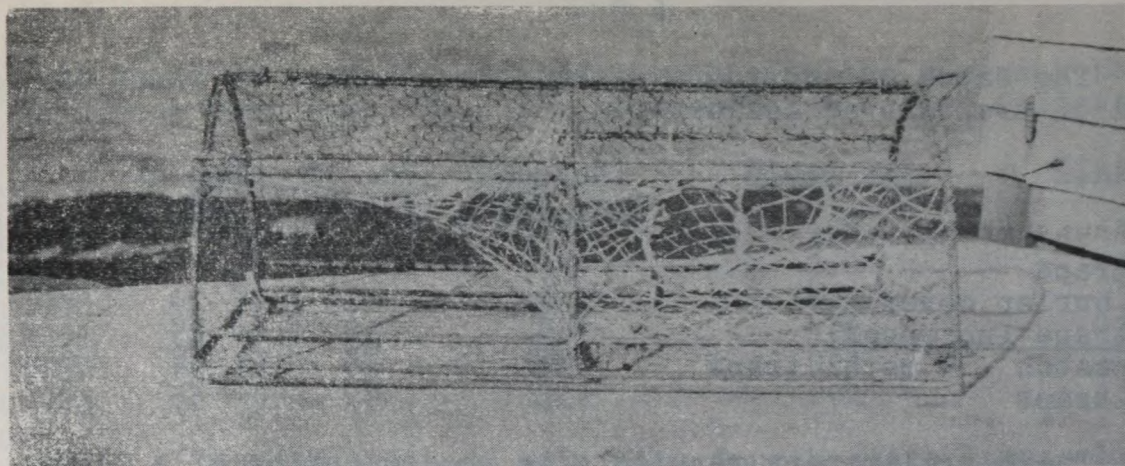
	<u>Weight in air</u>	<u>Weight in water</u>
Iron-framed, wire-covered trap	21 lb.	18 lb.
Soaked wooden traps, concrete ballast	67 lb.	16 lb.

The metal traps which were only about 1/3 as heavy in air actually weighed more in the water and should with their smaller surface area be less affected by wave action.

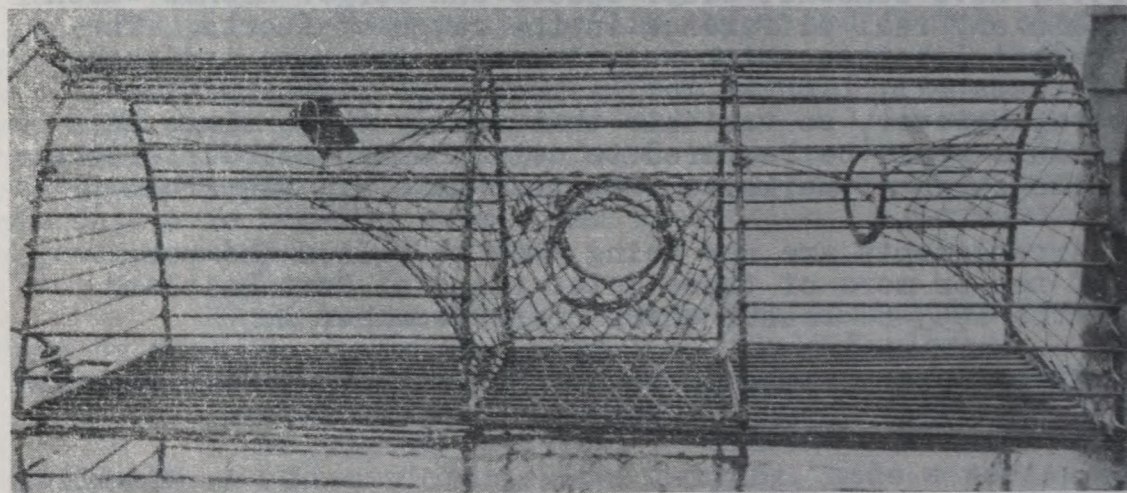
In 36 comparable trap hauls the iron-framed traps caught 23 lobsters, the wooden traps 60, a statistically significant difference. There was no obvious reason for this difference. Fishermen in general maintain that lobsters have an aversion to metal, a contention that is not supported by laboratory observations. One possibility believed to be worth further consideration was that the more open metal traps admitted too much light.

From November 1 to 6, 1953, four traps made of 1/4" steel rods welded to 3/8" iron frames were given preliminary tests off Port Maitland, N.S., while engaged in pre-season fishing primarily to obtain lobsters to tag. Two of these traps were partially covered with burlap to reduce the light. The weight of these traps in air and water, compared to the standard four-foot Port Maitland trap was as follows:

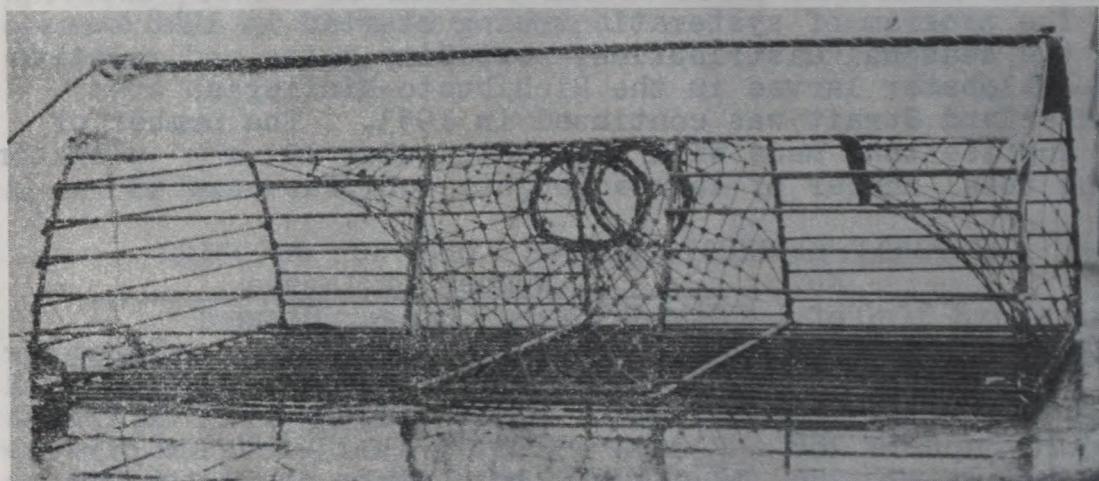
	<u>Weight in air</u>	<u>Weight in water</u>
Iron-framed, rod-covered trap	44 lb.	37 lb.
Wooden trap with fixed and loose stone ballast (not soaked)	114 lb.	40 lb.



Wire covered, iron framed trap tested at Miminegash, P.E.I., August and September 1953.



Trap of steel rods on an iron frame being tested at Port Maitland, N.S.



Steel rod, iron frame trap partially covered with burlap, being tested at Port Maitland, N.S.

The catch of short and marketable lobsters by count in each kind of trap was as follows:

	<u>No. of trap hauls</u>	<u>No. of shorts</u>	<u>No. of markets</u>
2 metal traps (partial burlap cover)	14	11	29
<u>2 metal traps (no cover)</u>	<u>14</u>	<u>18</u>	<u>25</u>
Combined catch - 4 metal traps	28	29	54
4 wooden traps	28	47	55

These preliminary results give no indication of a light effect, the catches from the traps with and without covers not differing significantly. The four metal traps caught fewer short lobsters but the individual catches were so variable that the difference is not statistically significant. The metal traps did, however, have somewhat wider spaces and larger meshes which could explain any real difference in the catch of shorts. The catch of market lobsters which was virtually the same indicates that metal traps will fish as well as wooden. The individual catches were, however, so variable that nearly three times as many trap hauls would be required to detect an actual difference of 10% in the catch of markets. Further data are required.

Arrangements are now being made to follow the performance of ten or more of these metal traps at Port Maitland throughout the 1953-54 season which opens December 1.

Field observations in connection with these experiments were made by U. J. Walsh, R. C. Murray and L. G. Kervin.

D. G. Wilder

Appendix No. 3

RELATIVE ABUNDANCE OF LOBSTER LARVAE IN NORTHUMBERLAND STRAIT

The program of systematic towing started in 1948 to determine the seasonal distribution, mortality rates and relative abundance of lobster larvae in the Richibucto-Minimegash area of Northumberland Strait was continued in 1953. The number of half-hour surface tows made with the rectangular 12' x 3' plankton net and the total number of larvae caught each year were as follows:

<u>Towing period</u>	<u>No. of tows</u>	<u>Number of larvae</u>				<u>Total</u>
		<u>Stage I</u>	<u>Stage II</u>	<u>Stage III</u>	<u>Stage IV</u>	
1948 June 5-Sept.13	128	931	302	189	148	1,570
1949 June 20-Sept.14	288	7,294	855	330	80	8,559
1950 June 9-Sept.27	256	11,726	3,256	1,563	452	16,997
1951 June 16-Sept.21	338	10,000	1,604	693	441	12,738
1952 June 4-Sept.23	589	22,452	5,042	2,404	2,973	32,871
1953 June 15-Sept.16	630	26,325	3,364	895	725	31,309

The average catch per tow during the six-week period in each year when each stage was most abundant was as follows:

	<u>Stage I</u>	<u>Stage II</u>	<u>Stage III</u>	<u>Stage IV</u>
1948	13.5	5.0	3.2	2.5
1949	38.9	4.7	2.0	0.5
1950	71.3	18.9	10.2	3.1
1951	46.2	9.2	4.6	2.9
1952	76.4	19.8	9.3	11.4
1953	75.3	7.2	2.1	1.8

During the past six years fourth-stage larvae have varied in abundance more (23:1) than have the first-stage (6:1), indicating that the success of a year class is more dependent on survival during the free-swimming larval period than on the number hatched. In the 1953 season production of first-stage larvae was good but survival during the first two stages was poor, relatively few larvae reaching the third and fourth stages.

According to recent growth estimates the larvae hatched in 1948 would reach a carapace length of 2 1/4" during the summer of 1953. Since the minimum legal size in this area is 2 1/2" carapace length, observations must be continued for several years to determine whether commercial production is correlated with previous abundance of larvae.

This year's towing program was energetically carried out by Capt. L. I. Cross on the M.B. "Gulf Explorer". L. G. Kervin and R. C. Murray sorted and counted the larvae.

From July 11 to August 30 the M.V. "Point Pleasant II", while engaged in exploration for herring, made a series of 24 ten-minute surface plankton tows in the vicinity of Sable Island (15), Banquereau (4), Georges Bank (2) and St. Pierre Bank (3). In the two tows made on Georges Bank on August 19 and 20 with a #0 mesh, 30" diameter net a total of nine lobster larvae was taken, four in stage 1, four in stage 2 and one in stage 3. No previous records of lobster larvae from this offshore bank have come to the writer's attention.

D. G. Wilder

Appendix No. 4

DRAGGING FOR EARLY BOTTOM STAGES OF LOBSTERS

During the fall of 1952 the M.B. "Gulf Explorer", using a newly-designed, fine-meshed bottom drag off Richibucto, N.B., caught a total of 432 lobsters including 19 which averaged about one inch total length. From their size distribution and certain morphological features these 19 lobsters were identified as stages six to eight, the first known records of the immediate post-larval stages from nature. Since most of these small lobsters were caught during the latter part of October it seemed likely that they had completed their first season's growth.

To obtain further information on growth during the first growing season another series of 93 ten-minute drags was made in this area from May 7 to June 3, 1953, before lobsters hatched in 1952 would begin their second season's growth. A third series of 92 drags was made from September 17 to October 31, 1953, to obtain further information on the immediate post-larval lobsters and to determine whether by the use of a larger drag it would be feasible to attempt relative abundance estimates of lobsters below commercial size.

The size frequency distribution in 1/4" carapace-length groups of the lobsters caught in the three series of drags was as follows:

Carapace length	Number of lobsters		
	Sept. 19 to Oct. 27/52 208 drags	May 7 to June 3/53 93 drags	Sept. 17 to Oct. 31/53 92 drags
1/4"	11	8	0
1/2"	10	6	6
3/4"	13	17	7
1"	18	27	2
1 1/4"	38	27	6
1 1/2"	51	45	9
1 3/4"	64	40	14
2"	112	52	25
2 1/4"	83	41	29
2 1/2"	22	9	13
2 3/4"	8	4	4
3+"	2	8	3
Totals	432	284	118

The eight smallest lobsters caught in the spring of 1953, which were distinctly separated from the larger lobsters, averaged 0.33" carapace length and 0.95" total length. Since, as shown by the plankton tows, no hatching occurs until about mid-June these lobsters must have been hatched in the summer of 1952. Capture of these lobsters confirms the conclusion that in this area lobsters moult five to seven times during their first growing season to reach an average total length of about one inch.

In the autumn of 1953 none of the earliest bottom stages was taken, reflecting the scarcity of fourth-stage larvae in the 1953 plankton tows (Appendix 3). Most of the lobsters were taken in the four-foot drag, the new eight-foot drag proving difficult to operate and maintain because of damage to the netting by large rocks. Further improvements in drag design appear to be necessary if sub-legal lobsters are to be taken consistently in sufficient numbers to reflect their relative abundance.

The spring and fall dragging programs were conducted by Captain L. I. Cross on the M.B. "Gulf Explorer".

Appendix No. 5

PHYSICAL AND CHEMICAL FACTORS LIMITING THE SURVIVAL OF LOBSTERS

Some aspects of the limiting effects of temperature, salinity and oxygen on lobster survival were studied during the years 1949 to 1951. This study was expanded to a factorial experiment in 1952 to provide more complete information on these effects and to determine whether or not any significant interactions between these factors occurred. Virtually all the experimental work has been completed and the data are being analyzed for presentation as a doctorate thesis and eventual publication.

Lobsters were acclimated to three levels of each factor, at temperatures of 5, 15 and 25°C., at salinities of 20, 25 and 30 parts per thousand, and with dissolved oxygen at concentrations of 2, 3 and 4.5 c.c./litre, in all of the 27 combinations of these levels. Lethal levels of temperature, salinity and oxygen were determined for each group. In each case the lethal level was defined as the level that would kill 50% of the animals in 48 hours. Acclimation to each combination of factors was accomplished in three steps. The lobsters were first acclimated to temperature, then to salinity and finally to oxygen, maintaining throughout the conditions to which the lobsters had already been acclimated. The results are summarized in the accompanying table to show major trends of the data.

Upper lethal temperatures were determined by subjecting groups of ten lobsters to a series of four temperatures maintained at intervals of 1°C. The lethal temperature was estimated by plotting percentage mortality at 48 hours against temperature, and the 50% point was determined by inspection. The effect of temperature, salinity and oxygen acclimation on the lethal temperature is as follows: (a) Lethal temperature is raised by an increase in acclimation temperature. (b) Lethal temperature is lowered by a decrease in acclimation salinity. (c) Lethal temperature is lowered by a decrease in acclimation oxygen.

Lower lethal salinities were determined by testing groups of ten lobsters in a series of four salinities maintained at intervals of two parts per thousand. The lethal salinity was estimated from a graph of mortality in 48 hours plotted against salinity. The three factors had the following effects on the lethal salinity: (a) Lethal salinity is raised by an increase in acclimation temperature. (b) Lethal salinity is lowered by a decrease in acclimation salinity. (c) Lethal salinity is lowered by a decrease in acclimation oxygen.

Lower lethal oxygen concentrations were determined by testing groups of ten lobsters in a series of four oxygen concentrations maintained at intervals of 0.2 c.c. of oxygen per litre. The lethal oxygen level was estimated graphically. The following relationships were established: (a) Lethal oxygen is raised by an increase in acclimation temperature. (b) Lethal oxygen is raised by a decrease in acclimation salinity. (c) Lethal oxygen is unaffected by a change in acclimation oxygen.

Lethal levels of temperature, salinity and oxygen for lobsters acclimated to 27 different conditions

Acclimation conditions			Lethal temperature	Lethal salinity	Lethal oxygen		
Temp. °C.	Sal. ‰	O ₂ c.c./l.	°C. averages	‰ averages	c.c./l. averages		
	30	4.5	25.8	6.0 } 9.1	.2 } .20		
		3	25.4 } 25.1			11.5 } 9.1	.2 } .20
		2	24.0 } 25.1			10.0 } 9.1	.2 } .20
5	25	4.5	24.6	9.6 } 10.7	.2 } .33		
		3	22.5 } 23.2			10.7 } 10.7	.4 } .33
		2	22.5 } 23.5			12.0 } 10.7	.4 } .33
	20	4.5	23.8	9.2 } 9.6	.5 } .53		
		3	23.0 } 22.4			9.2 } 9.6	.6 } .53
		2	20.5 } 22.4			10.6 } 9.6	.5 } .53
	30	4.5	28.4	11.4 } 10.7	.6 } .56		
		3	28.5 } 28.3			10.2 } 10.7	.6 } .56
		2	28.0 } 28.3			10.6 } 10.7	.5 } .56
15	25	4.5	28.0	9.6 } 9.9	.7 } .63		
		3	28.0 } 27.8			10.0 } 9.9	.6 } .63
		2	27.5 } 27.8			10.2 } 9.9	.6 } .63
	20	4.5	27.6	8.0 } 8.4	.9 } .70		
		3	27.8 } 27.5			9.0 } 8.4	.6 } .70
		2	27.2 } 27.5			8.4 } 8.4	.6 } .70
	30	4.5	30.8	19.9 } 17.4	.8 } .86		
		3	29.5 } 29.5			16.0 } 17.4	.9 } .86
		2	28.6 } 29.5			16.4 } 17.4	.9 } .86
25	25	4.5	29.5	13.6 } 14.3	.9 } .86		
		3	29.5 } 29.2			14.5 } 14.3	.9 } .86
		2	28.8 } 29.2			15.0 } 14.3	.8 } .86
	20	4.5	29.3	11.0 } 11.1	.9 } 1.07		
		3	29.0 } 28.9			11.2 } 11.1	1.1 } 1.07
		2	28.5 } 28.9			11.2 } 11.1	1.2 } 1.07

Statistical analysis confirms these conclusions and shows in addition that interactions of the three factors have significant effects on the lethal levels. The three lethal levels are altered by the temperature and salinity interaction, and lethal temperature is altered by the temperature and oxygen interaction. No significant effect was demonstrated for the oxygen and salinity interaction.

This work has provided for the first time a sound basis for advice to the industry regarding the levels of these three factors that should be maintained for satisfactory commercial holding of live lobsters. Some mortalities have been explained and some unfavourable conditions have been demonstrated.

During these experiments much valuable assistance was provided by Marjorie Myers, C. J. McFarland and U. J. Walsh.

D. W. McLeese

Appendix No. 6

COMMERCIAL HOLDING CONDITIONS FOR LOBSTERS

In the Maritime Provinces lobsters are held commercially in crates, cars, pounds and to some extent in tanks. At times heavy mortalities in these units have resulted in severe financial loss to the industry. Disease has caused mortality at times, but poor conditions of temperature, salinity, and possibly oxygen have usually been suspected. The exact effect of these factors on lobster survival was unknown since detailed studies of the temperature, salinity and oxygen conditions in holding units had not been made and lethal levels of these factors had not been accurately determined. Since 1949 information on the lethal levels for lobsters has been obtained experimentally and certain opportunities to observe commercial holding conditions have occurred.

Heavy mortality among lobsters held in crates was reported at Tignish, P.E.I., in late June, 1952. Observations from June 24 to July 5 showed that mortalities could be attributed to low salinities occurring at high temperatures on six of the twelve days.

Some observations of the conditions in lobster cars were made at Cocagne, N.B., Cape Tormentine, N.B., and Borden, P.E.I., in August of 1953. Nearly maximum water temperatures occur at this time and it was suspected that poor holding conditions would be demonstrated. Satisfactory conditions were found since water circulation in the cars was increased by strong wave action and the cars were not heavily stocked with lobsters. Severe mortality occurred in July when greater numbers of lobsters were held but no observations were made in this area then.

Unfavourable conditions of temperature and particularly oxygen were found in a Deer Island, N.B., lobster pound during the neap-tide period in July, 1953, when water exchange is at a minimum. Routine sampling showed increased surface temperatures and an oxygen reduction of 75% at one sampling station. Extensive

sampling there showed a temperature gradient of 4 to 5°C. from top to bottom and showed an oxygen reduction of 10 to 50%. Some immediate changes were made to increase water circulation in the pound.

Heavy mortality occurred in a Grand Manan, N.B., lobster pound in July, 1953. Samples taken there failed to demonstrate lethal conditions but an oxygen reduction of 40% was shown. Further oxygen reduction may have occurred before new water entered the pound.

Samples of conditions in tank holding units were obtained at St. Andrews, N.B., and Pt. du Chene in August of 1949 and 1953 respectively. Sea water is pumped to the top tank in each tier and drains into the two lower tanks. Satisfactory temperature and salinity conditions were found but in the bottom tanks the oxygen was reduced by 50%. No undue mortality was reported for the bottom tanks but any further reduction in oxygen would approach a limiting level.

Water is pumped intermittently to a tank holding unit in Saint John, N.B., since full-salinity sea water is not always available due to freshwater run-off from the Saint John River. The water in the tanks is aerated with compressed air when pumping is not possible. Temperature was satisfactory but good salinities were not always maintained. The tanks were also overloaded, resulting in oxygen reduction to the lethal level. If proper precautions regarding salinity and load conditions are taken, this type of holding unit can be successfully used. Advice was provided concerning the construction and operation of this unit.

These observations have shown that oxygen reduction is prevalent where lobsters are held commercially. The importance of oxygen as a limiting factor had previously not been fully appreciated. Temperature by itself was never found at a lethal level but it does limit lobster survival through its effect on the lethal levels of salinity and oxygen.

A considerable variety of conditions in commercial holding units for lobsters has been demonstrated by the few observations that have been made. More extensive systematic sampling would add appreciably to the knowledge relating mortality to holding conditions and would provide a basis for advice.

D. W. McLeese

Appendix No. 7

THE EFFECT OF TEMPERATURE ON THE SURVIVAL OF LOBSTERS HELD IN STAGNANT, AERATED, ARTIFICIAL SEA WATER

Experiments started in 1951 and continued through 1952 to improve techniques for the inland holding of live lobsters showed that commercial quantities of lobsters could be held for several weeks in stagnant, aerated, artificial sea water. A

circular on this method of holding was distributed to the trade in January, 1953.

In the spring of 1953 two further experiments were conducted to determine more accurately the effect of temperature on the survival of lobsters held in artificial sea water. The results of these experiments are illustrated in the accompanying figure. The number of days to 50% mortality in each experiment was as follows:

<u>Experiment 8</u>		<u>Experiment 9</u>	
<u>Av. temp.</u> <u>°C.</u>	<u>Days</u>	<u>Av. temp.</u> <u>°C.</u>	<u>Days</u>
1.2	30	1.4	29
6.2	22	6.2	32
13.7	11	16.4	15
19.8	6		

Experiment 8 showed a straight line relationship between average temperature and time to 50% mortality, an increase of 1°C. decreasing the time 1.3 days. Generally, however, survival times in this experiment were shorter than in previous experiments.

Experiment 9 was run to obtain further information on the time-temperature relationship and to see if, by taking special precautions in the selection and handling of the lobsters, the holding period could be prolonged. At average temperatures of 6.2°C. and 16.4°C. survival was considerably better than in experiment 8. At 1.4°C., however, there was no improvement over experiment 8 and the lobsters died faster than those of experiment 9 held at 6.2°C. During the last half of the holding period the lobsters held at 1.4°C. were abnormal in behaviour and appearance, being extremely sluggish and stiff with the legs held out rigidly and the membrane between the carapace and abdomen markedly swollen. Deaths in this particular tank were apparently caused by a disturbance of the osmotic balance, rather than from the accumulation of toxic waste products which presumably was the principal cause of death in other experiments.

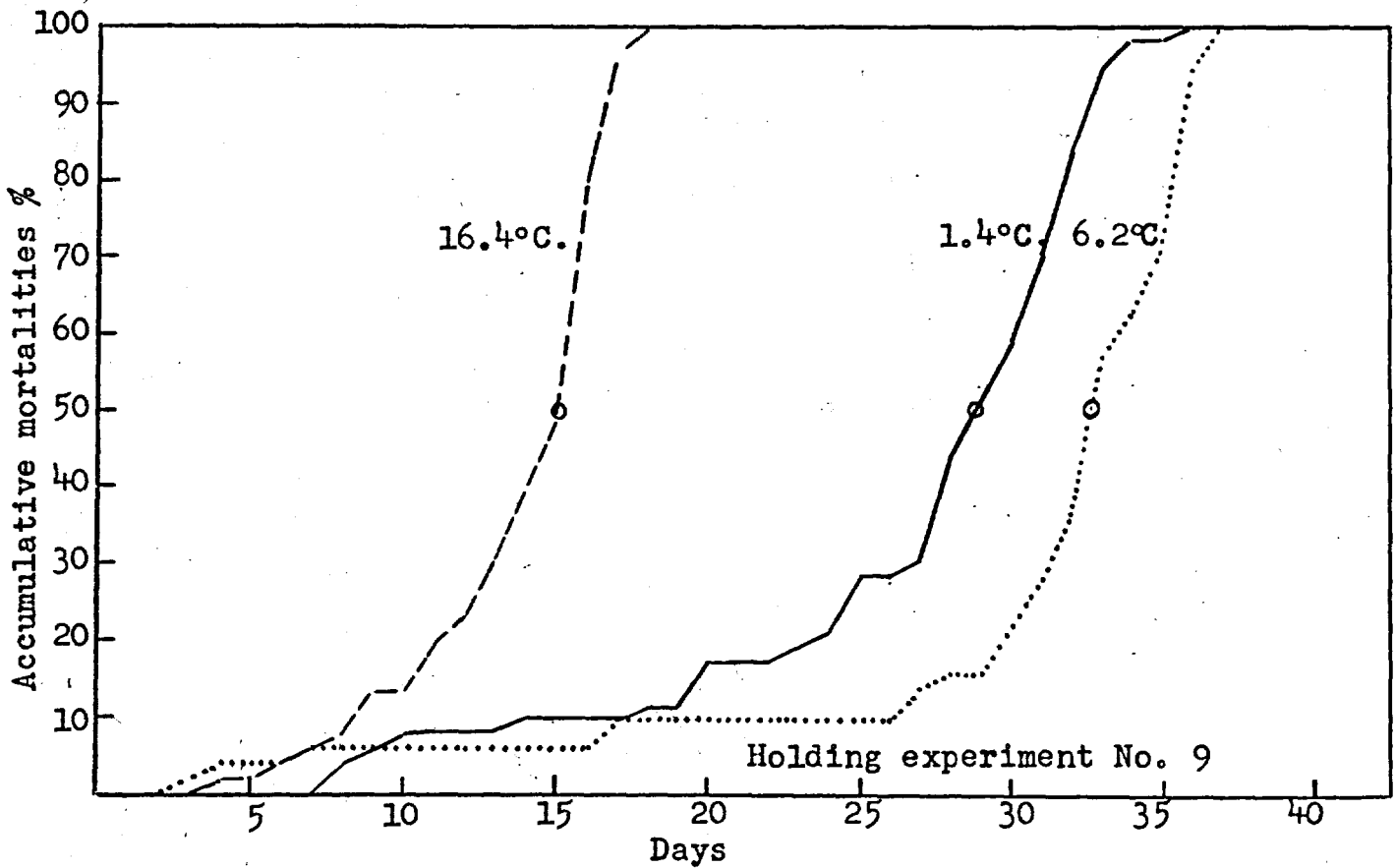
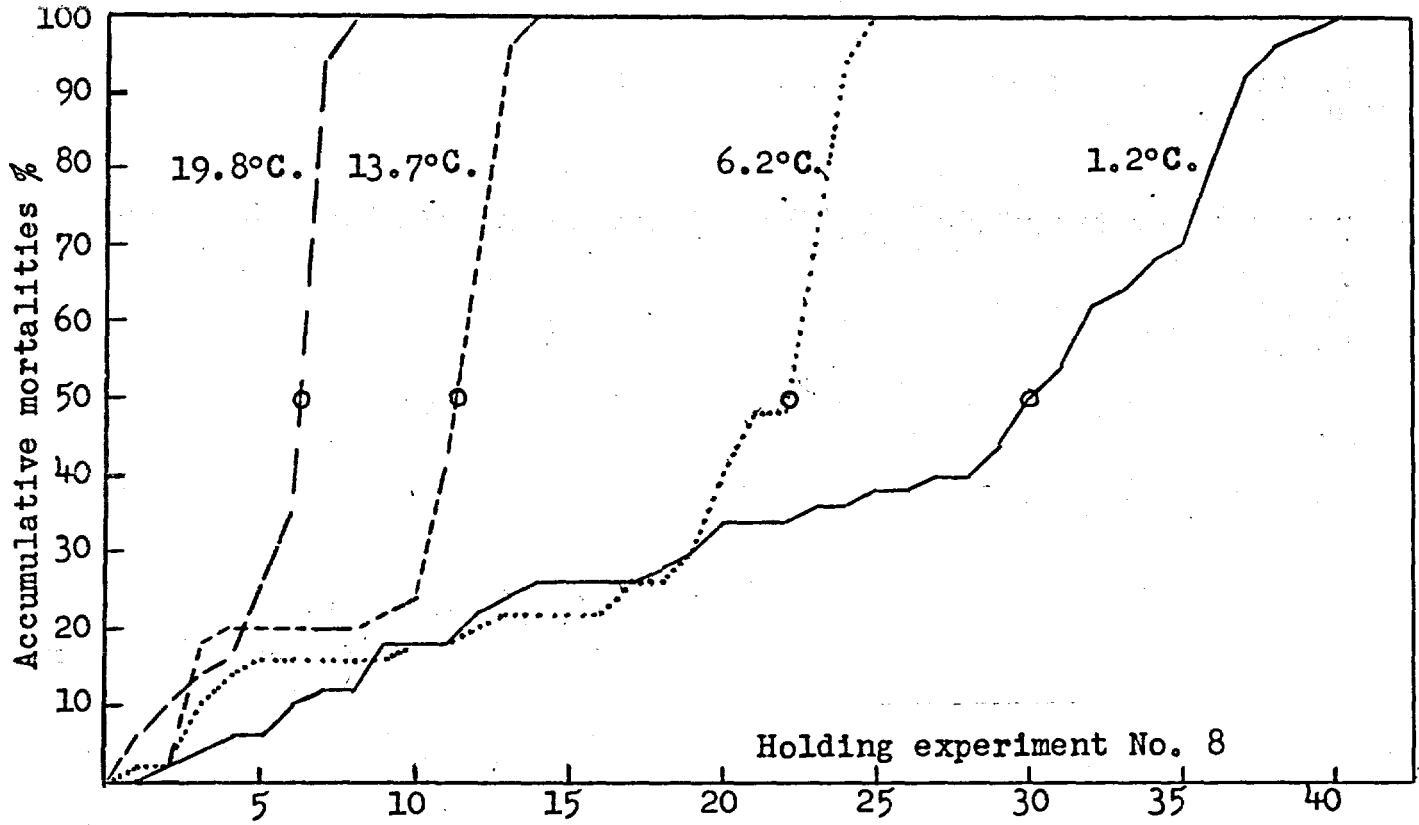
Most of the observations in experiment 8 were made by R. C. Murray and U. J. Walsh.

D. G. Wilder

Appendix No. 8

THE MEAT YIELD OF STARVED LOBSTERS

During the course of experiments on limiting factors and the relative toxicity of metals, lobsters have been held for various periods without food. Samples of these lobsters have been measured, weighed, boiled and the weight of claw and tail meat determined. In one experiment a stock of lobsters was



Effect of temperature on the survival of lobsters in stagnant, aerated artificial sea water

divided and held under identical conditions except that one half was starved, the other fed sardine herring at the rate of one pound per day per 100 pounds of lobsters. For comparative purposes the meat yield of a sample of freshly-caught lobsters was determined. These data, not previously reported, are of considerable interest to those who hold lobsters commercially. The average meat yields were as follows:

Stock	No.	Live wt.	Meat yield		Solid waste		Liquid waste	
		grams	grams	%	grams	%	grams	%
Freshly-caught winter lobsters	11	441	114	25.8	227	51.5	100	22.7
Spring lobsters held 7 months without food	5	470	77	16.4	233	49.6	160	34.0
Summer lobsters held 4 months without food	6	471	88	18.7	255	54.2	128	27.2
Summer lobsters held 5 weeks and fed 1 lb. herring per 100 lbs. per day	14	465	89	19.1	232	49.9	144	31.0
Summer lobsters held 5 weeks without food	14	454	80	17.6	215	47.3	159	35.0

The average meat yield of lobsters held 7 months without food dropped to 16.4% of the live weight, a reduction of about 36% considering the freshly-caught winter lobsters as a standard. The meat yield of those held for 4 months without food dropped to 18.7%, a reduction of 27%.

The recently moulted summer lobsters which would have had a low meat yield at the start of the holding period did not respond well to feeding, the meat yield after 5 weeks averaging only 19.1%, or about 26% below "normal". The meat yield of lobsters starved for 5 weeks averaged 17.6%, or about 32% below normal. The difference in these two groups is not statistically significant.

These experiments have shown that lobsters can be held without food for at least 7 months and remain active and apparently healthy. Such prolonged starvation periods are, however, accompanied by a marked reduction in meat yield. No objectionable flavours developed in the meat during this period but the general opinion of a group was that the starved lobsters were less tasty than those freshly caught.

For short holding periods up to 5 weeks, feeding at the daily rate of one pound of herring per 100 pounds of lobsters has no marked effect on the meat yield.

Appendix No. 9

LARVAL ABUNDANCE AND SPAT SETTLEMENT

For the third time in four years the spawning and settlement of oysters in Maritime waters was generally poor. The occurrence of larvae in tows was light and irregular, and spatfall in the Shippegan, N.B., and Malagash, N.S., districts was negligible. At Ellerslie, P.E.I., a major "brood" of larvae appearing early in July, failed to set anywhere but on test collectors. Another "brood", not seen in tows, set heavily in mid-August but its density, late occurrence and fouling by mussels made the catch a failure commercially. Some of these effects were due perhaps to the season's colder water temperatures, along with a pronounced temperature drop in late July.

The Orangedale, N.S., area alone experienced a successful spatfall with a quantitative assessment at Gillis Cove of 720 spat per collector (concrete-coated cardboard egg-crate filler) and at Crowdis Bridge 7,200 spat per collector. For this type of collector, with an area of 700 square inches, a count of 1,600 is considered the optimum.

For comparison, the salient characteristics of the past four oyster-spawning seasons are presented.

1950 - This was a cold summer, with little or no spawning in any area.

1951 - Spawning was average, but larvae did not survive much beyond the "straight hinge" stage.

1952 - Spawning and spat settlement were successful in all respects.

1953 - Cooler temperatures prevailed: larval "broods" behaved erratically as they approached maturity and spat settlement was most irregular.

A casual survey of records has shown variations in spat settlement apparently inconsistent with hydrographic conditions. Knowledge of the conditions influencing spawning and growth and survival of larvae is not yet sufficient to explain these variations at all completely.

S. E. Vass

Appendix No. 10

METHODS OF SPAT COLLECTION

It was planned this year to test the efficiency of certain spat collector types in all waters under investigation but most of the work proved abortive due to the widespread spat failure and will have to be repeated.

Orangedale, N.S., was the only district where a comparison could be made. Among the collectors tested there was a new

type of shell bag: a double thickness of wire screen fashioned into a hollow triangle 18" high and 15" to each face, holding half a bushel of shell between the two thicknesses of screen. The old style collector was simply a quantity of shell bagged with screen, and spat settlement was confined mainly to the outer pieces of shell. The new form offers the advantages of inner and outer collecting surfaces and greater stability. The efficacy of this new type was compared with those of shells spread on the bottom and of shells strung on wires and suspended from racks. A quantitative assessment of the catch in the Orangedale area is presented.

<u>Type of collector</u>	<u>Average numbers of spat</u>	
	<u>Gillis Cove</u>	<u>Crowdis Bridge</u>
Shell on bottom	0.2 per shell	no test
New type shell bag	2 per shell	43 per shell
Shell suspended in wires	9 per shell	67 per shell
Concrete-coated egg-crate filler	720 per filler	7,200 per filler
Brush	no test	17 per linear foot

In view of the inconclusive results attending past work, a further test of the effectiveness of DDT in preventing barnacle settlement on cardboard collectors will be carried out in 1954 at Shippegan, N.B. Virtually no oysters or barnacles were caught there this summer but fouling of collectors by limpets occurred for the second consecutive season. The use of cardboard collectors for obtaining commercial supplies of spat in the Shippegan district has been discontinued, owing to the proven superiority of shell-type collectors in those rough waters.

S. E. Vass

Appendix No. 11

REARING OF OYSTERS IN DYKES AND PONDS

(a) Shallow dykes on tidal flats, Malagash, N.S.

A small experiment was performed at Malagash, N.S., in 1952, to observe the effect of planting oyster spat on the ground, behind a low-walled dyke on the tidal flats. The results (Appendix 10 of the 1952 Report of this station) show an unusually good survival (about 80%) at the end of the growing season but growth retarded by the high density of about 400 spat per square foot. The potentialities of this operation were realized at once, since, if it were successful, it might supplant the present, expensive practice of rearing on trays, and a larger scale experiment was started in 1953.

The dyke, constructed of sand, mud and stones about a wooden core, encloses an area of 280' x 120', with the greatest dimension extending seaward from a point reached by the average

high tide. It retains at low tide about six inches of water at the landward end and about two and one half feet at the seaward end. A gate in the seaward wall permits draining. An area within the dyke of 110' x 200' was cleaned of silt and shellfish and divided into twenty-five plots measuring 22' x 40'. These were arranged in a standard, 5 x 5 Latin square design and received plantings of five densities: 36, 72, 144, 288 and 576 spat per square foot, using about 5,000,000 spat newly separated from cardboard collectors by "threshing". Planting was done by broadcasting known volumes after determining the number of spat per quart; actual densities were checked by sampling. Random samples of spat were taken to determine size distribution and mortality caused by threshing. Ten oyster rearing trays, placed near the dyke, received spat plantings corresponding to the densities on the plots and thus served as a control. Plantings were concluded on May 5 and the experiment ran through the growing season until September 23.

Three adverse occurrences during the summer made the experiment effective from a practical viewpoint. (1) A severe and prolonged storm failed to effect any marked, horizontal movement of spat within the dyke, although it caused heavy silting. (2) Through an act of vandalism a section of wall was destroyed and considerable tramping over the planted area took place but the organization within the plots apparently was only slightly affected. (3) Erosion of the walls, arising from faulty construction, resulted in an irregular and often heavy deposition of mud on the plots, but this was confined mainly to lateral portions of the enclosure.

The data collected this autumn had not yet been fully analyzed as this report was drafted but a preliminary inspection indicated that the experiment was moderately successful in spite of the above-mentioned set-backs and a rather poor growing season. It was observed that eel-grass and other aquatic growth, normally absent from the upper reaches of the flats, grew well within the dyke. Such growth might be prevented or inhibited by allowing the dyke to drain periodically.

Because spat collection was a failure in 1953, it is unlikely that the experiment will be repeated in the same manner in 1954. It will be, however, continued through until the spring, when the degree of winter killing is to be determined. It is also planned to test pumping equipment as a means of removing silt and oysters from such dykes.

(b) Tidal rearing pond, Ellerslie, P.E.I.

In many countries it has been a common practice to hold oysters in tidal pools and ponds for such purposes as fattening, over-wintering, etc. A small experiment, companion to the one being conducted at Malagash, was begun at Ellerslie, P.E.I., in August, 1953, in which a rectangular pond was dug in the bank and connected to the inlet by a short channel. The pond measures 20' x 30' and was dug to such a depth as would produce a water level of two and one half feet at average half-tide. This depth

can be maintained by a gate at the junction of the pond and its channel and tidal flushing is accomplished by reducing the effective height of the gate.

The bottom was hardened with small-sized gravel and planted with young oysters (1952 year class) at a density of about 160 per square foot. By its use, a closer study of ice damage and winter killing will be made possible; while during the summer it will serve to complement the dyke work at Malagash. The purpose and design of the pond were suggested by Mr. H. R. Found, Department of Fisheries, Ellerslie.

S. E. Vass

Appendix No. 12

EXPERIMENTS IN REARING OYSTERS IN CAPE BRETON

A long-range program has been developed for the Bras d'Or Lakes area with a view of presenting to the potential oyster farmer the methods most suitable for that region, along with the risks and results which he might reasonably expect. In effect, the work will be a practical experiment in oyster rearing and no attempt will be made to protect it from the normal vicissitudes of an oyster culturist's experience. Normal practical methods will be applied throughout from spat collection to market maturity.

Spat will be obtained from the following collector types: concrete-coated cardboard egg-crate fillers, shells strung on wires suspended from racks, bags of shells, shells spread on the bottom and brush; small oysters will also be picked from the littoral zone. The seed oysters from each source will be planted on a plot about one fifth of an acre in area at an approximate density of 100,000 spat per acre; provision has been made for replication of these plantings over a four-year period.

Each lot of seed oysters will be carried through to maturity, the treatment varying with the source. For example, the spat caught on shell strewn on the bottom will require only one or more major cleaning operations before they reach market size; on the other hand, the spat caught on cardboard collectors must be sunk during the first winter, threshed in the spring and tray-reared for one complete season before they are ready for planting. At maturity, records of costs, mortalities, growth rates and yields will be available for analysis making it possible to assess the various methods on a cost-versus-yield basis.

The experimental area is located on the north shore of North Denys Basin, near Gillis Cove. It consists of six blocks of four plots each; those in the first four blocks measuring 31' x 280' and those in the remaining two blocks, 87' x 100'. All plots therefore enclose one fifth of an acre, with the longest dimension running seaward, while the complete series lies parallel to the shore. The first block will receive annual plantings of

weathered shell to serve as one type of collector which, after spat settlement, will be transferred to plots within the second block. The remaining blocks will be planted each year with stock from cardboard collectors (tray-reared for one year), shell collectors, brush, and picked oysters, respectively. The 1953 plantings will be completed by the middle of November.

It is believed that suitable oyster ground is limited in the Bras d'Or region, owing to the steep, bottom gradient characteristic of lakes of glacial origin. Some exploration for new ground may therefore be carried out concurrently with the rearing experiments. Attempts at oyster farming in Cape Breton waters have been quite casual in the past and it is hoped that this program will induce an expansion of the industry.

S. E. Vass

Appendix No. 13

EFFECT OF SUNLIGHT ON OYSTER GROWTH

An experiment designed to determine the effect of sunlight on oyster growth was carried out at Ellerslie, P.E.I., during the period June 27 to September 5. A table-type aquarium of wooden construction was placed outside the east wall of the station building. It was divided into four compartments, each of about 60 litres capacity, two of which were closely fitted with plywood covers. The station's salt-water system fed the aquarium and was adjusted to maintain a flow of one litre per minute. Water levels were kept at 3 inches, thus providing a constant volume of 20 litres. Temperature variation between tanks was negligible.

Each compartment received ten oysters from the 1950 year class and ten from that of 1951. These were evenly distributed on the tank floor and so oriented as to present the incurrent siphons to the water flow. Some of the data obtained at the end of the growing season are presented.

Oysters from open tanks:	mean increment in length	5.1 mm.
	mean increment in width	4.4 mm.
	mean increment in weight	7.9 gm.

Oysters from covered tanks:	mean increment in length	3.6 mm.
	mean increment in width	3.4 mm.
	mean increment in weight	7.9 gm.

Determinations of shell density, inter-valvular space and index of condition were not available for this report.

The results are inconsistent with those obtained by Medcof (1943) in a roughly similar experiment. Also the short duration of the experiment and difficulties experienced in controlling water supply and algal growth, make replication in 1954 advisable.

S. E. Vass

Appendix No. 14

STUDIES OF POTENTIAL OYSTER GROUND

Exploration for new oyster ground was tried in May, 1952, using a boat equipped with an echo sounder. Flat, firm bottom discovered by this method in Egmont Bay, P.E.I., was further tested by an experimental planting of about six barrels of oysters. Each oyster was marked with a notch in the shell lip, made by a grindstone - a method now believed to have been too severe. Growth during the first summer was restricted in most specimens to filling in the notch. A sample of twenty-five obtained in October, 1953, showed that a high mortality (37%) has occurred since planting, possibly due to the damage which attended the notching treatment, while growth in the remainder was poor.

Further exploration for firm bottom will be attempted with the echo sounder in the future and the Egmont Bay planting will be enlarged and continued to test the value of exposed firm bottom discovered in this way.

S. E. Vass

Appendix No. 15

OYSTER DISEASES

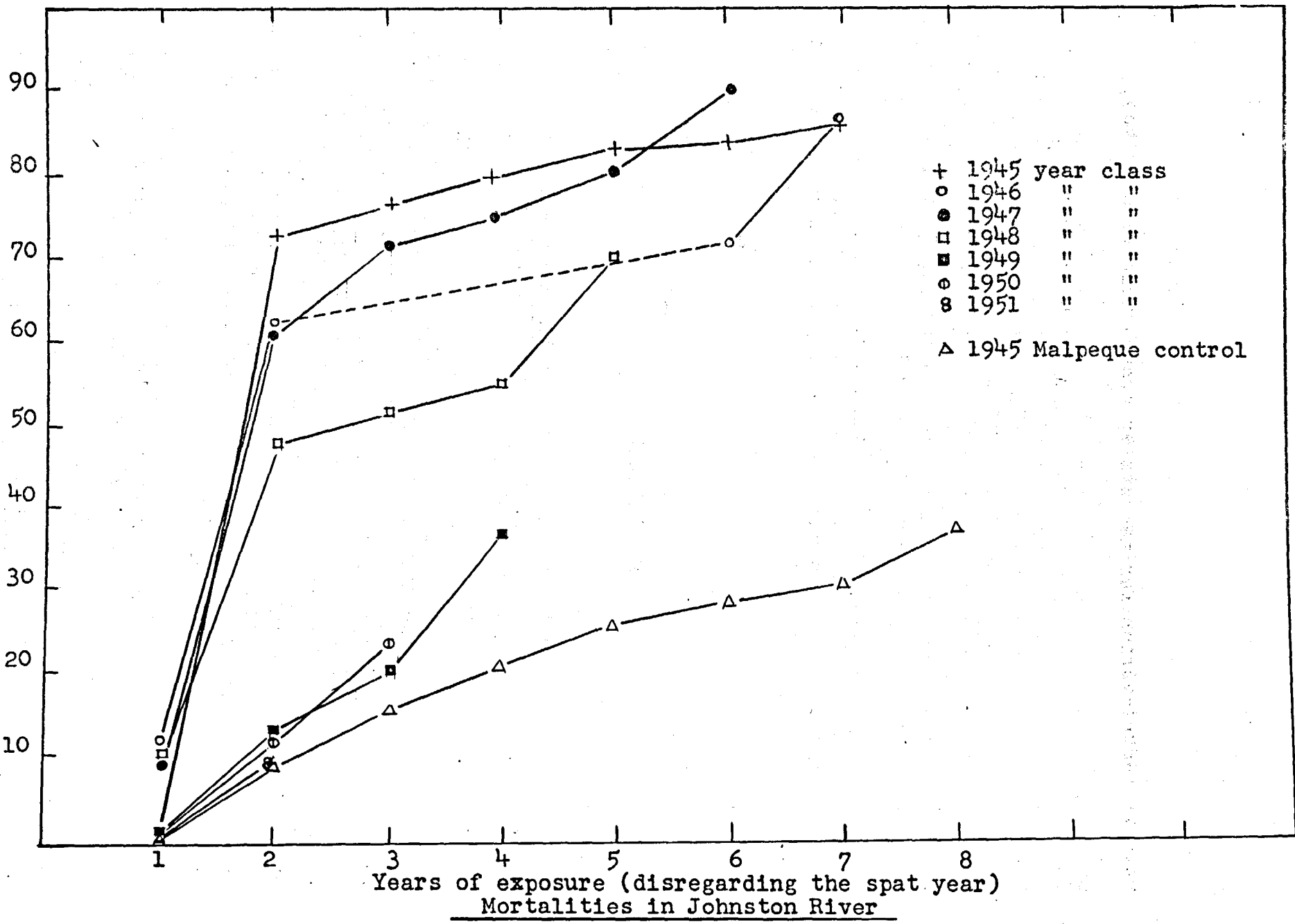
(a) The "Malpeque disease"

For several years a comparison has been made of the mortalities of susceptible native and resistant Malpeque stocks of the same year classes, held side by side in trays in Johnston and Enmore Rivers, P.E.I.

In Appendix 11 of the 1951 Annual Report, a graph was presented showing the accumulated mortalities of certain Johnston River year classes contrasted with those of a representative year class of Malpeque oysters serving as controls. This graph is presented again here with data from 1952 and 1953 added. Data from 1949 and 1950 concerning the native 1946 year class were previously reported as unreliable and therefore omitted from the graph. The results in 1951 were also considered questionable. Data gathered in 1952 and 1953 show, however, that the accumulated mortalities of the 1946 year class are comparable with those of preceding year classes.

The mortality curves for the 1949, 1950 and 1951 year classes continue to approximate those of the Malpeque controls. The assumption that this indicates development of resistance in the native stocks appears justifiable. These three year classes exhibit an almost normal mortality during their second year in striking contrast with the mortalities of the four preceding year classes. It would seem more reasonable to expect a progressive decline in second-year mortalities, since this is the critical period after infection. The divergence of the curves in the

Accumulated mortality (expressed in percentage of original no.)



third and fourth years may, however, denote the remaining degree of susceptibility in the younger native stocks.

(b) The West River disease

Oysters fished from West River, P.E.I., and held in cold-air storage in Charlottetown during the winter of 1952-53, continued to display a mortality curve and symptoms comparable to those observed in similar tests in 1950 and 1951 (Appendix 13 of the 1952 Annual Report). It is expected that a more searching, microscopic examination of oysters affected by the West River disease will be carried out in 1954.

(c) A possible disease in Kent County, N.B., oyster stocks

Since about 1950 there has been a marked decline of oyster landings from Kent County, N.B., which, beginning at Cocagne, spread northward to Buctouche (ten miles distant) by 1952 and now afflicts the Richibucto district some twenty miles farther north. Total landings in the county were as follows:

1949	7,003 cwt.
1950	3,974 cwt.
1951	4,822 cwt.
1952	1,495 cwt.
1953	250 cwt. (to Oct. 31).

A survey of these districts in August, 1950, and an examination of the Cocagne area in October, 1952, showed that most of the oyster beds were small "stack" beds surrounded by mud, sand and eel-grass. Clustering, slow growth and poor shape were found to be common. No evidence of disease or of undue mortality was detected during the 1952 examination at Cocagne, although the absence of certain year classes was noted, including the classes then supplying the market and near-market sizes. In October, 1953, dredging in five localities at Buctouche and Richibucto took less than a hundred oysters, mostly those in their second and third year. Some living spat were obtained and a few market-size oysters were collected, mainly from up-river points. No moribund specimens or abnormal symptoms were detected but there was some evidence of a rather high mortality among younger oysters during recent years.

The poor growth, extensive clustering and possible earlier failures of spat production, combined with the heavy fishing intensity of the past decade, might be responsible for the present very low yield of the Kent County fishery. There is, however, an unconfirmed report that shells from Prince Edward Island oysters were dumped on the Cocagne shore in 1951 after shucking in Moncton and, since the "Malpeque disease" is known still to be present in Island waters, it may have been introduced in this way into New Brunswick waters. After oysters became scarce at Cocagne, some fishermen moved northward to more productive localities and many have carried the disease, leading to scarcity in the northern areas.

To indicate whether or not the "Malpeque disease" is now present in Kent County waters, Buctouche oysters were placed in trays at Buctouche and at Eilerslie, P.E.I., in June, 1953. If the disease is still absent from Buctouche the oysters held there may be expected to suffer a lower mortality than those held at Eilerslie where the disease has caused excessive mortalities among oysters from disease-free areas in the year after their introduction. It is further planned to hold Cape Breton oysters, which are known to be susceptible at Buctouche, where they will become infected should the causative organism be present.

A more thorough survey of the three districts will be carried out next spring, along with a detailed examination of shellfish from each district. Meanwhile, it is being recommended that the transfer of oysters from Kent County to other waters be prohibited.

S. E. Vass

Appendix No. 16

THE MORPHOLOGY AND SEXUAL REPRODUCTION OF THE BORING SPONGE, *CLIONA CELATA*

The techniques developed in 1952 (Appendix 16 of the Report of this Station for 1952) were applied this year to a study of the morphology and reproduction of *Cliona celata*, the boring sponge which attacks oysters in Malpeque Bay, P.E.I. The writer was able to obtain an understanding of much of the morphology of the species, and a set of photomicrographs was prepared to illustrate some of its anatomy and histology. The use of transparent crystals of calcite for culturing the sponge, a technique originated by Truitt (1940), was tried with partial success. Since ordinary photographs of the excavations of the sponge were confusing, a method was developed for making stereoscopic photographs and photomicrographs. The apparatus required is simple and inexpensive enough to permit its use when only one or two photographs are to be taken, and may be applicable to other projects.

The anatomy of *C. celata* differs from that of other Monaxonid sponges in several respects related to its unusual habitat. For example, the delicate dermal membrane which is so extensive in many sponges and beneath which lies a system of large incurrent chambers is reduced to a vestige in *Cliona*, so that destructive solutions must diffuse through a system of relatively long canals of small calibre to reach vital tissues.

Oogenesis in *Cliona celata* takes place chiefly in those parts of the shell where the largest sponge masses lie, spermatogenesis occurring in regions where the shell is thin and the sponge relatively tenuous. Spermatozoa are produced from a type of amoebocyte which has numerous basophil granules in its cytoplasm. These gather into roughly spherical masses,

about 100 microns in diameter, which become enclosed by a thin membrane. The usual two consecutive nuclear divisions occur and the minute spermatozoa are released into the canal system by the rupture of the membrane.

Eggs develop from archaeocytes, a type of large amoebocyte with a large nucleus enclosing a spherical nucleolus. These become enclosed in a cavity of the mesenchyme, where they are attended by several amoebocytes known as trophocytes which apparently are involved in their nutrition, and one of which (according to other authors) eventually carries the sperm nucleus to the egg. The egg cytoplasm becomes highly granular, bearing a perinuclear zone of acidophil and a peripheral zone of basophil granules. It remains irregular in shape until it is discharged.

After fertilization the eggs enter the excurrent canal system and are discharged from the oscula. This was observed in only one case in early July. Each egg, which is roughly ellipsoid in shape and 45-60 microns in diameter, carries with it from fifteen to thirty trophocytes which remain actively amoeboid for some time but later expand and meet each other at their edges to form a membrane completely enclosing the egg. If two eggs are nearly in contact their membranes become attached to each other. In the case observed, eggs fell from an osculum on to a nearby shell where they adhered to each other to form a fragile but extensive mat.

Cleavage is subequal and holoblastic and does not begin until as much as four hours after the egg has been discharged. At about the thirty-two- or sixty-four-cell stage the trophocyte-membrane disappears and each of several cells in the morula extends a single conical pseudopod, two or three times the diameter of the cell in length, which droops at the tip toward the substratum and appears to be more or less rigid and immobile.

Unfortunately it was impossible to follow development beyond this stage, although a few days later the earliest boring of a larva was found in a piece of calcite. It took the form of a minute, bottle-shaped excavation, neck uppermost, with an inner surface displaying the same irregularly chipped texture shown by borings produced in calcite by sponges spreading vegetatively.

Some of these observations were unexpected, to say the least, and since they were made on only one group of eggs they must be verified by further observations. They suggest that this species omits the free-swimming, ciliated larval stage from its ontogeny. This speculation is supported by the fact that we have never known oysters to become spongy while kept in a floating tray, although they and the material of the tray itself not infrequently bear other species of sponges (e.g., Halichondria, Microciona) and other organisms whose dispersal involves ciliated larvae. Such a restriction on the rapidity of spread of Cliona would obviously facilitate control measures.

QUAHAUG INVESTIGATIONS

An increased demand for the quahaug, or hard-shelled clam, Venus mercenaria, has resulted in a more intensive fishing effort in certain Maritime areas during the past few years. Coincident with this has been the occurrence of extremely successful spatfalls in some districts, producing large beds of particular year classes. Some preliminary work was undertaken to obtain information concerning two aspects of the fishery: the duration of intensive fishing which the areas might support, and the value of transplanting young quahaugs from the crowded beds.

The offshore bars at Neguac, N.B., and the shores south of Panmure Island, P.E.I., have supplied most of the production during recent years (Figure 1). Samples to determine age distribution were taken in these areas and small plots containing about 200 measured, marked specimens were laid out at each place for growth-rate studies. As a control, similar operations were conducted at Malagash, N.S., where the fishing is quite casual. The limited sampling possible may not be truly representative and the estimations of age are difficult to the inexperienced observer but an approximate age-frequency distribution for the three areas is given in Figure 2.

During the summer the plot at Neguac was rifled by local fishermen - a fact confirmed by the finding of marked specimens among confiscated, under-sized quahaugs. At Panmure Island the stakes indicating the plot had disappeared by October and no marked quahaugs could be found. Specimens from Malagash yielded average increments in length, height and thickness of 3.5, 3.0 and 1.8 mm., respectively.

At Neguac it was observed that numerous quahaugs had died during their first four years, a large percentage having been drilled. The clam drill, Polinices, was present everywhere. The 1952 year class survived unusually well, although there was evidence suggesting extensive winter-killing. The density of quahaugs on the Neguac bars was such that in many places an area of one square foot would yield a small shovelful when the surface alone was scraped. At Panmure Island, where the concentration was less pronounced, most animals were able to burrow and living clam drills were seldom seen.

Casual observations during the summer showed that quahaugs are present in many Maritime districts. Quahaugs have been taken from a variety of environments ranging from sandy soil to black mud with thick eel-grass cover and from a vertical range extending from the littoral zone to three or four metres below low-tide level.

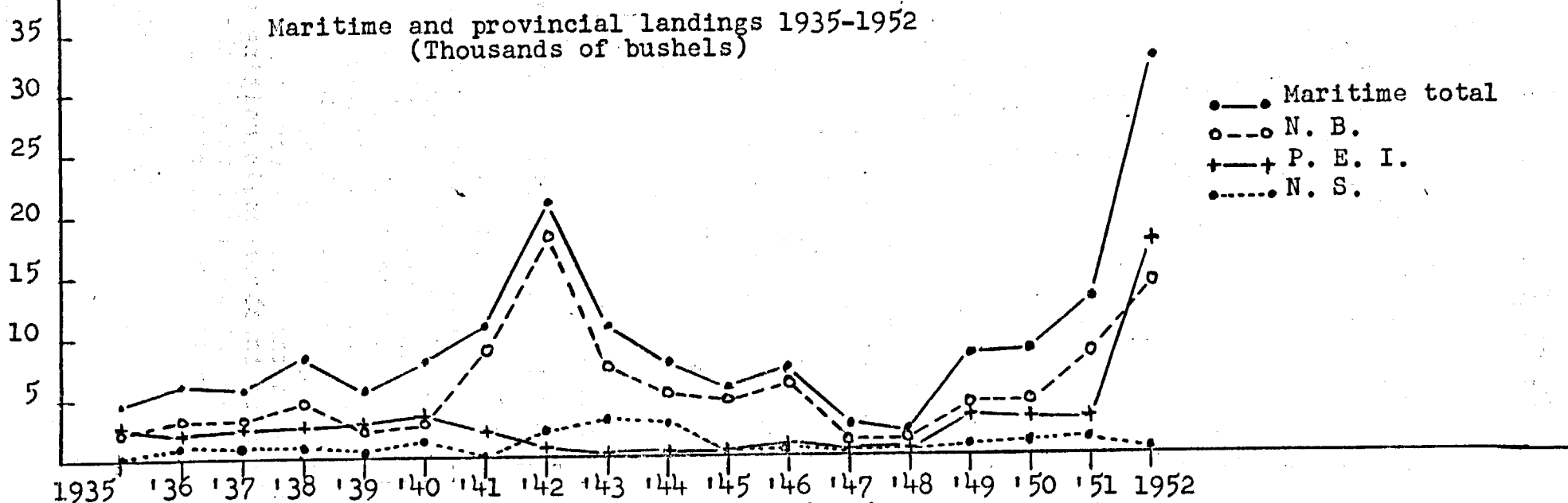
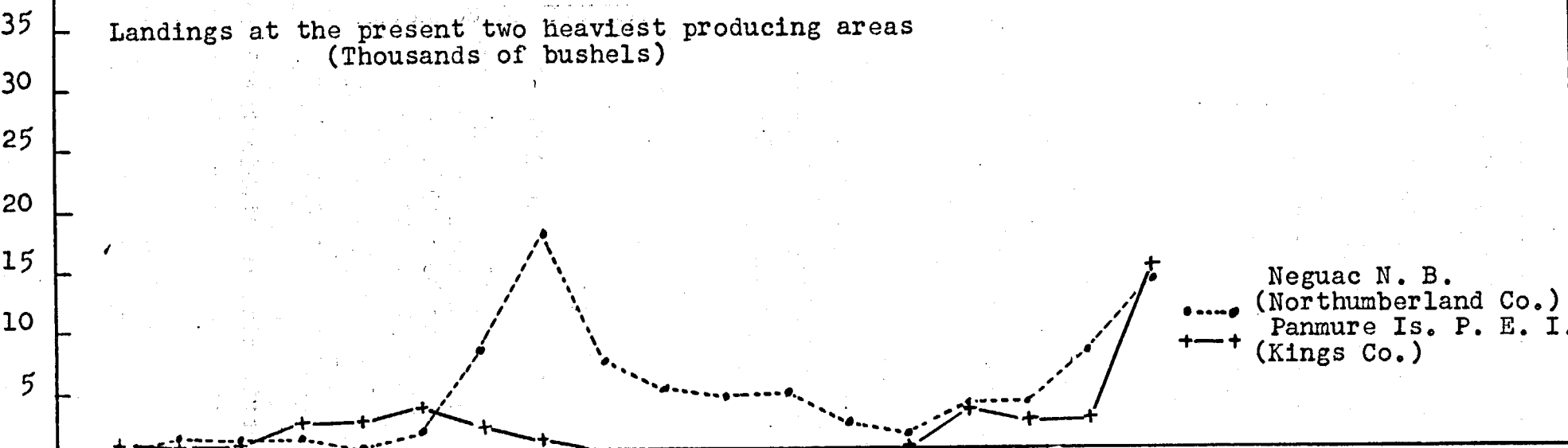
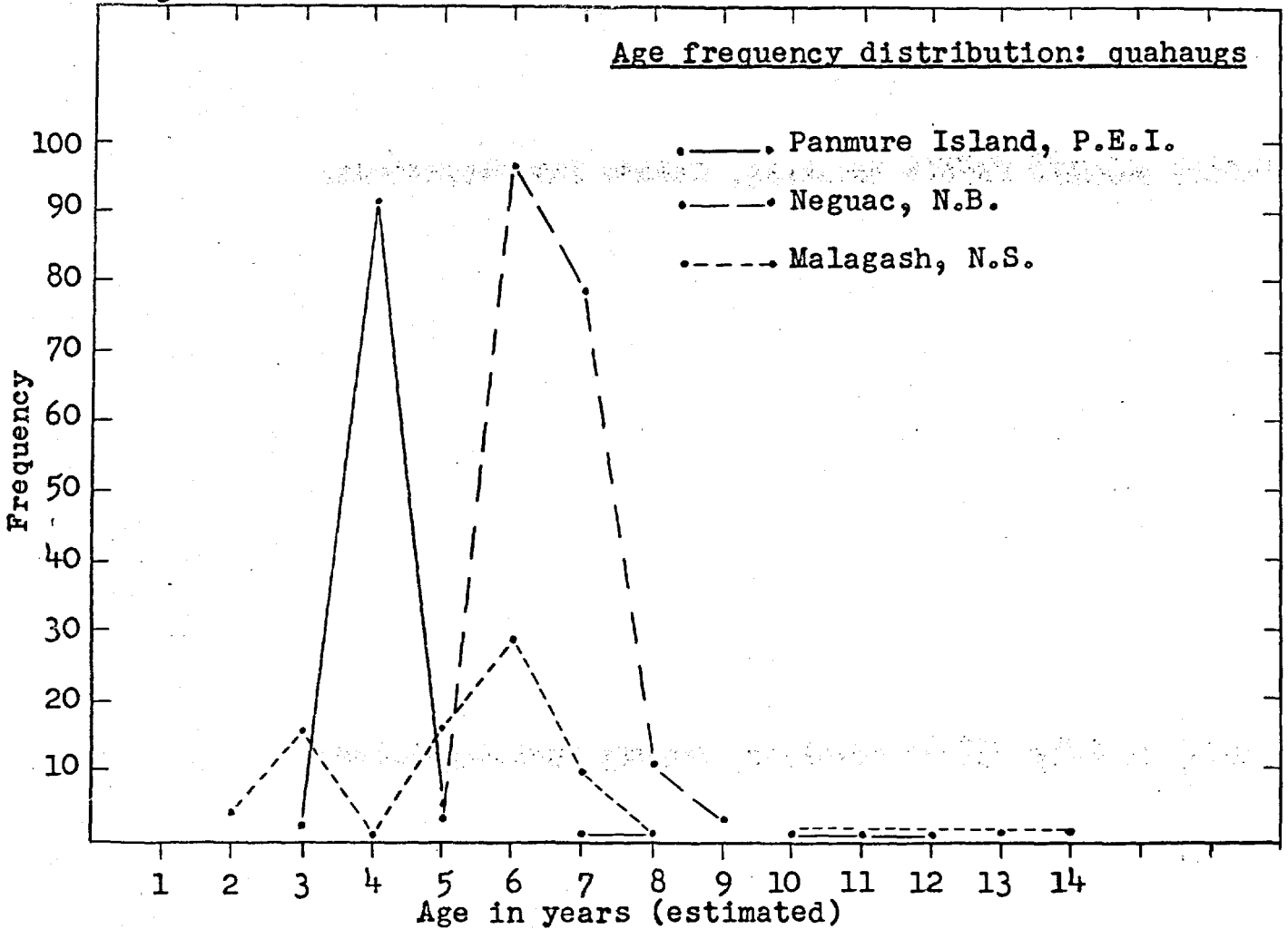


Figure 1. Maritime quahaug production 1935-1952.

Figure 2.



S. E. Vass

Appendix No. 18

TRIAL SHIPMENT OF CLAMS (MYA) USING A NEW TYPE OF REFRIGERATED CONTAINER

The Canadian National Railways have developed a shipping container for use in the movement of fresh fish from maritime points to inland markets. This insulated box of three bushels (160 lb.) capacity is refrigerated by pre-cooled, inner liners containing a eutectic mixture which maintains a temperature of 29° F. (-1.7°C.) for 50 hours. In preparation for shipment the liners are cooled to 20° F. (-6.7°C.), the freezing point of the eutectic mixture, and the fish is chilled to 29° F. The liners, when re-assembled, completely surround the contents and as heat flows inwardly through the outer walls it is absorbed in melting the eutectic mixture within the liners. This melting is completed in about 50 hours, thus determining the life of the container as a refrigerated unit.

A trial shipment of soft-shelled clams (*Mya*) was made from Charlottetown to Montreal on October 7. A second container, similarly

processed, was returned to Ellerslie for periodic sampling. Controls were taken from the original stock and from those clams subjected to the cooling process. By careful handling of the Ellerslie container, cooling effects could be separated from the combined effects of cooling and jarring which attended the Montreal shipment.

Unfortunately, no facilities were available in P.E.I. for holding the clams at 29° F. Instead, they were held at 36° F. for twelve hours and then transferred to -10° F. until the outer tissues approached 29° F. Temperature determination at this stage proved to be most awkward. The warmer temperature of the inner tissues caused a more rapid melting of the eutectic mixture during shipment and consequently shortened the period of refrigeration; but this course was preferred to that of prolonged cooling, with its inevitable freezing of peripheral tissues. Since living material was being used, it was felt that a slightly higher shipping temperature could be tolerated.

Sampling began at Ellerslie when the trial shipment was due to arrive in Montreal. The clams were inspected for macroscopic evidence of frozen tissue, which evidence was absent, and for response to a mechanical stimulus, which proved to be normal in almost all cases. Recovery was determined by the time required for feeding and burrowing to begin after planting in aquaria and in all samples this was accomplished within 20 minutes.

Storm conditions at Ellerslie prevented earlier planting of the two control groups in the river bottom and they were simply dropped through the water. Their subsequent dispersal by wave action resulted in the loss of about 5% of each group. It was not possible to test more critically in aquaria those controls which were recovered, because of irregular operation of the salt-water system but they appeared to be in good condition.

Temperature and mortality records are presented:

Elapsed time (hours)	33	35.5	38	42.5	46	50	61
Temperature of container at Ellerslie (°F.)	35.6		37.4	41.0	41.0	41.9	46.4
Temperature of container at Montreal (°F.)		31.0					
Mortality in 24 hours at Ellerslie (based on random samples of 50 clams)		2%				4%	
Total mortality at Montreal on arrival			1.6%				

The higher temperature of the Ellerslie container at the 33-hour point is attributed to a shorter period of cooling

at -10°F., while subsequent temperature readings were influenced, of course, by previous opening of the container. Inspector P. J. Marchand, Federal Department of Fisheries, Montreal, reported favourably on the condition of the Montreal shipment. Only 2 lb. (30 clams) out of 125 lb. were dead or broken on arrival.

In this type of container, fifty hours of efficient refrigeration is contingent upon an initial temperature of the contents of 29° F. Before a more critical assessment of the method can be made, a means of thoroughly cooling the clams to 29° F. must be found and this is imperative if shipments are to be made by commercial operators. The results of the experiment, while not decisive, indicate that the method is practicable and it should be possible to deliver small quantities of living clams to points not presently served by rail.

The writer acknowledges the courteous co-operation received from Mr. Durbar, manager of the cold storage plant of the P.E.I. Department of Industry and Resources at Charlottetown.

S. E. Vass

Appendix.No. 19

CLAM FARMING EXPERIMENT AT POCOLOGAN

The single profitable exception in all efforts at clam farming was observed at Kate's Ledge, Pocologan Harbour, N.B., and was reported in the 1952 Annual Report (Appendix No. 18). Six bushels of seed clams, averaging 1 3/4" in length, were planted on this flat in 1950 and two years later twelve bushels of marketable clams were harvested.

In September, 1953, 61 clams were dug from a small planting made in May, 1949, on the same flat. In the 3 1/2 years since planting, the clams showed an average increase in length of 66% which in this case is equivalent to approximately 400% increase in volume per clam planted. With such rapid growth rates, heavy mortalities could be sustained by clams planted on this area and the resulting yield by volume would still be several times the amount planted.

Such results encourage further commercial trials and this year three relays were made at Kate's Ledge flat using seed clams dug from non-commercial flats elsewhere in the harbour. In all 3.75 bushels, an estimated 13,000 clams, were planted.

J. S. MacPhail

Appendix No. 20

A COMMERCIAL-SCALE EXPERIMENT IN CLAM CLEANSING

The initiation of a project for the cleansing of polluted clams, undertaken jointly by the Fish Inspection Laboratory of the Department of Fisheries and this Station was reported last year (Appendix No. 25). The results showed that such clams, when exposed to pollution-free waters, cleanse themselves and become fit for human consumption in less than 96 hours. This year a commercial-scale operation in the cleansing of clams from a moderately polluted area was undertaken jointly by the Fish Inspection Laboratory, this Station and the Department of National Health and Welfare. Commercial diggers were permitted to dig under supervision from the mildly polluted area at Oak Bay. The clams were transported by truck to the cleansing station at Holt's Point where they were culled for breakage, placed in floats and allowed to remain to cleanse for an appropriate period. Samples were taken at intervals for determination of coliform content, and, when they were found to be pollution-free, were removed from the floats and taken to the shucking plant.

During the three months of operation 534 barrels of clams were processed at the cleansing station. The clams were marketed by the fresh clam meat trade and realized an estimated \$13,884.00. Of this amount, the clam diggers received \$6,943.00 with the balance shared by the employees, suppliers and shareholders of the participating shucking establishment. The cost of cleansing has been estimated at about \$4.60 per barrel.

Results of this season's small commercial-scale trial operation suggest:

- (1) That the cost of cleansing per barrel would decrease sharply if the volume handled per unit of time were increased towards a level 100 to 200 per cent higher than that of the 1953 project.
- (2) That the local clam trade would be willing to pay a portion of cleansing costs.
- (3) That the present population of market-sized clams in Oak Bay exceeds 5,000 barrels.
- (4) That the local Oak Bay digging force is unable to harvest more than 600 barrels in any three-month season.
- (5) That only the exceptionally productive diggers from other areas find it profitable to travel to Oak Bay to participate in the harvesting.
- (6) That the larger volume of clams required for a lower-unit-cost cleansing programme in Charlotte County could be supplied only through the exploitation of additional polluted beds chosen in localities where the necessary labour force could be recruited locally.

Bacteriological findings include:

- (1) As in earlier trials of the sort, the clams, when transferred from water having a higher level of coliform

bacterial pollution to water having a lower level of such pollution, reflected the change in their own decreasing internal concentration of these bacteria. In most cases the two water areas differed less with regard to level of coliform concentration than had been the case in previous trials. As a result the decreases obtained in the clam's coliform load were less extensive than those observed in earlier experiments.

(2) Rainfall heavy enough to produce land run-off resulted in higher coliform counts in adjacent waters. This was observed to be true of both the digging area and the cleansing area.

(3) During such periods the partially cleansed clams became re-populated with coliform bacteria. In some cases the density of the new population exceeded that of the original.

M. W. Mullan

Appendix No. 21

PRELIMINARY EXPERIMENTS ON THE FOOD OF THE GREEN CRAB

Investigators in the United States have attributed extensive damage of clam stocks to depredations by the green crab, Carcinides maenes, although little precise information on its feeding habits is available. Recently the green crab has been found on clam flats in Passamaquoddy Bay (Appendix 22). During the autumn of 1953 a series of preliminary experiments was begun to determine its rate of feeding on different sizes of clams, the sizes "preferred" by different sizes of crabs, and the type of food selected by crabs when they are presented with a variety of shellfish. Several small plantings of clams were also made on flats where crabs are abundant in an attempt to assess their probable importance as predators in this area.

In the feeding experiments two tanks were set up, one containing 10 small crabs (1 3/8 - 1 7/8" carapace width) and the other 10 large (2 1/4 - 3"). At the beginning of each experiment shellfish were placed in the tanks; examinations were made at 24-hour intervals and any shellfish that had been eaten were replaced. Each experiment was run for 6 days. The results indicate that all crabs prefer small clams to large ones, although large crabs ate a higher proportion of large clams than did small crabs. Both large and small crabs ate 1" clams at the rate of 1.9 per crab per day. The feeding rate decreased rapidly with larger-sized clams, although the volume of clam meat consumed per crab per day remained almost constant. Small crabs ate no clams larger than 2" in length, while large crabs ate clams up to 2 1/2".

In the food selection experiments 10 small clams (Mya arenaria), 10 mussels (Mytilus edulis), 10 Macoma balthica, 10 periwinkles (Littorina littorea), two 1 1/4" quahaugs (Venus mercenaria) and several barnacles (Balanus balanoides) were put into each tank. The small crabs ate clams and Macoma at about the same rate but their rate of feeding on mussels was only half as great. They ate only one small periwinkle and did not eat

quahaugs or barnacles. Large crabs ate clams, mussels and Macoma at approximately equal rates but seemed to prefer periwinkles to all other food. They ate one quahaug but did not eat barnacles.

In the experiments on the flat, four plantings were made, each of 100 $1\frac{1}{2}$ - $2\frac{1}{2}$ " clams marked with Volger's Red Ink. Two plantings were made on the sand and mud soil of St. Andrews flat on Sept. 12 in the vicinity of natural stocks of large clams; the other two at either end of the loose sandy soil of the Bar Road flat on Sept. 15, one in the vicinity of a bed of large clams and one in an area where there were a few seed clams of the year but which was otherwise barren. All plots were dug one month later. On the St. Andrews flat recoveries of whole clams were 78 and 88%, from the Bar Road flat 48 and 37% respectively. In every case the average length of clams recovered was slightly larger than that of the planted stock (0.3 - 1.2 mm.). Reduction in numbers appeared to be almost entirely the work of crabs.

These experiments indicate that the green crab is a serious clam predator, which, since it also feeds extensively on other shellfish, may maintain its abundance independently of the size of the clam stocks. It is not clear, however, how great a menace it constitutes since some of the other shellfish it eats may be competing with the clam for food and space on the flats and because the crab offers competition to other predators. Further experiments are planned, particularly to compare its effects with those of Polinices, a snail which, heretofore, has been our most serious clam predator.

J. S. MacPhail, E. I. Lord, L. M. Dickie

Appendix No. 22

ABUNDANCE AND DISTRIBUTION OF THE GREEN CRAB - A CLAM PREDATOR

The green crab, Carcinides maenes, was first reported in Canadian Atlantic waters in July, 1951, when specimens were found in the Digdeguash River, Passamaquoddy Bay. It was again observed in several areas within the bay in 1952 but its distribution did not appear to be widespread nor was it abundant. Extensive collections during the summer of 1952 at Lepreau Ledges in the Bay of Fundy failed to show any signs that it had spread outside Passamaquoddy Bay.

The crab appeared in great numbers on all flats in Passamaquoddy Bay in the early summer of 1953 and by September was observed to be equally numerous in Pocologan Harbour and Lepreau Basin, 60 miles east of the mouth of Passamaquoddy Bay. Specimens were also found in Nova Scotia at Sandy Cove on the northern shore of St. Mary Bay in August and at Perea River in Minas Basin in November, 1953.

It is evident from these observations that conditions suitable for survival, reproduction and spread of the crab

population have occurred in the Bay of Fundy during the past three years and are probably related to the general increase in average water temperatures.

J. S. MacPhail

Appendix No. 23

THE BAIT WORM INDUSTRY OF THE MARITIME PROVINCES

Exploration for blood worms, Glycera, and sand worms, Nereis, in the coastal areas of the Maritimes reported in this Station's Annual Report for 1951 (Appendix 27) and 1952 (Appendix 24) resulted in the discovery of promising concentrations of worms of good commercial quality in Yarmouth County, Nova Scotia, and Lepreau Basin in Charlotte County, New Brunswick. Exploitation in these areas began in 1952. During the past year about three million worms were taken from Yarmouth County, N.S., for which the shippers paid about \$45,000. Small quantities were also shipped from Charlotte County, N.B., and from the St. Mary Bay area in Nova Scotia. In the latter area, however, small concentration of worms coupled with absence of the seaweed, Ascophyllum Mackaili, now used for packing, makes large commercial-scale operations impractical.

During May, 1953, the south shore of Minas Basin was explored. Worms were found to be abundant in several places from Pereau River to Avon River but these were without exception smaller than commercial size. The area was examined again in late August but there was no perceptible increase in the size of worms present. Commercial use of these seems unlikely.

It is expected that the great demand for bait worms in the United States will continue throughout 1954 and will result in a high production in Yarmouth County, N.S., and an increased production from the Lepreau area of Charlotte County, N.B.

An investigation of the life history of the bait worm, related especially to the productivity of the areas has been initiated and is reported in Appendix 24.

W. L. Klawe

Appendix No. 24

STUDY OF THE BIOLOGY OF BLOOD WORMS, GLYCERA DIBRANCHIATA EHLERS

The necessity for the study of the biology of blood worms, Glycera dibranchiata Ehlers, has been stressed in the Annual Report for 1952 (Appendix 24). During the spring and summer of 1953 investigations on the population of this animal were undertaken at Wedgeport, Yarmouth County, N.S. Analysis of the

data collected will continue at the University of Toronto during the winter but several conclusions may be drawn from what has been done so far.

Sex ratio and spawning

Examination of large numbers of worms collected in late May and early June showed that about 10% of commercial-sized worms contained mature gametes. In the total number of these mature worms only one male was found. This agrees with observations of previous investigators that the number of females is greatly in excess of the males. From diggers' reports of a greater abundance of "spawners" (mature worms) earlier in the spring, it appears that the principal spawning period had already passed before the field work was begun.

Larval development

Mature eggs were obtained from adults collected in early June and were fertilized in vitro. Larvae were reared in the laboratory to the free-swimming trochosphere stage. Attempts to feed these failed and all died within 12 days without showing further development. Various attempts to collect larvae in plankton tows were unsuccessful.

Population study

Samples dug from the flats during the spring showed that only about 20% of the worms which could be taken by this method were of commercial size. Additional samplings were made at regular intervals throughout the summer to follow changes in size-composition as a result of their growth and exploitation by the fishery.

Previous investigators have failed in their attempts to mark worms by vital dyes and stains, or to tag them, but during the summer the writer succeeded in marking them with a silver nitrate pencil. Numbers of worms were marked and released on the flats and several were recovered. The data are not yet analyzed but they should greatly facilitate the study of growth and movement. The information on rate of exploitation and abundance which can also be obtained from these recoveries will help to explain the reports by the diggers that there was no noticeable reduction in the numbers of worms from 1952 to 1953, although in 1952 some parts of the flats were dug as often as three times.

Other information

Observations have also been made on the feeding habits, movements and distribution of the worms in the intertidal zone. It was found that abundance varies from place to place on the flat. They were most heavily concentrated in muddy soil, rich in decomposed organic matter and were scarce in sand. This distribution is related to the fact that the food of the adults

consists mainly of the organic detritus included in the mud which it ingests. Tag returns have indicated very little movement of worms about the flats during the summer.

W. L. Klawe

Appendix No. 25

FLUCTUATIONS IN DIGBY SCALLOP LANDINGS AND FORECASTS OF PRODUCTION

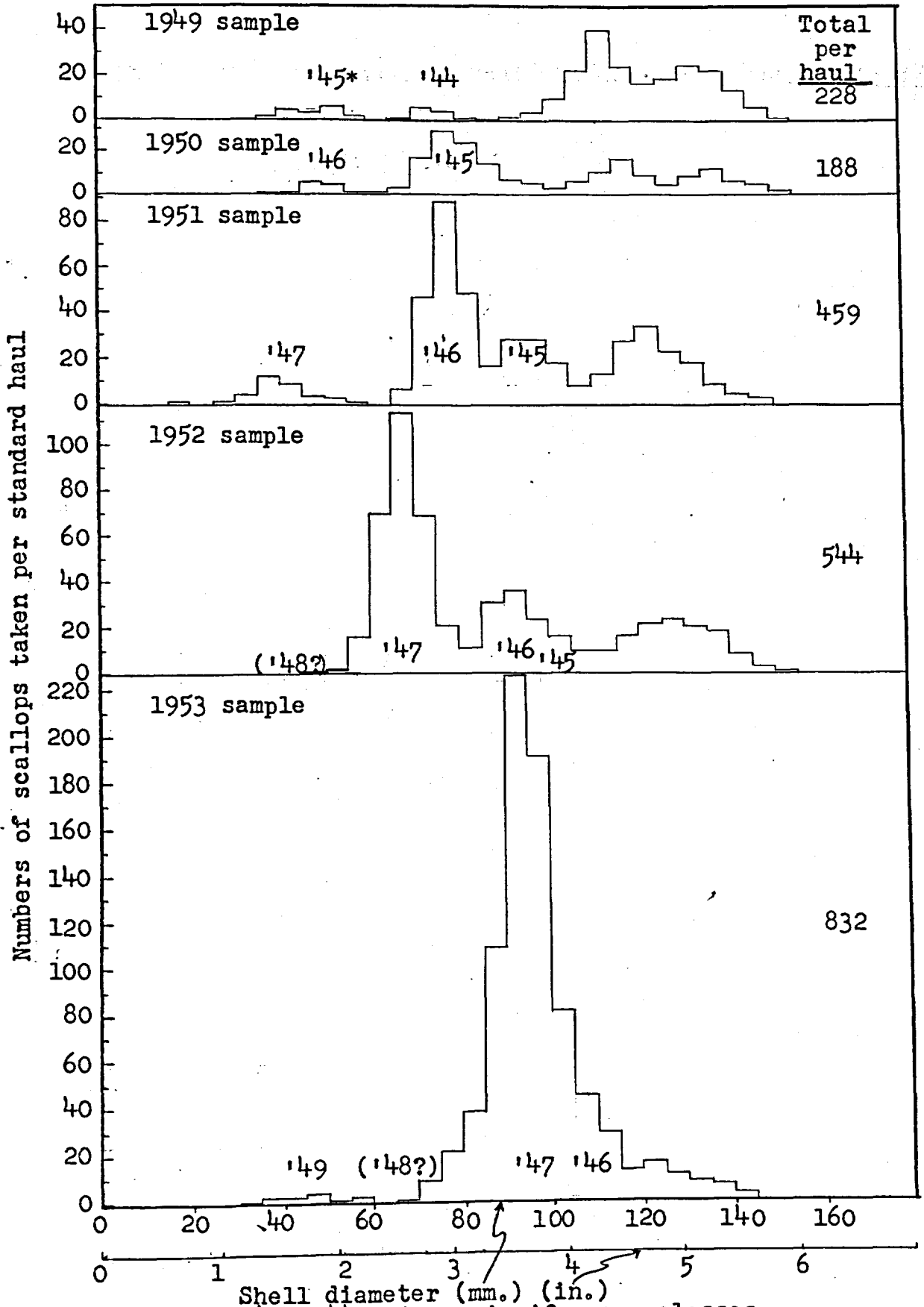
Investigations of the Digby scallop fishery have shown that production is closely related to the abundance of catchable scallops and that abundance is correlated with water temperatures. If water temperatures are high following spawning time, a strong year class of scallops is produced. Six years later when these have grown to fishable size, landings are high. Conversely, low temperatures are followed by low catches six years later (Appendix 19 of the 1948 Annual Report). From these findings the low production about 1948 was explained as resulting from weak year classes produced during the early 1940's when water temperatures were low. It also appeared that high water temperatures in 1946, 1947 and 1949 should have produced strong year classes which would lead to increasing catches starting about 1952 and that in the future a knowledge of water temperatures would permit forecasts of scallop production.

To increase the precision of such forecasts, an annual systematic sampling of the Digby scallop stocks was initiated in 1949 (Appendix 22 of the 1950 Annual Report). An example of the data on relative abundance and size composition which are obtained by this method is illustrated in the accompanying figure for Buoy Ground, one of the more important inshore beds.

On this bed, the 1949 sampling with standard scallop gear showed that most of the catchable scallops (greater than 3 1/4" shell diameter) were between 4 1/2" and 6". There were also two smaller size groups averaging 2" and 3" and belonging to the 1945 and 1944 year classes respectively but these were still too small to be taken in numbers by the commercial fishery. Average catch per boat and total production during the 1949-50 fishing season were low.

The 1950 sampling showed that the larger-sized scallops were considerably reduced in abundance, that the 1944 year class was completely over-shadowed by the more abundant 1945 year class which averaged a little over 3" in shell diameter, and that the 1946 year class was present as 2" scallops. Catches from the inshore beds in 1950-51 were lower than in the previous season, but average catches for the season were higher because fishermen spent most of their time fishing the better-stocked offshore beds which are less accessible than inshore beds and had hitherto been fished relatively little.

Changes in size- and age-composition and relative abundance of scallops on Buoy Ground (1949-1953)



* The figures '45, '44, etc., signify year classes.

The 1951 sampling indicated that the population was dominated by the strong 1946 and 1945 year classes. Numbers of the 1947 year class also appeared but were less than 2" in diameter and of little value commercially. That year fishing was resumed on the inshore areas but the increase in abundance of small scallops did not compensate for the reduced abundance of large, and 1951-52 production was lower than at any time since 1931.

The survey of 1952 showed that, to the catchable stock remaining from 1951, the exceptionally strong 1947 year class had been added. In July, when the sampling took place, this year class averaged only 2 3/4", but by the time fishing began in October they exceeded 3 1/4" and fishermen took large numbers of them. Their abundance was so great that, despite low meat yields from such small-sized scallops, total landings were nearly double those of the previous year and average seasonal catch per boat rose from less than 10,000 pounds in 1951-52 to 20,000 pounds in 1952-53, higher than at any other time in the history of the fishery except 1937.

On the basis of this year's samplings, the prospects for 1953-54 appear even better. The Buoy Ground samples were completely dominated by the 1947 year class which is more abundant than any other on record, and although in July the scallops in it averaged only 3 3/4", by October they should have grown to over 4", a size from which meat yields are high. A situation similar to that on Buoy Ground holds on all inshore beds and should lead to an increase in catch over last season, confirming the prediction made in 1948 based on the trend in water temperatures.

The 1952 and 1953 samples also offer further support for the correlation between water temperature and year-class strength. The 1947 water temperatures were the highest on record up to then and the year class produced was unusually strong; but in 1948, water temperatures dropped sharply and both series of samples indicate that the 1948 year class must have been very weak. None of them were taken in the samples. Water temperatures for 1949 were high again and there are indications of a good 1949 year class as some of them appeared in the 1953 samples, although the scallops composing it average only 1 3/4", too small to be taken in quantity by the sampling gear.

Although the combined information from water temperatures and sampling of the stocks permits prediction of the trend in production, the annual sampling of the Digby beds has not been continued long enough to permit the calculation of an index of abundance from which catches may be forecast with precision. Some of the weaknesses of such an index were pointed out last year (Appendix 29 of the 1952 Annual Report). Forecasts for the next few years will be further complicated by the fact that throughout the period for which we have data, price has remained high. This year, however, price has dropped sharply, and there are signs that it may be discouraging effort. In addition, a new

regulation of the fishery was introduced last season, eliminating the legal minimum-size limit of 4" (which was difficult to enforce and disregarded by fishermen) and raising the mesh size of scallop drags from 2 5/8" to 3 1/4" inside diameter. This change in regulation was based on experiments and recommendations made by this Station (Appendix 23 of the 1950 Annual Report and Appendix 26 of the 1952 Annual Report), but it has not yet been in force long enough to permit an evaluation of its short-term effects on the commercial landings.

It is proposed to continue the annual sampling in an attempt to standardize it better and to improve its reliability for forecasting production, as well as to follow any changes in the relationship between landings and population which may result from the new regulation.

L. M. Dickie

Appendix No. 26

OFFSHORE SCALLOP EXPLORATIONS

Explorations for scallop beds on the Scotian Shelf and St. Pierre Bank were carried out during the summer. The offshore scallop dragger "Elaine W." was chartered for one trip to Middle Ground and the Sable Island area from July 8 to 20, and the "Irish Patriot" for four trips to Emerald Bank, Sable Island, Middle Ground, Banquereau and St. Pierre Bank from August 6 to October 13. Both draggers are built for offshore work and their equipment copied from the American draggers working out of New Bedford.

Emerald Bank was found to be very rocky and rough and dragging was possible in only a few areas. No scallops were found and, from poor catches of other animals, the bank appeared to be especially barren. On the western part of Banquereau, where the bottom is suitable for dragging in waters shallower than 35 fathoms, a few isolated patches of scallops were found, but this area does not appear to support scallops in commercially attractive quantities.

Scallops in concentrations of interest commercially were found on Middle Ground, Sable Island Bank and St. Pierre Bank. On Middle Ground catches equivalent to more than 1000 pounds of meats daily were made at about 44° 42' N. and 60° 39' W. but the bed is small, hence difficult to find even with Loran and Canadian fishermen have indicated that under present conditions they would not consider fishing there as worth while as on Georges Bank. On Sable Island Bank two areas were found and the "Irish Patriot" attempted to fish them as though on an ordinary commercial operation from September 15 to 30. Highest catches were 500 pounds per day, which are sub-commercial landings at present prices. One of the two areas so fished holds some promise for improvement as the young scallops present on it

grow to sizes which yield better "meats". No improvement can be expected on the other as the scallops there are already old and the meats watery and stringy.

The best catches for the summer were made on the northern part of St. Pierre Bank, where from September 3 to 15 an area of approximately 25 square miles bounded by lines through $46^{\circ} 19'$ and $46^{\circ} 25'$ N. latitude and 57° and $57^{\circ} 05'$ W. longitude was discovered. It yielded catches equivalent to between 1,000 and 2,000 pounds per day. The 1947 year class predominated in the population. Fishermen indicate that this bed, although smaller in total extent, will probably be preferred to Georges Bank scallop grounds as a source of supply for some Canadian boats. A second trip to St. Pierre Bank from October 1 to 13 gave some promise of an additional bed about 50 miles to the south of the first but stormy weather prevented thorough exploration there.

The results of the summer's work show that there are beds of scallops off our coast which can support commercial fishing. It is believed that a continuation of this exploratory work should show further beds which would provide the basis for an active industry.

L. M. Dickie from notes by
L. P. Chiasson

Appendix No. 27

SCALLOP EXPLORATIONS IN THE VICINITY OF ECUM SECUM AND SHEET HARBOUR

Scallops are reported commonly in many of the harbours on the southern coast of Nova Scotia. Fishermen in the vicinity of such harbours entertain the hope that scallops are present in sufficient concentrations to support small-scale commercial fisheries. During the summer four days were spent working among the islands between Ecum Secum and Sheet Harbour with light, Lunenburg-type scallop gear. Scallops were picked up occasionally but not in worthwhile quantities. These specimens were always old and large (6" and over in shell diameter) and were located in shallow water (1 to 3 fathoms) on fairly rocky bottom. No concentrations which could support even a small inshore fishery were found.

L. P. Chiasson

Appendix No. 28

STUDIES OF TEMPERATURE TOLERANCE OF SCALLOPS

It has been suggested that rapid changes from low to high temperatures, with minor changes in salinity, may be responsible for observed mass mortalities which have occurred

in late summer and autumn among scallops in the southern Northumberland Strait. To test the plausibility of such a theory, the writer began studies of the tolerance of scallops to changes in temperature and salinity during the summer of 1952 (Appendix 28 of the 1952 Annual Report) and the experiments were continued by Mr. J. S. MacPhail, assisted by Mrs. E. I. Lord, during the winter of 1952-53. The following table summarizes the results to date:

Temperature at which 50% mortality occurs in 24 and 48 hours at various acclimation temperatures in scallops of different seasonal conditions

	<u>July</u>	<u>January</u>	<u>March</u>
<u>Acclimation 15-17°C.</u>			
Temp. for 50% death in 24 hrs.	23.2	-	-
Temp. for 50% death in 48 hrs.	22.6	-	-
<u>Acclimation 10-11°C.</u>			
Temp. for 50% death in 24 hrs.	21.5	-	23.0
Temp. for 50% death in 48 hrs.	20.6	-	22.6
<u>Acclimation 2-3°C.</u>			
Temp. for 50% death in 24 hrs.	-	23.6	22.3
Temp. for 50% death in 48 hrs.	-	22.3	21.6

Although the information is still incomplete, three important inferences may be drawn from the table:

(1) During any one season of the year, the higher the acclimation temperature the higher the lethal temperatures.

(2) During any one season of the year, the use of longer than 48-hour periods as end points for experiments may show that the incipient upper lethals are lower than the 48-hour lethals of the table.

(3) There appears to be a marked seasonal change in resistance to high temperatures as scallops acclimated to 10-11°C. in July died at lower temperatures than scallops tested in March, while at 2-3°C. acclimation, January scallops were more resistant than March scallops.

If these inferences are confirmed by subsequent experiments they have important implications in the interpretation of field observations. For example, scallop fishermen recognize regular seasonal changes in the condition of meats, which are firm and white in the winter but watery and darker coloured in late summer. This seasonal cycle appears to be reflected in the resistance to high temperature and may be related to the spawning cycle, low resistance in summer when the gonads are maturing most rapidly, and high resistance in late fall and early winter subsequent to spawning and during the late growth period. It has also been observed that the mortalities among scallops

may take place near spawning time. At this time resistance to temperature changes appears to be lowest. Whether or not the actual incipient lethals overlap the range of temperature changes in nature remains to be established but present information suggests that they are close enough to warrant continued experiments.

L. P. Chiasson

Appendix No. 29

STATISTICS OF GROUND FISH LANDINGS

One of the most time-consuming phases of the Groundfish Investigation is the collection of basic statistics. Landings are recorded by the Department of Fisheries but their allocation to area of capture, fishing method and fishing effort is done by the Station. Inshore catches are taken close to the point of landing, which indicates where they are made, but the increasingly important offshore catches are taken from widely dispersed grounds and details concerning these operations must be obtained directly from fishermen by field technicians. The landings of individual vessels and log records of area fished, gear and effort are compiled on cards at our statistics office at Halifax. The card system, which was started in 1946, is becoming increasingly valuable as the basis for following changes in abundance of groundfish stocks.

The information is being summarized in a series of statistical circulars and during the year two of these, describing offshore fresh-fish landings for the years 1949 and 1950, were distributed. Statistics of 1952 groundfish landings in the Provinces of New Brunswick, Nova Scotia, Prince Edward Island and Quebec are summarized, without gear and effort data, in the accompanying table. The more complete details, as submitted to ICNAF (the International Commission for the Northwest Atlantic Fisheries) in March, 1953, represent the first attempt to present the groundfish statistics picture as a whole and in succeeding years it is anticipated that a more detailed breakdown by species, months and area fished may be given. Messrs. Sullivan, Fitzgerald, Fraser, MacPherson, Mrs. Cunningham and Miss Morrison are responsible for this statistical program.

Five countries - Canada, France, Portugal, Spain and the United States - have had a continuing interest in the groundfish of ICNAF's Sub-area 4 (the Scotian Shelf and Gulf of St. Lawrence). The Latin countries have fished the eastern part of the area during spring and early summer for cod to be salted and the United States has fished throughout the area for cod, haddock and recently for redfish to be sold fresh or frozen. The assessment of the status of the fisheries depends primarily on the compilation of good statistics for all countries fishing in the area and the establishment of ICNAF should make this possible. The whole picture is not yet available for cod but those for haddock, halibut and redfish are more complete and analyses of the factors responsible for fluctuations in total landings may now be made (refer to figure).

Summary of 1952
landings of principal species of groundfish
in Canada, excluding Newfoundland - by sub-area

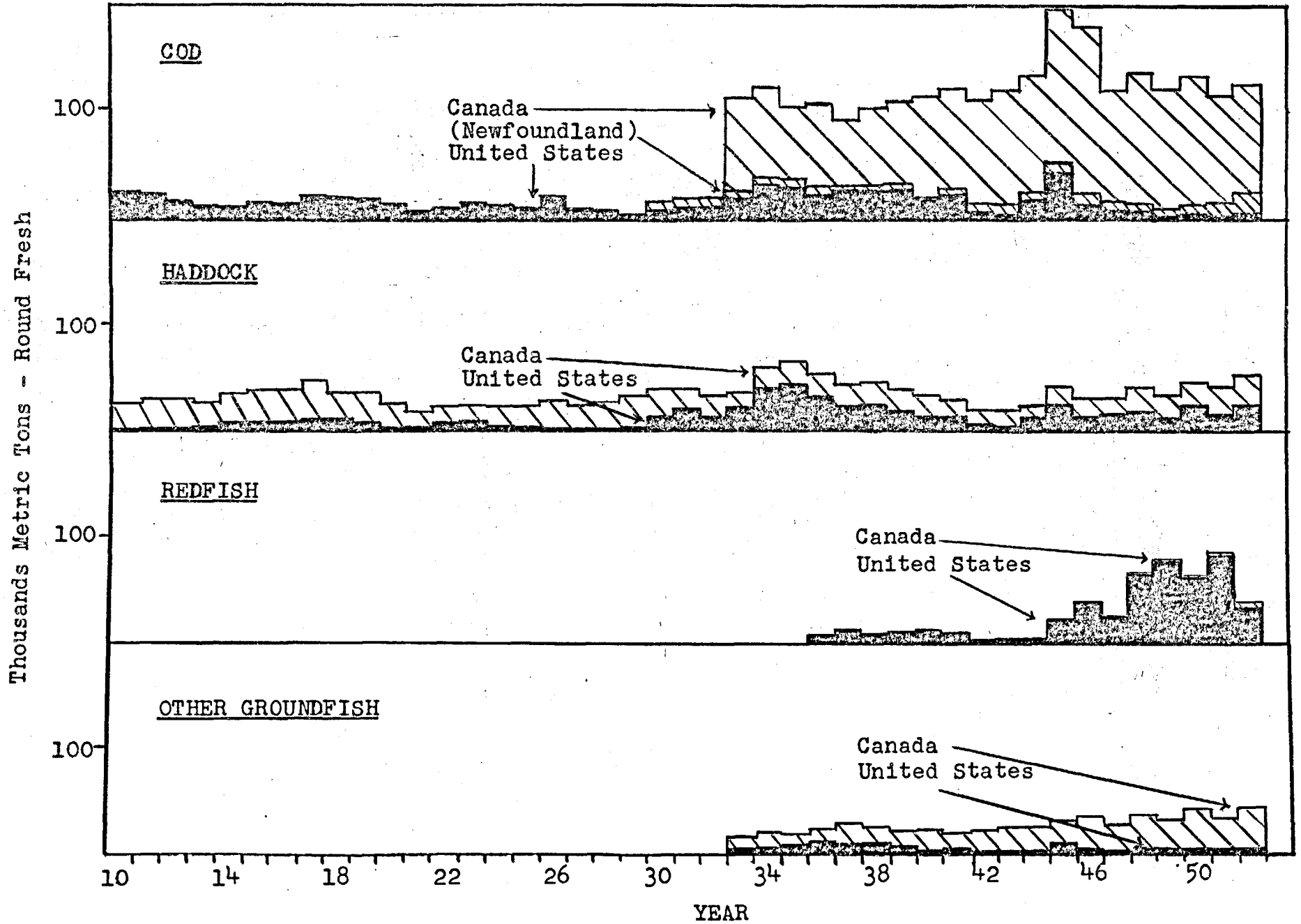
thousands pounds fresh

<u>Sub-area</u>	<u>Cod</u> ¹	<u>Haddock</u> ¹	<u>Pollock</u> ¹	<u>Halibut</u> ²	<u>Redfish</u> ³	<u>Flounders</u> ⁴	<u>Other</u> ⁵ <u>Groundfish</u>	<u>Total</u> <u>Groundfish</u>
1 (Greenland)	1,228	-	-	-	-	-	-	1,228
2 (Labrador)	1,038	-	-	-	-	-	-	1,038
3 (Grand Banks)	44,674	5,328	193	1,112	4,719	17,973	2,185	76,184
4 (Nova Scotia and Gulf of St. Lawrence)	185,674	49,529	25,645	2,870	3,212	24,413	30,706	322,049
Total	232,614	54,857	25,838	3,982	7,931	42,386	32,891	400,499

1. Head-on, gutted. 2. Head-off, gutted. 3. Round.
4. Head-on, gutted - plaice (Hippoglossoides); round - yellowtail (Limanda), witch (Glyptocephalus) and winter flounder (Pseudopleuronectes).
5. Head-on, gutted - catfish (Anarchichas), cusk (Brosme), hake (Urophycis) and skate (Raja).

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Groundfish Statistics - Sub-area 4 - 1910-52



Cod - During the recent war total fishing effort was reduced and cod abundance increased. Large cod became particularly abundant and both catch-per-unit-effort and total Canadian landings were high in 1945-46. Since the war, full-scale international fishing has been resumed and the abundance of large cod (over 10 lb.) has decreased to the lowest level recorded during the past fifteen years. Landings by Canadian and United States fleets have been reduced to the pre-war level but the relationship of the present total catch to the total long-term average is not yet known. The rapid conversion from traditional line-fishing methods to otter trawling during the past decade has enabled Canadian fishermen to compensate for decreased cod catches on local grounds by extending "fresh-fishing" operations to different species and more distant banks. Landings of redfish and flounders have increased since the war from negligible quantities to 8 and 42 million pounds, respectively, in 1952 and to still higher levels in 1953.

Haddock - The long-term history of haddock landings is more complete, in that Canada and the United States take most of the catch and statistics have been compiled by these countries for many years. During recent years Spain has fished for haddock, as well as cod, but catches from Sub-area 4 have been relatively small. As in the case of cod, fluctuations in landings have depended to a great extent on economic factors but the increasing importance of otter trawling and fluctuations in abundance have also had significant effects on the total yield. Canadian landings were relatively high during the first war, during the late twenties and during the recent post-war period but below average during the early twenties and from 1931 to 1947. The low haddock landings at the end of the recent war appear to be related to the high abundance and increased landings of cod. United States haddock catches increased sharply with the increased use of otter trawling during the thirties and the Canadian share of the total catch similarly increased with the development of otter trawling in recent years.

It may be noted in the figure in Appendix 30 that haddock show great variation in year-class strength, a factor which has had an important effect on abundance and yield to the fishery. Year classes immediately prior to 1915 and those of 1920-25, 1928-29, 1943, 1946 and 1947 have been shown to be abundant, with those of 1914, 1920, 1929 and 1943 particularly outstanding. The increased catches at the end of the first war, during the late twenties, during the mid-thirties and during the recent post-war period are largely based on these relatively abundant year classes. Good recruitment of young haddock has continued during 1953 (good 1949 year class) and landings are predicted to be above average in 1954.

Redfish - High landings of redfish by United States otter trawlers from Sub-area 4 since the last war demonstrate clearly the importance of this species. Canadian mainland otter trawlers are beginning to take redfish and it is expected

that the 8 million pounds landed in 1952 will be more than doubled in 1953.

W. R. Martin

Appendix No. 30

VITAL STATISTICS - COD AND HADDOCK - LOCKEPORT AREA

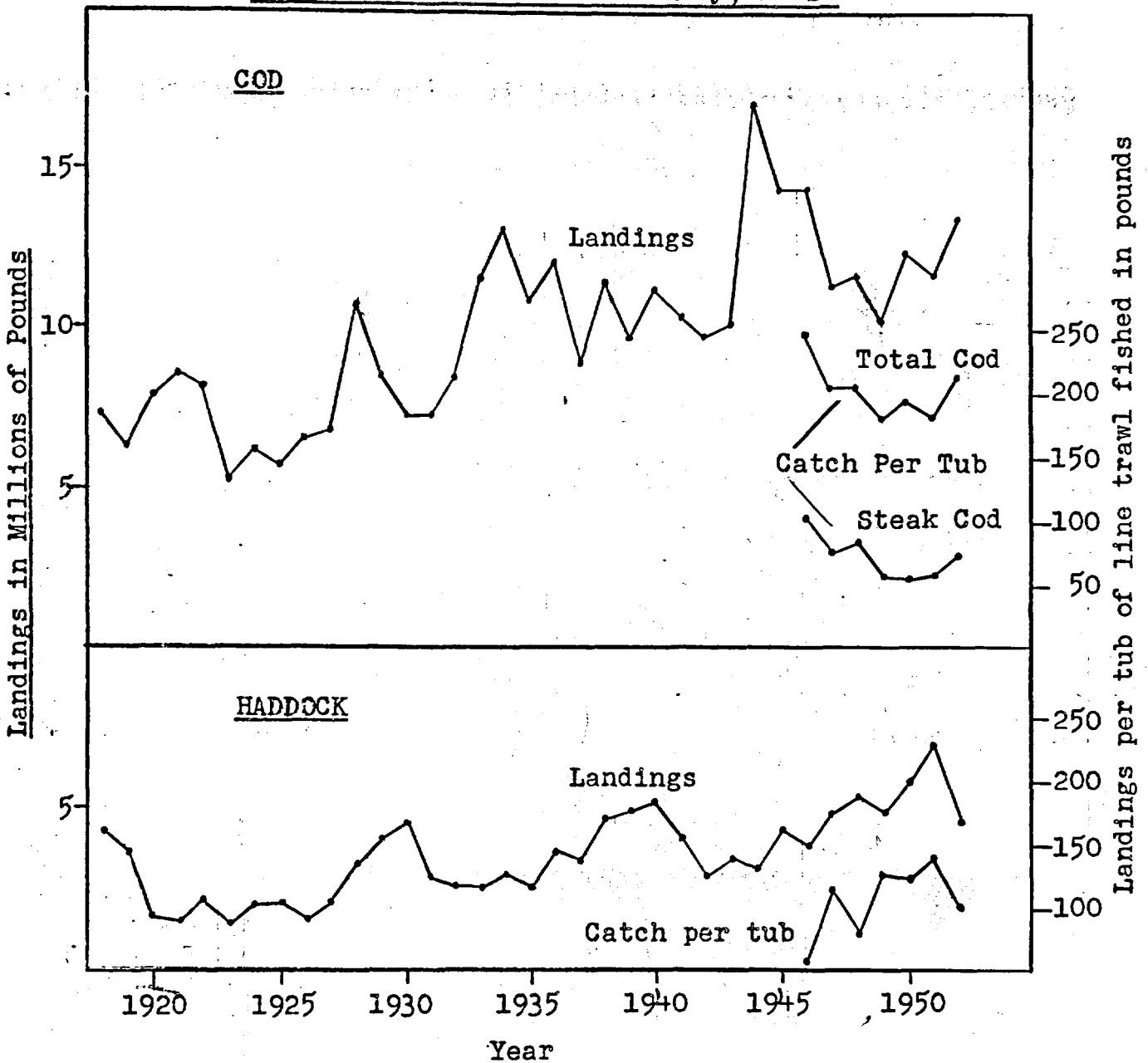
Only superficial analyses have been made to date of accumulating data on recruitment, growth and total mortality but vital statistics covering an eight-year period are now available and increased effort must be directed toward interpretation of the various factors limiting the long-term yield. Two papers on this aspect of groundfish research were prepared for the Third Annual Meeting of the International Commission for the Northwest Atlantic Fisheries and more detailed analyses are required for meetings of the "Scientific Advisers to Panel 4", a recently established working committee of the Commission.

In a general review of the status of the cod and haddock fisheries of Sub-area 4 in Appendix 29 it is noted that analysis has been seriously hampered by lack of complete statistics on catch and fishing effort. However, the cod and haddock stocks of the Lockeport, N.S., area, including Roseway and LaHave Banks, are principally fished by inshore line fishermen and a more complete picture of these stocks is available. The area is of interest because of the intensive year-round fishing and the proximity to Sub-area 5 where it has been shown that regulation of fishing may be expected to increase the yield to the fishery.

In the first place, it is important to note that in the Lockeport area we are dealing with discrete stocks which have been shown to be distinct from those on adjacent grounds (Browns and Western Banks). Studies of tagging results, vertebral counts, growth, age-composition and infection with parasites all support this conclusion.

Statistics of landings and of catch-per-unit-effort are plotted in the accompanying figure. Statistics of inshore landings for Shelburne County are available from 1918 as an approximate measure of the total yield. A long-term increase in landings of both cod and haddock is recorded which is not consistent with the more stable long-term picture for Sub-area 4 as a whole (see Appendix 29). The greater landings in recent years are undoubtedly related to increased fishing intensity. Catch-per-boat is now much greater as a result of increased boat size and the introduction of such equipment as mechanical line-haulers, echo sounders, direction finders, Loran and radio telephones. Fishing effort (number of eleven-line tubs fished) has been recorded in relation to landings for over one-third of the boats landing at Lockeport since 1946 and the resultant data on landings-per-tub are believed to be closely related to the abundance of groundfish in the area. Landings-per-tub have fluctuated in the same manner as total landings and we may conclude that landings depend to a very great degree on the availability and actual

Inshore Landings and Abundance of Cod
and Haddock - Shelburne County, N. S.



abundance of local stocks.

The observed changes in cod abundance are largely due to changes in the abundance of "steak" cod (see figures). Average weights of cod landed at Lockeport have decreased progressively from 1946 to 1952. ("Steak" - 19 to 14 lb.; "Market" - 5.5 to 4 lb.; and "Scrod" - 1.9 to 1.6 lb.) The changes have partially resulted from a more stringent size cull since 1951 when a higher price was offered for "steak" cod but this merely emphasizes the fact that the abundance of large cod has been reduced. The decreased abundance

of old "steak" cod has in turn reduced the total landings.

Regular samples of the landings have been taken at Lockeport for size- and age-composition analysis. The data have been grouped by years and by quarters (February-April, May-July, August-October and November-January). Percentage age-compositions have been translated to numbers of fish of each age taken per tub of line trawl fished. A summary of these data for the period 1947-52 is shown in the second figure.

Cod are first recruited to the fishery at the age of two but are not fully recruited until they are four years of age. Haddock also first appear in landings at the age of two but are not fully recruited before they are five years of age. In both species it should be noted that relatively old fish are taken in the first quarter of the year when they concentrate for spawning while the youngest fish are taken in the fourth quarter following the period of summer growth.

Cod growth is rapid, reaching "market" size (52 cm., 2.5 lb.) at the age of four years, maturity (70 cm., 6 lb.) at seven years and "steak" size (84 cm., 10 lb.) at the age of nine. Gutted weight increases by about 42% between the ages of four and five and about 32% between the ages of seven and eight years. Haddock grow more slowly than cod from the same area and more slowly than Georges Bank haddock. They reach maturity (45 cm., slightly less than 2 lb.) at four years and "large" size (50 cm., 2.5 lb.) at the age of five. Gutted weight increases by about 42% between the ages of four and five, about 31% between five and six and about 15% between seven and eight years.

Cod sizes landed range from 40 to over 100 cm., averaging approximately 60 cm. total length (4 lb.) and about 80% of these cod are immature. Haddock sizes range from 36 to over 70 cm., averaging approximately 55 cm. (3 lb.) with only about 12% immature.

Considerable variation is observed in year-class strength and it may be noted in the figure that greater variation is found in haddock than in cod. The year classes 1939, 1940, 1943, 1946 and 1948 have been of greatest importance to the cod fishery and those of 1938 to 1940 and 1943 have dominated the haddock fishery during the 1947-52 period. Recently increased haddock landings have mainly resulted from the large 1943 year class.

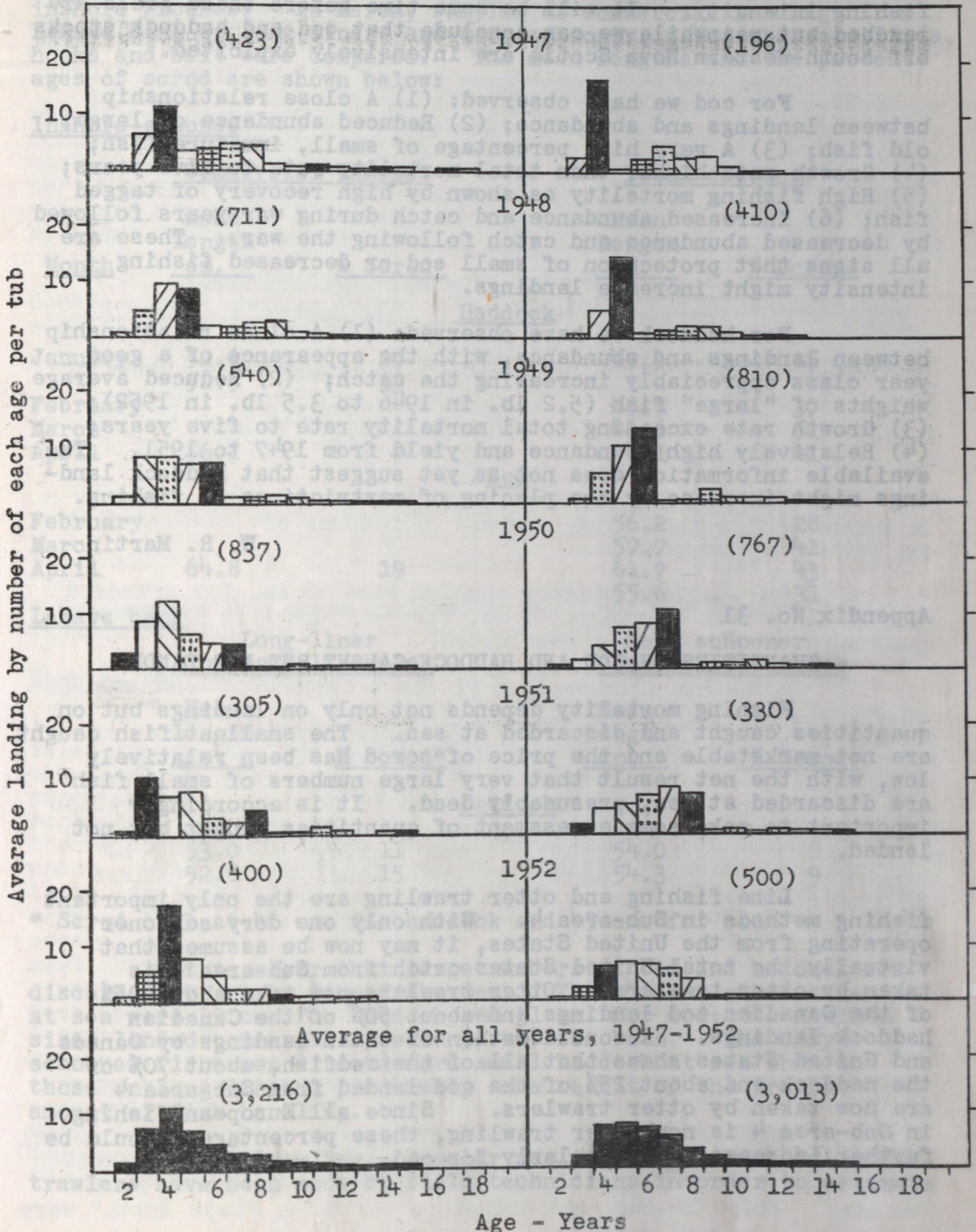
When the data shown at the bottom of the accompanying figure are plotted on a logarithmic scale, all abundance indices for cod-age-groups four to nine fall on a straight line giving a total annual mortality rate of about 37%. Similar treatment of haddock data gives an average annual total mortality rate of about 40% beyond six years. Preliminary results of cod and haddock tagging (Appendix 33) show that a major part of the total mortality is due to fishing, and natural mortality of cod and haddock at commercial sizes must be low.

Variation in year-class strength and average age-composition
as number landed per tub fished

Lockeport, LaHave and Roseway

COD

HADDOCK



Continued investigation of these vital statistics of the cod and haddock stocks off western Nova Scotia and analysis of accumulating data for other stocks in Sub-area 4 will lead to an understanding of the population dynamics and eventually to the determination of optimum age for first capture and optimum fishing intensity. It will be some time before these goals are reached but meanwhile we can conclude that cod and haddock stocks off south-western Nova Scotia are intensively exploited.

For cod we have observed: (1) A close relationship between landings and abundance; (2) Reduced abundance of large, old fish; (3) A very high percentage of small, immature fish; (4) Growth rate higher than total mortality rate to five years; (5) High fishing mortality as shown by high recovery of tagged fish; (6) Increased abundance and catch during war years followed by decreased abundance and catch following the war. These are all signs that protection of small cod or decreased fishing intensity might increase landings.

For haddock we have observed: (1) A close relationship between landings and abundance, with the appearance of a good year class appreciably increasing the catch; (2) Reduced average weights of "large" fish (5.2 lb. in 1946 to 3.5 lb. in 1952); (3) Growth rate exceeding total mortality rate to five years; (4) Relatively high abundance and yield from 1947 to 1951. The available information does not as yet suggest that haddock landings might increase by the placing of restrictions on fishing.

W. R. Martin

Appendix No. 31

QUANTITIES OF COD AND HADDOCK CAUGHT BUT NOT LANDED

Fishing mortality depends not only on landings but on quantities caught and discarded at sea. The smallest fish caught are not marketable and the price of scrod has been relatively low, with the net result that very large numbers of small fish are discarded at sea, presumably dead. It is accordingly important to make some assessment of quantities caught but not landed.

Line fishing and otter trawling are the only important fishing methods in Sub-area 4. With only one dory schooner operating from the United States, it may now be assumed that virtually the total United States catch from Sub-area 4 is taken by otter trawlers. Otter trawlers now take about 25% of the Canadian cod landings and about 50% of the Canadian haddock landings. A consideration of total landings by Canada and United States shows that all of the redfish, about 70% of the haddock and about 25% of the cod landed from Sub-area 4 are now taken by otter trawlers. Since all European fishing in Sub-area 4 is now otter trawling, these percentages should be further increased, particularly for cod.

Line fishing - During 1953 a few observations were made by D. N. Fitzgerald at Lockeport concerning quantities of cod and haddock discarded at sea by line fishermen. A number of total catches of cod and haddock were measured at sea on the "Mallotus" for comparison with samples of commercial landings from the same inshore grounds. In March, samples of commercial landings from LaHave Bank by long-liners and dory schooners using the same lines, hooks and bait were compared. The mean lengths and the percentages of scrod are shown below:

Inshore grounds

<u>Month</u>	<u>Commercial samples</u>		<u>Total catches</u>	
	<u>Mean length cm.</u>	<u>% Scrod*</u>	<u>Mean length cm.</u>	<u>% Scrod*</u>
<u>Haddock</u>				
January	52.6	20	49.3	25
	52.5	13		
February			48.5	37
March			46.6	51
April	56.1	7	54.1	41
<u>Cod</u>				
February			56.2	28
March			57.7	41
April	64.8	19	61.7	43
			55.6	31

LaHave bank

	<u>Long-liner Commercial samples</u>		<u>Dory schooner Commercial samples</u>	
	<u>Mean length cm.</u>	<u>% Scrod*</u>	<u>Mean length cm.</u>	<u>% Scrod*</u>
<u>Haddock</u>				
	53.0	11	54.0	8
	52.8	15	54.3	9

* Scrod cull at 46 cm. for haddock and 49 cm. for cod

It is clear that large numbers of cod and haddock are discarded at sea by line fishermen. The minimum sizes taken at sea were 29 cm. for haddock and 31 cm. for cod; the minimum sizes landed commercially were 36 cm. for both. The dory-schooner fishermen discard more small haddock at sea than do those on long-liners, presumably as a result of the greater amount of fish handling.

Otter trawling - Regular sea trips on commercial otter trawlers have been made by field technicians in order to estimate

quantities of groundfish caught but not landed. Since wastage has been greatest for haddock, efforts have been concentrated on this species. During 1951 and 1952, sampling indicated that more than half the number of haddock caught by otter trawlers were discarded during the months of May to November. In March, when large haddock become concentrated for spawning, catches are high and wastage at sea is small.

Eight sea trips were made during 1953 by Messrs. Fraser, MacPherson, Fitzgerald and Kohler for the purpose of extending earlier observations on haddock wastage. Results for only four trips may be listed since the observers ran into difficulties with sampling as a result of changes in fishing operations to other species and more distant grounds. During the second August trip a "41" Yankee trawl, with the newly adopted Georges-Bank mesh size, was tested at the request of the trawler owner.

<u>Month</u>	<u>Fishing grounds</u>	<u>Per cent discarded by number</u>
February	Western Bank	nil
May	N.E. Cape Breton	14
August	Sable Island	54
August	Sable Island and Banquereau	28 for standard 4" mesh cod-end 19 for test 6" mesh cod-end

The 1953 observations confirm those of earlier years in demonstrating that large numbers of haddock are discarded at sea during summer months.

The smallest haddock sampled were 18 cm. for standard gear (2 7/8" mesh opening), 33 cm. for "41" trawl (4 1/2" mesh opening) and 38 cm. for those landed.

Since the introduction of the Georges-Bank mesh regulation in June, 1953, United States trawlers are required to use 6" mesh cod-ends in Sub-area 4. The resultant escapement of baby haddock, together with the smaller minimum market size acceptable in the United States (38 cm.), means that the quantities of haddock discarded at sea by United States trawlers will be reduced to a minimum. If the Canadian fleet adopts 6"-mesh cod-ends (perhaps voluntarily), these trawlers will still be discarding appreciable numbers of small haddock at sea unless the present minimum size of marketable haddock (42 cm.) is reduced to the United States level.

W. R. Martin

Appendix No. 32

SELECTIVITY BY OTTER TRAWLS WITH COD-ENDS OF VARIOUS MESH SIZES

Experiments with large-mesh cod-ends on three commercial otter-trawler trips effectively demonstrated that small haddock and cod could be released while large fish were retained within the net. Trips in July and August on the M. V. "Cape North" were

made to banks in Sub-area 4 and to St. Pierre Bank in Sub-area 3. A trip in September was made on the M. V. "Cape LaHave" to banks in Sub-area 4. On each trip four Government representatives collected data and on one of the trips John R. Clark of the U.S. Fish and Wildlife Service assisted. Special gear was provided and normal remuneration guaranteed to the operating company and crew.

Large-mesh cod-ends and lengthening pieces were used on a standard "1 1/2 Iceland" otter trawl. All operating procedure, except for measurements of fish, was as nearly normal as possible. The escapement of haddock and cod was measured in part by using a fine-mesh cover over the cod-end and in part by means of comparisons between catches by nets with large and with standard mesh.

All cod-ends tested were made of 45-yard, four-ply, double-strand manilla twine. The following table presents the mesh sizes of the cod-ends tested:

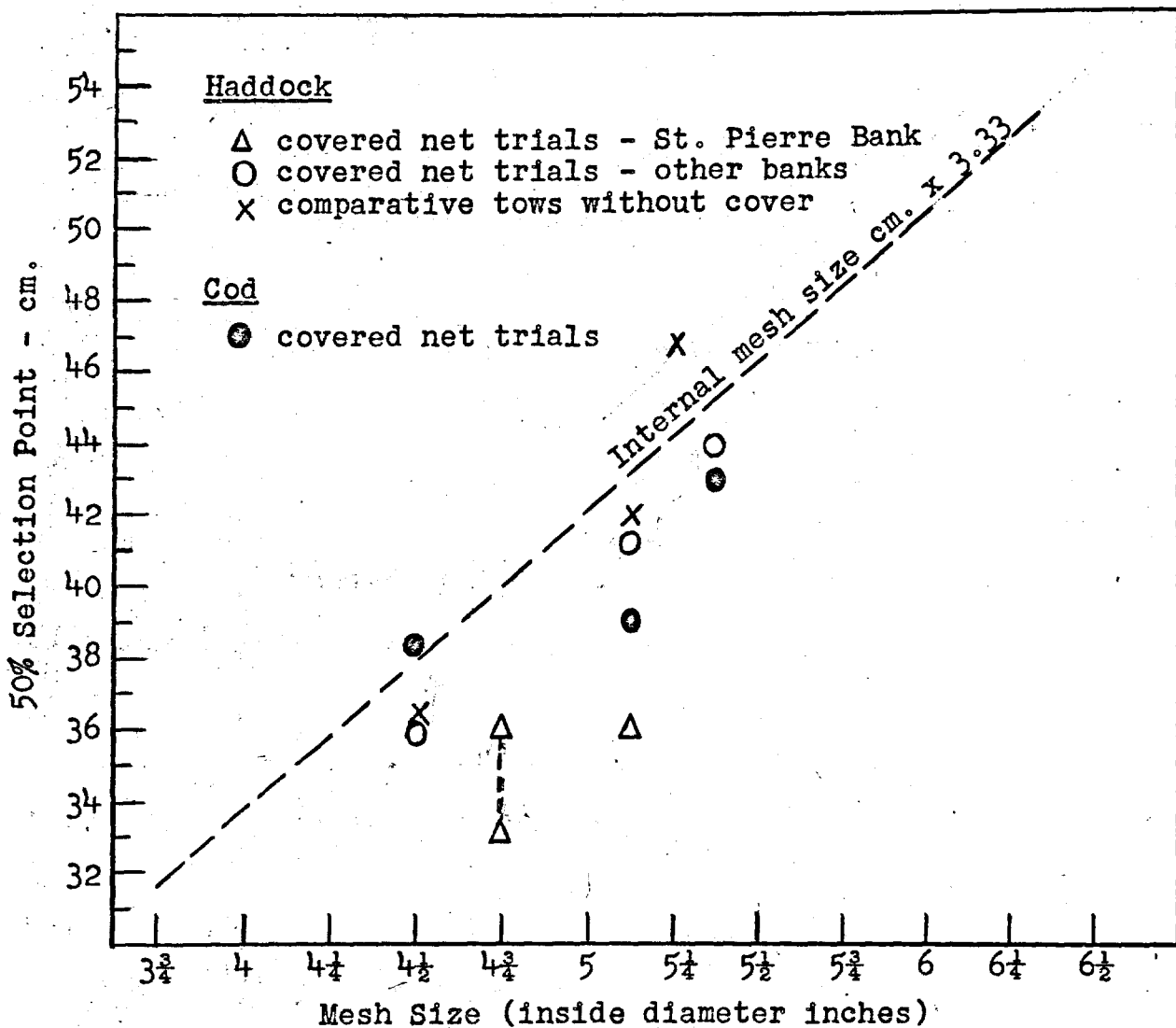
<u>Trip number</u>	<u>Between knot centres dry, unused</u>	<u>*Inside measurement wet and used</u>
1	6"	4 1/2"
1	7"	5 1/4"
2	6 1/4"	4 3/4"
2	6 3/4"	5 1/8"
3	6 1/2"	5 3/8"
all	4" (standard)	2 7/8"

* Measured with a gauge similar to that used and described by the U.S. Fish and Wildlife Service.

Mesh selection results

The accompanying figure presents graphically the 50% selection points (the length at which 50% of the fish entering the trawl are retained) for haddock and cod for the cod-end mesh sizes tested. The dotted line shown in the figure is from the regression formula developed by Beverton and Holt for the theoretical relationship between mesh size and 50% selection point. The 50% selection points for these experiments tend to be less than would be expected from the theoretical relationship. This is particularly true for haddock in the case of covered-net trials on St. Pierre Bank where large quantities of small haddock (36-44 cm.) dominated the catches. As a specific example, three 50% selection points are shown for the 5 1/8" mesh cod-end. This mesh size, used in covered-net trials on Banquereau, gave a 50% selection point at 41 cm. and on St. Pierre a 50% selection point at 36 cm. These selection lengths are contrasted with one of 42 cm. as determined by comparative tows on St. Pierre Bank. Indications are that where large catches were taken the cover over the cod-end dampened the selective action. There is also a suggestion, though less readily measured, that large catches may have

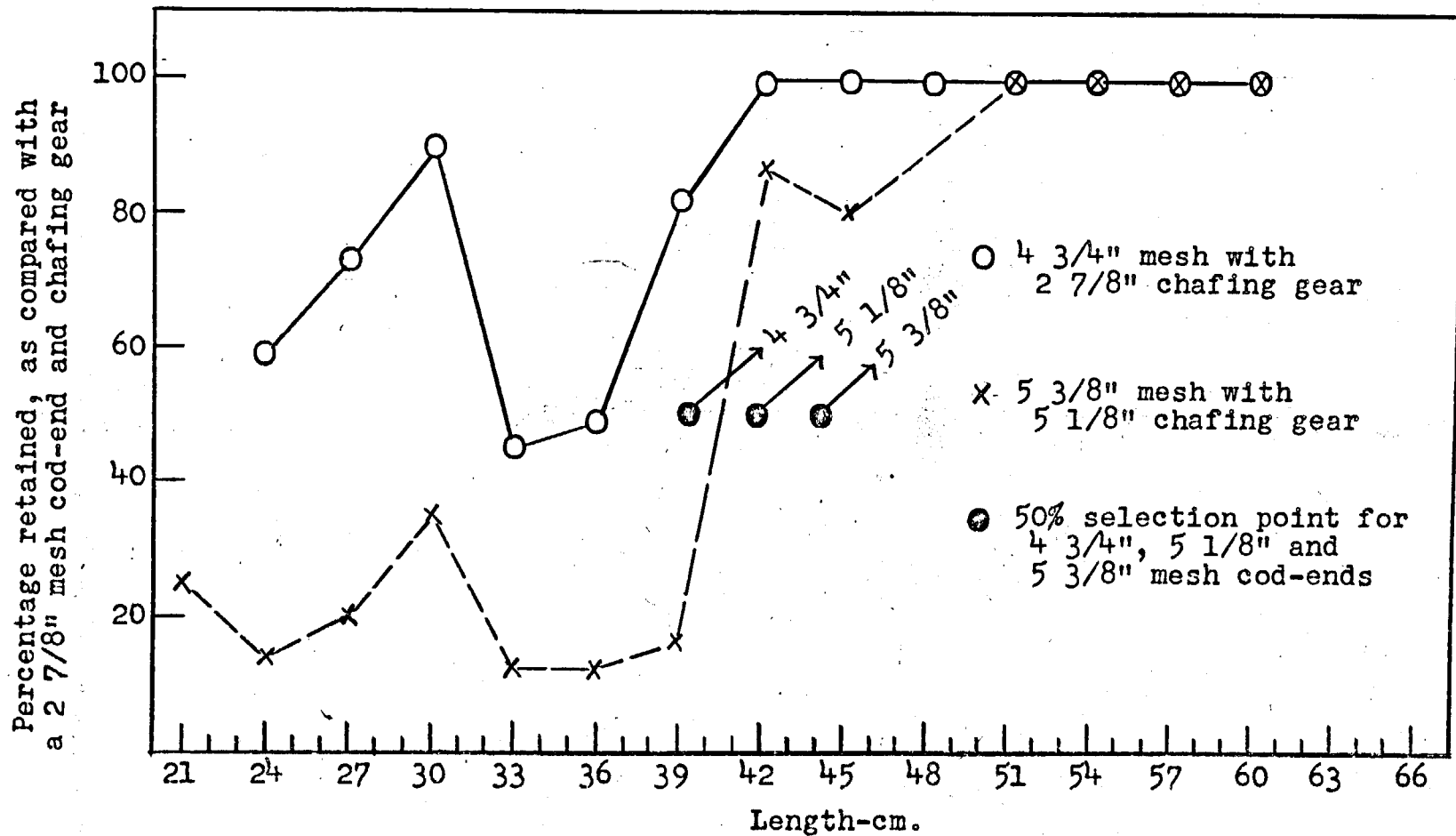
Mesh Selection



dampened the selective action of the large mesh even when no cover was present. Such factors must be taken into account when considering the precision of the 50% selection points and comparing the various mesh sizes.

Since Sub-area 4 supports a mixed fishery for cod and haddock the fact that the two species have similar 50% selection points (accompanying figure) is of major importance. While the data obtained for cod are not so extensive as those for haddock they do show clearly that there are no large differences in mesh selection for the two species. Only scanty data were obtained for other species. Large quantities of small silver hake, a trash fish under present marketing conditions, were released through the large-mesh cod-end. Examination of the catch of flounders in the cover, while the 5 3/8" mesh was being used,

Effect of chafing gear on sizes of haddock selected by large-mesh cod-ends



showed that the largest flounder escaping was 35 cm. in length. A flounder of this size is near the bottom of the presently acceptable size range for those species taken offshore.

Effect of chafing gear

The common Canadian practice of using a "chafing gear" on top of the cod-end makes it more difficult to assess what selective action the large mesh will have. This "chafing gear" consists of a used portion of a lengthening piece, attached across the cod-end just forward of the splitting strap and along the lacing at the sides of the cod-end but open aft. The purpose of this gear is to decrease the wear on the cod-end as it is hauled along side and over the rail. During the third mesh experiment trip an attempt was made to assess the effect of a chafing gear on selective action.

The results of comparative tows using a cod-end of 5 3/8" mesh with 5 1/8" chafing gear and cod-ends of 4 3/4" and 2 7/8" mesh with 2 7/8" chafing gear are presented in the accompanying figure. The haddock taken have been grouped into three-centimetre length groups and the number in each length group for the two larger mesh sizes has been expressed as a percentage of the number taken by the smallest mesh size. These data show that although small haddock are released by the large-mesh cod-ends when the cod-end is covered by a chafing gear, the selection curve is altered with the 50% selection point at a shorter length. Data for cod give similar results. It should be noted that while these comparative tows were being made fishing was variable and results are not conclusive. It appears, however, that "chafing gear" as now used considerably reduces the selective action of the cod-end meshes. Any consideration of possible adoption of large-mesh cod-ends should take the chafing gear into account.

Discussion

The advisability of adopting a larger mesh size must be considered from two aspects. The first of these, the conservation aspect, requires an analysis of the vital statistics for the stocks of fish to determine whether by increasing the size at first capture the yield from these stocks of fish may be increased. For Sub-area 4, knowledge of haddock and cod stocks is not yet sufficient to allow determination of the optimum age at first capture. It appears reasonable to assume, however, that there would be no harm in releasing some of the large numbers of small haddock discarded at sea (Appendix 31) and an increased yield might result from release of these small fish for later capture. The second aspect to be considered is that of increased efficiency of fishing method. It is certain that by reducing the number of small fish brought aboard the catch can be more easily handled both in dressing fish and in hauling the trawl. Also, under some conditions where tows are now shortened because of the number of small fish taken, less frequent hauls would be necessary if small fish were released. The net result would be more time spent in actual fishing. Along with the above examples of increased efficiency, results from more extensive experiments in

other regions are beginning to show that the larger-meshed trawls take larger quantities of marketable fish. From both points of view there would appear to be advantages in the adoption of large-mesh cod-ends.

At present only small quantities of haddock and cod below 45 cm. are landed by Canadian offshore trawlers (from these experimental trips, 15% of the scrod haddock and 3% of the scrod cod). It thus appears that under present commercial culling practice a mesh size of 4 1/2" or 4 3/4" (inside diameter) could be adopted by the Canadian fleet with negligible loss of marketable fish and then only those of the smallest scrod sizes. These mesh sizes (50% selection point at 37-39 cm.) would still bring aboard a large number of fish below the acceptable commercial size but the numbers would be much reduced from those now taken with the 2 7/8" mesh.

It is of interest to note that the company participating in these experiments is adopting a 4 1/2" mesh (6" between knot centres, new) for its whole fleet. By following the effects of the general change in mesh size by United States and Lunenburg fleets, valuable information will be provided for a consideration of general adoption of large mesh by all other trawlers fishing in Sub-area 4.

F. D. McCracken

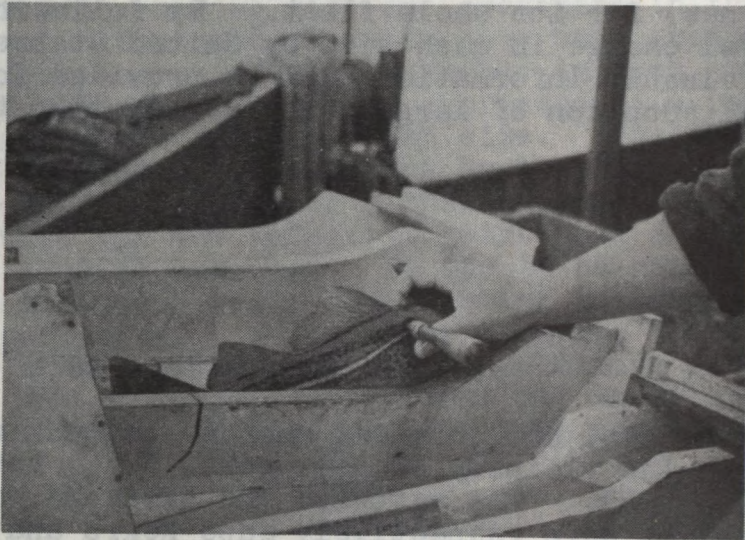
Appendix No. 33

COD AND HADDOCK TAGGING

A total of 1,804 cod and 580 haddock were tagged and released in the vicinity of Lockeport, N.S., between May 27 and October 20, 1953. The westward and eastward boundaries of the tagging region were respectively Cape Negro and Little Hope shoal with most of the fish being released on the shore ground at depths between 10 and 46 fathoms. However, 281 cod and 46 haddock were released on the inner edge of Roseway Bank. The M. B. "Mallotus" was used and C. J. Bayers tagged almost all the fish released.

Four series of tags were used for both cod and haddock. These were Lea hydrostatic tags (yellow), Petersen disk tags with both disks coloured yellow, Petersen disk tags with the numbered disk white and the other disk red, and monel metal strap tags. Hydrostatic tags and disk tags were attached by means of stainless steel wire passed through the flesh of the fish between the first and second dorsal fins (see accompanying figure). Strap tags were used in this tagging experiment to provide a basis for comparison with the results of previous cod and haddock tagging experiments in Sub-area 4. As in previous tagging experiments the strap tags were attached to the ventral part of the tail region as far forward as possible on the caudal peduncle. With a few exceptions, only one type of tag was used on a particular fish.

Fish for tagging were taken by hook and line and precautions (discarding injured fish, holding fish in tanks of water before and after tagging and providing a flow of water to the tagging troughs (accompanying figure)) were taken to ensure that the fish released would be in as good condition as possible.



Flesh of cod in tagging trough has been pierced with a hollow needle through which a stainless steel wire will be threaded for tag attachment. Note that the tagging troughs are partly filled with water.

Some details of the tagging and a summary of the tag returns up to October 31 are presented in the following tables:

Tagging

<u>Type of tag</u>	<u>Cod</u>		<u>Haddock</u>	
	<u>Number tagged shore grounds</u>	<u>Number tagged Roseway Bank</u>	<u>Number tagged shore grounds</u>	<u>Number tagged Roseway Bank</u>
hydrostatic red and white disks	691	242	255	21
yellow disks	294	11	79	19
strap	280	23	84	3
	249	14	116	3
Total	1,514	290	534	46

Recoveries of cod tags

<u>Type of tag</u>	<u>To Oct. 31</u>		<u>*From early tagging</u>		<u>From Roseway tagging</u>		<u>Tags recovered in plants</u>	
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
hydrostatic red and white disks	150	16	97	23	21	8	9	6
yellow disks	96	31	94	34	3	27	7	8
Strap	71	23	50	33	3	21	1	1
	18	8	9	12	2	14	9	50
Total	335	18	250	27	29	10		

* Returns to October 31 from fish tagged before July 31

Recoveries of haddock tags

<u>Type of tag</u>	<u>Recoveries to October 31</u>		<u>Recoveries from shore tagging</u>		<u>Recoveries from Roseway tagging</u>	
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
hydrostatic red and white disks	7	2.5	6	2.3	1	
yellow disks	4	4	2	2.5	2	
strap	5	6	5	6		
	1	1	1	0.9		
Total	17	3	14	3	3	6

A number of points may be noted from a preliminary assessment of the data:

(1) The percentage recovery for tagged cod is much higher than for haddock. The differences in recoveries may be a result

of differences in tagging mortality although the haddock released appeared to be in as good condition as the cod.

(2) About 75% of the cod retaken were caught within the tagging area. Three cod were recaptured east of Halifax with one as far east as Port Beckerton. Cape Sable marked the westward boundary of recaptures. Only one recapture has come from offshore, on LaHave Bank, and this is a doubtful record.

(3) Percentage recovery for cod, to the end of October, from the early portion of the tagging indicates that fishing mortality makes up a large portion of the total annual mortality (see Appendix 30).

(4) Comparison of the size-composition of the tagged cod with the size-composition of the recovered fish shows that within the tagging region these were similar, but outside the tagging region all recaptured fish were over 60 cm. in length.

(5) One haddock was recaptured outside the general tagging area, to the westward off Brier Island. Three tagged on the shore grounds were retaken on Roseway Bank and one tagged on Roseway Bank was retaken on the shore grounds. None have been recaptured further offshore than Roseway Bank.

(6) A comparison of tag returns by tag types affords the following information:

(a) Up to October 31 the disk tags have given higher percentage returns than the hydrostatic tags.

(b) Percentage tag returns for both the disk tags and the hydrostatic tag have been at least twice as great as for the strap tag.

(c) Fifty per cent of the strap tags have been recovered in the processing plants. These were missed by the fishermen both when the fish were caught and when they were landed ashore. This fact combined with the low percentage recovery for strap tags suggests that a relatively high percentage of these tags may have been missed altogether. Of the other three tag types, the yellow disk has been missed least often by fishermen while the hydrostatic tag and the red and white disks gave approximately the same results.

(7) The co-operation of fishermen, fish processors and fishery officers along with the efforts of D. N. Fitzgerald have been important factors in this tagging experiment. Information on date and location of capture has been provided for about 85% of the tag recoveries and examination of the fish has been possible in about 80% of the recaptures.

F. D. McCracken

Appendix No. 34

REDFISH ECOLOGY IN THE GULF OF ST. LAWRENCE

During the months of May to October, 1953, the distribution of redfish along the Laurentian Channel of the Gulf of St. Lawrence was investigated in an attempt to define the extent and nature of the redfish stocks of this area. Knowledge of the horizontal and vertical distribution of redfish is needed in order that we may understand the relation of the otter-trawl fishery to the fish stocks. The M. V. "J. J. Cowie" (Captain H. H. Butler) was used for this investigation with summer students, D. Steele and L. H. Roberts, carrying out the field program.

General survey of the upper Laurentian Channel - July 21 to September 4

The upper Laurentian Channel was explored by bottom dragging from Gaspé and Southwest Point, Anticosti, to the head of the deep channel near the Saguenay River. Redfish were found in large numbers as far west as Cape Magdalen on the south and Seven Islands on the north sides of the channel. At the upper end of the channel such species as Greenland halibut, capelin and Vahl's eelpout were taken but catches of redfish were negligible. Redfish were most plentiful in the Cape Magdalen-St. Maurice area at depths of 100 to 175 fathoms where the size modes for males and females were 35 to 36 cm. and 38 to 40 cm., respectively. Larger fish of both sexes were found at 150 to 175 fathoms off St. Maurice. Along the northern side of the channel the largest redfish catches and sizes were taken off Ellis Bay, Anticosti, from 100 to 160 fathoms; smaller fish were taken in the Seven Islands area. Females outnumbered males in the shoaler depths but the percentage of males increased in deeper water to about 50% at 150 fathoms. Mature females were spent and feeding on mysids, amphipods, copepods, shrimp and fish, different foods being found in redfish from different depths. The males were all empty at the time of this survey. Only three Sphyrion lumpi ecto-parasites were found.

Seasonal variation in distribution - June 18 to October 28

Seasonal changes in abundance and sex ratios of redfish are shown below for the Fox River-English Point and the St. Maurice-Fame Point areas along the Gaspé coast. Data are presented on half-hour daylight drags with a 40-ft. flounder net in the 100- to 130-fathom depth range where redfish were taken in greatest numbers.

Fox River and English Point

Number of fish per drag	Number of drags				
	June	July	August	September	October
0-25	7	4	6	4	6
26-50	3	2	2		
51-100	1	3	1		1
101-200				1	4
> 200					2
Percentage ♂	61	53	52	30	40

St. Maurice and Fame Point

<u>Number of fish per drag</u>	<u>Number of drags</u>				
	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>	<u>October</u>
0-25	3	2			7
26-50	2				
51-100					4
101-200			2	1	4
> 200				1	3
<u>Percentage ♂</u>	<u>59</u>	<u>76</u>	<u>41</u>	<u>28</u>	<u>46</u>

It may be seen that the number of fish taken per drag increased progressively from June to October. Males outnumbered females in June and July but from August to October females were taken in greater quantities than males on the bottom. At greater depths (130 to 160 fathoms) the percentage of males approximated 50% of the total throughout the period studied.

Mature females were 50% spent in June with the largest females appearing to spawn first. Ninety-nine per cent were spent by early July. Both sexes were feeding well in June and early July but from August to October the females were eating less and all males were empty. The gonads of large females had well-developed eggs by October but the male gonads showed no signs of ripening.

The sizes of redfish did not change significantly during the period studied. The mode for males remained at 35 to 36 cm. and that for females at 38 to 40 cm. Small redfish were taken in such very small numbers that it was difficult to assess age at maturity. The data available showed 50% maturity at 24 to 25 cm. for males and at 25 to 26 cm. for females.

Diurnal variation in distribution - July 8 to October 20

A number of tows were made in the evening, after dark, for comparison with daylight tows (St. Maurice to English Point area). A series of observations showing the percentage decrease in numbers of fish taken per drag in the 110- to 130-fathom depth range is shown below.

Percentage reduction by number after dark

<u>Date</u>	<u>Depth fms.</u>	<u>Numbers of fish in tows in day- light</u>	<u>Percentage reduction after dark</u>		
			<u>Total</u>	<u>Males</u>	<u>Females</u>
July 8	110	93	23	35	7
Sept. 4	110	254	48	87	23
Sept. 4	130	289	78	90	60
Oct. 9	110	157	89	97	85
Oct. 14	110	330	84	85	83
Oct. 15	110	74	50	65	44
Oct. 19	110	101	67	80	60
Oct. 19	130	468	85	94	79
Oct. 20	110	121	83	81	83
Oct. 20	130	129	68	80	60

A consistent decrease in catch is apparent for night dragging with males showing a more pronounced movement off bottom after dark. It is of interest to note that commercial draggers regularly make good catches at night in this Gaspé area and fishing captains report best night catches from about 2:00 to 5:00 a.m.

Observations in the southern Gulf

D. Steele accompanied the commercial trawler "Fort Louisburg" on a trip to the Bird Rocks area from May 27 to June 4. About 190,000 lb. of redfish were taken at depths of 130 to 180 fathoms. Seven hundred fish were sampled showing 70% mature males, 24% mature females and 6% immature. Seventy-eight per cent of the mature females were spent with the largest appearing to release their young first. Observations on small fish showed 50% maturity at 25 cm. for males and 26 cm. for females. The sizes taken were large, the mode length of males being 35 to 36 cm. and that for females being 38 to 40 cm. No Sphyrion lumpi were observed. The observations conform with those made at Gaspé, apart from an apparent difference in spawning time.

The "J. J. Cowie" fished in the St. Pauls-Bird Rocks area from 108 to 180 fathoms on September 17 and 18. Eight hundred and sixty-seven fish were sampled showing 40% mature males, 34% mature females and 26% immatures. Gonads of large females were ripening but male gonads remained small. The large females were feeding but the males were empty. Fifty per cent maturity was observed at 23 cm. for males and 24 cm. for females. The size-composition differed from that of other areas in that large numbers of small redfish down to 20 cm. were taken in the catches.

Discussion

This study has served to clarify a number of points in the ecology and life history of redfish. Some of the factors involved in vertical movements of redfish, on and off the bottom, may be deduced.

Mature females tend to be off bottom at spawning time. Redfish leave the bottom during the evening with males demonstrating the greatest movement. The sex ratio does not vary so much seasonally in deep water, presumably because of the reduced light effect at greater depths. Active movement of redfish off bottom is associated with reduced feeding.

Although redfish release young in the northern Gulf, very few small redfish are taken. The 1914-15 Canadian Fisheries Expedition showed large numbers of larvae over the deep-water channels of the Gulf but none over shoal-water grounds. Herring dragging with small-mesh otter trawls failed to catch small redfish in the shoal-water areas of the southern Gulf. The only large catches of small redfish were made between Bird Rocks and St. Pauls Island. It is possible that the larvae are carried south with the resultant outward movement of Gulf water as far as Cape Breton before settling to the bottom and after they grow to maturity they may gradually move northward along the Laurentian Channel.

The causes of seasonal changes in abundance are not understood but the summer increase in catches may merely result from differences in vertical distribution rather than from an extensive movement of fish into the area.

It is planned that this investigation will be continued during 1954. Studies of changes in diurnal movements away from the bottom, mid-water dragging and larval towing should throw more light on the ecology of redfish in the Gulf of St. Lawrence area.

W. R. Martin

Appendix No. 35

WINTER FLOUNDER INVESTIGATIONS

During the past year, investigations on winter flounders were limited to tagging and mesh experiments in St. Mary Bay, N.S., collection of catch and effort records for small dragger operations and sampling of commercial catches for size- and age-composition.

Tagging

Between October 15 and November 26, 1952, 2,010 flounders were tagged and released in St. Mary Bay. The M.B. "Mallotus" (Captain R. H. McDonald) was used for this work and D. N. Fitzgerald assisted with the actual tagging. From April 28 to May 12, 1953, a further 1,421 flounders were tagged using the M.V. "J. J. Cowie" (Captain H. H. Butler). L. H. Roberts did the actual tagging.

One of the purposes of this tagging is to provide a further estimate of fishing mortality for comparison with earlier taggings in the fall of 1949 and in both the spring and fall of 1950. Other purposes are to provide further information on the estimates of natural mortality used in assessing the St. Mary Bay flounder population and to check the previous assumption that the flounder population of St. Mary Bay proper does not mix to any extent with that off Cape St. Mary. The tag recoveries to date (incomplete for this season's fishing) are summarized in the following table and compared with previous tagging results.

<u>Date of tagging and number tagged</u>	<u>Percentage recoveries</u>			
	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1953</u>
Fall, 1949 (2,616 fish)	4	26	6	.3
Spring, 1950 (1,520 fish)		38	22	1
Fall, 1950 (2,009 fish)		11	14	.7
Fall, 1952 (2,010 fish)				11
Spring, 1953 (1,421 fish)				19

It appears that the percentages of tags recovered in 1953 will be lower than those in 1950 and probably comparable with those in 1951 which gave a fishing mortality of 21%. The

information obtained on fishing mortality considered along with recruitment, rate of growth and total mortality should provide the vital statistics necessary to determine the optimum age for first capture and optimum fishing intensity.

The results support the view that flounder stocks off Cape St. Mary are relatively discrete from those in the upper portion of the bay. It may be noted also that with two exceptions all tag returns in 1953 have come from the St. Mary Bay area. One fish tagged in the fall of 1952 off Cape St. Mary was retaken by May, 1953, in Argyle Sound, N.S., while the other tagged in the fall of 1950 was retaken off Cape Cod, Massachusetts, in October, 1953.

Mesh experiments

Experiments to determine the selective action of large-mesh cod-ends for winter flounders were carried out in Passamaquoddy Bay during 1950 and summarized in the 1952 Annual Report. During 1953 these experiments were continued in St. Mary Bay, an area which supports a commercial fishery for winter flounders. From May 18 to 28, catches with cod-ends of 4", 4 1/2", 5" and 5.7" mesh size (all inside measurements) were compared with catches of a standard 3"-mesh cod-end. The M.V. "J. J. Cowie" was used for these experiments and L. H. Roberts acted as observer. The number of winter flounders taken by the larger-meshed cod-ends and those taken by comparable tows with the 3"-mesh cod-end are presented in the accompanying figure in three size groups.

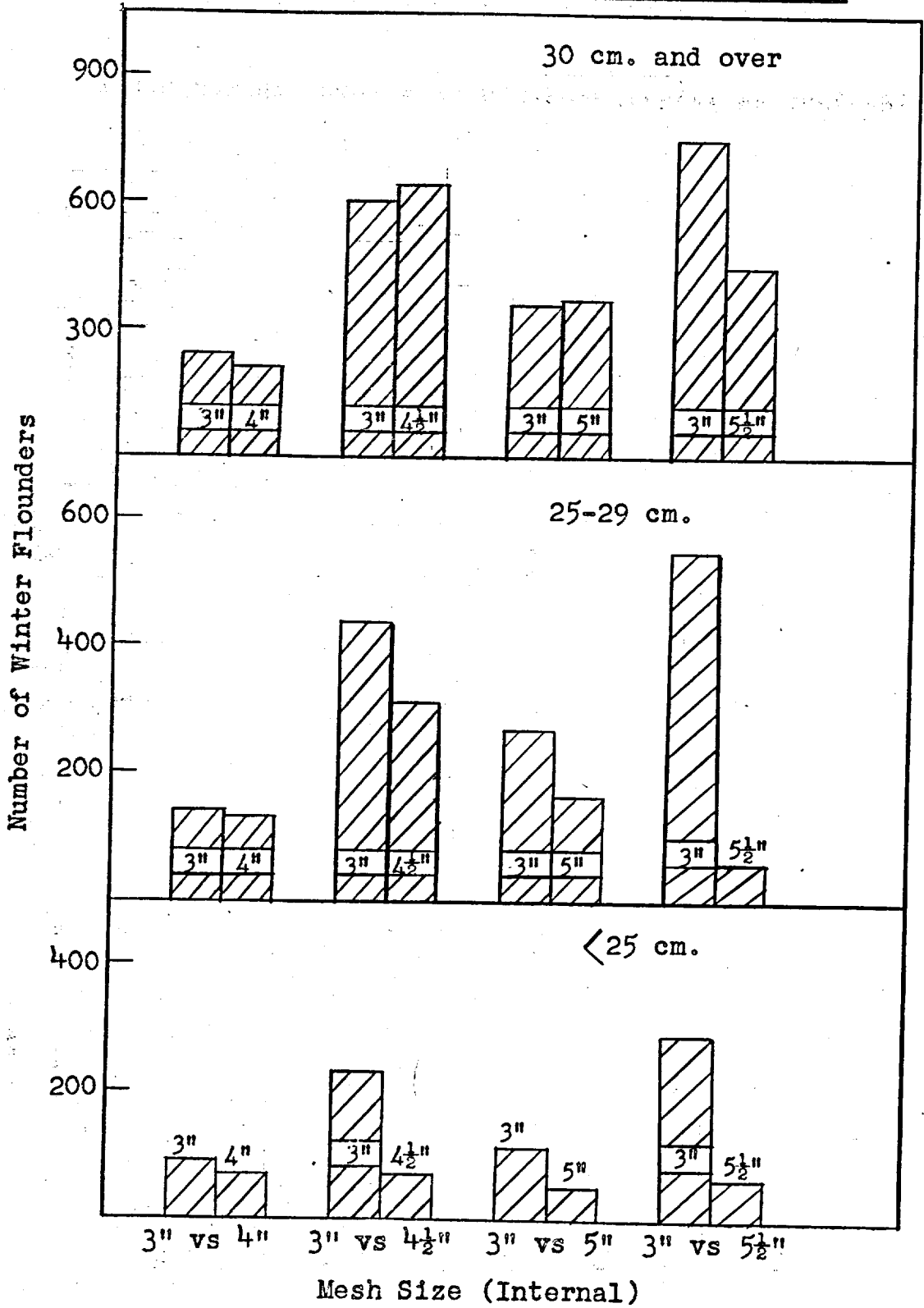
The 4"-, 4 1/2"- and 5"-mesh cod-ends took approximately the same number of marketable flounders (30 cm. and over) as the 3"-mesh cod-end. The number of flounders of these sizes taken by the 5.7"-mesh cod-end, however, was considerably less. The latter is in contrast with the results of 1950 when the 5 1/2"-mesh cod-end and the 3"-mesh cod-end took almost equal numbers. All four larger-mesh cod-ends took fewer flounders in the other two size groups than did the 3"-mesh cod-end and in general as the mesh size increased the number taken became proportionately less. Similar results were obtained in 1950 except that in those experiments a 4 1/2"-mesh cod-end took almost as many flounders in the 25-29 cm. size group as the 3" cod-end. It was observed in both experiments that cod-ends with a mesh size of 4.5" or larger materially reduced the amounts of such trash as sculpins and sea cucumbers.

The mesh experiments have demonstrated that large-mesh cod-ends will release small unmarketable flounders and other trash species. The selection of the most suitable mesh size will depend on determination of optimum size for first capture of flounders and the effect of increased mesh size on the landings of other species which have become increasingly important to the in-shore dragger fishery.

General consideration of inshore dragging in southwestern Nova Scotia

No new areas were exploited in 1953 but small draggers continued to operate in Annapolis Basin, Argyle Sound, Minas Basin

Flounder Mesh Experiments - St. Mary Bay



and St. Mary Bay. As in 1952, fishing was carried out in Argyle Sound only during April and May at the time of spawning concentration and the flounders taken were small (average size 32 cm.). In the other areas the fishery tended to remain at about the level reached in 1952.

Minas Basin - Two small draggers operated here from May through August landing about 100,000 lb. of winter flounders and 70,000 lb. of haddock. Both landings and effort are similar to those of 1952, although reduced from those of 1951 when seven draggers landed about a third of a million pounds. Catch-per-unit of effort was relatively high in 1953.

Annapolis Basin - Five draggers operated here between May and October (three sporadically) and landed about 125,000 lb. of winter flounders. Again landings and effort are similar to those of 1952 but reduced from 1951 when nine draggers landed about half a million pounds.

St. Mary Bay - About thirty small draggers operated here during 1953 and this number is approximately the same as in 1951 and 1952. Catch and effort records were not as detailed as in previous years but indications are that total effort was somewhat decreased as a result of more sporadic fishing operations. Landings to the end of October were about 600,000 lb. of winter flounders, 750,000 lb. of haddock and 175,000 lb. of catfish. Similar landings were produced in 1952. Comparison of 1953 landings with those of years previous to 1952 shows that they have decreased by about half a million pounds from those in 1950 and 1951. On the other hand, haddock and catfish landings, which increased sharply in 1951, have remained relatively constant.

Discussion

Available evidence supports the conclusion that the flounder populations of southwestern Nova Scotia are being intensively fished and that further expansion cannot be anticipated. It appears desirable to continue to restrict fishing effort. The adoption of a larger mesh size for better utilization of the available stocks should be considered.

F. D. McCracken

Appendix No. 36

RELATIVE EFFICACY OF BAITS FOR GROUND FISH

Experiments conducted at Souris, Tignish and Richibucto in 1949 and 1950 demonstrated the relative efficacy of baits for hake and cod. Catches per pound of bait used decreased in the following order: (1) for hake - squid, mackerel, herring, clams and shack (waste fish from the catch); (2) for cod - squid, Nova Scotia herring, mackerel, Gulf herring, clams and shack. Squid bait took greater catches of larger fish.

During the period January 23 to May 18, 1953, bait experiments were again carried out, at Lockeport, N.S., using the M.B. "Mallotus" (Captain R. H. McDonald) rigged as a long-liner. Five frozen baits, Nova Scotia herring, Gulf spring herring, Gulf summer fat herring, mackerel from Cape Breton and squid from Newfoundland, were compared. Six nine-line tubs and three baits were fished in each set, with the standard bait, Nova Scotia herring, used in all sets. The bait was changed every three lines, the order of baits was changed for each set and the two series of baits were fished on alternate fishing days. Fishing weather was poor and only 18 sets were made with 13 of these on inshore fishing grounds. The fish were tallied as they were taken from the lines and weighed at the wharf in lots separated by baits used and by normal cull for species and sizes. Special sets were made to compare differences in size and quality of squid bait.

The relative efficacy of baits for cod and haddock, the two important species taken, is shown for the inshore sets in the table below. Total weights landed were divided by total numbers caught in order to show the average sizes of fish taken.

<u>Bait</u>	<u>Number of sets</u>	<u>Pounds of bait per line</u>	<u>Pounds caught per pound of bait</u>			<u>Average weight in pounds</u>	
			<u>cod</u>	<u>haddock</u>	<u>total</u>	<u>cod</u>	<u>haddock</u>
Squid	6	3.4	4.0	2.5	6.5	7.1	2.7
Mackerel	6	3.3	2.4	2.7	5.1	5.2	2.4
N.S. herring	6	3.3	3.0	2.2	5.2	4.2	2.7
Spring herring	7	3.2	2.2	1.5	3.7	4.8	3.1
Fall herring	7	3.3	2.4	1.8	4.2	5.0	2.8
N.S. herring	7	3.3	3.4	1.8	5.2	4.6	2.7
Squid							
poor quality,							
small	1	2.5	1.4	0.7	2.1	2.5	2.9
large	1	3.4	1.4	1.1	2.5	3.7	2.9
good quality,							
large	4	3.5	4.3	3.1	7.4	7.3	2.6

It may be noted that Nova Scotia herring took the greatest numbers of cod but the average weight of fish caught was low; the resultant catch per pound of bait was lower than that for squid but higher than that for mackerel and Gulf herring. Squid proved to be the best bait for cod, taking large numbers of large fish.

The greatest quantities of haddock were taken by mackerel and squid. There was little variation in the size of fish caught but those taken on mackerel bait appeared to be slightly smaller.

Total catches taken with squid were much better than those made with other baits. Squid can be twice as expensive as herring bait and still give a better net profit, but it must be of good

quality for best results. Total catches with mackerel and Nova Scotia herring were similar, mackerel being better for haddock and herring being better for cod. Gulf herring baits gave relatively small catches.

Samples of the baits were taken in April and again in May for fat determinations. The results, expressed as average percentage of the wet weight of the whole fish, are given below:

<u>Bait</u>	<u>April sample</u>	<u>May sample</u>
Squid - good quality	6.6	5.3
poor quality	-	6.7
Mackerel	5.6	8.7
N.S. herring	17.0	10.0
Spring herring	3.2	9.9
Fall herring	13.6	13.8

There is no apparent relationship between the efficacy of baits for groundfish and their fat content.

Records were taken of the appearance of baits on hooks at the time of hauling as a measure of their staying power for fishing. Squid lasted better than mackerel and mackerel in turn better than herring. When all baits remained on the hooks, Nova Scotia herring took the greatest catches of cod, but when bait tended to disappear from the hooks squid took most fish, especially cod. Mackerel disappeared from the hooks less rapidly than herring and took more haddock (but fewer cod). It appears that the staying power of baits on line trawl is an important factor in their effectiveness for fishing.

The results obtained in 1953 have extended observations to a different area and another species. They have also served to point out the importance of quality and staying power of baits on hooks for efficient line fishing.

Captain C. Bayers carried out the field program and analyzed the results of this experiment.

W. R. Martin

Appendix No. 37

DANISH SEINING EXPLORATION

The only commercial Danish seiner on the Canadian mainland, the M.B. "Gay Rover", was chartered for one month during the summer of 1953 in order to carry out exploratory seining in the southern Gulf of St. Lawrence. Operations were conducted at either end of Northumberland Strait, in the Richibucto-Cape Wolfe area and off Lismore and Cape George. The Quebec Department of Fisheries chartered the boat for an additional month of seining in Bay Chaleur.

The "Gay Rover" (39 ft., 13 gross tons) is equipped with 75 h.p. Leithrop engine, 12 h.p. Wisconsin deck engine, automatic rope coiler, 2,000 fathoms of 2 1/4" manilla rope, #13 European plaice seine and operates with a total crew of three men. The Board's M.B. "Gulf Explorer", which is equipped with a Bendix echo sounder assisted in finding suitable fishing grounds off Richibucto.

Poor weather conditions and failure to find extensive areas of smooth bottom seriously limited the effectiveness of the exploratory fishing. The work accomplished may be summarized as follows: total days - 31, travel time - 6 days, Sundays - 4, weather unsuitable (high winds) - 12 days, days fished - 9, foul hauls - 9, completed hauls - 13. Five hauls were completed from Richibucto, N.B., and eight hauls from Lismore, N.S. The final week of the operation was spent between Souris, P.E.I., and Cheticamp, N.S., in order to fish known flounder grounds in this area but high winds prevented seining. The results of completed hauls are shown in the table below.

Approximate catch of marketable fish
in pounds

Date	Area	Depth fath.	No. hauls	Winter flounder	Witch	Plaice	Yellow-tail	Hake	Cod	Haddock
June 5	5 miles north of Richibucto	2-3	1	3	-	-	20	-	3	-
June 8			1	40	-	-	45	-	-	-
July 20	4 miles off Cape Wolfe	12	2	3	-	1	-	2,700	35	48
July 21			1	5	-	-	4	100	5	-
July 27	Lismore	13-15	3	65	40	13	20	250	5	105
July 28	Cape George	22-23	3	-	600	650	-	37	30	40
July 29	Lismore - Cape Bear	20	2	-	240	1,500	8	45	35	25

At Richibucto, exploration was restricted to grounds which have produced profitable catches to dragners. On the sandy bottom along the bars north of Richibucto a large number of net anchors prevented satisfactory sets. Only small quantities of winter flounders and yellowtails were taken. A good haul of hake (2,500 lb.) was taken about four miles off Cape Wolfe, P.E.I., in 12 fathoms but very much smaller catches were taken in two additional sets at the same station.

At Lismore fishing in 13 to 15 fathoms on grounds fished by local dragners yielded only small quantities of groundfish, with hake dominant. Better hauls were made in 22 to 23 fathoms off Cape George with plaice and witch of marketable size making up the greater part of the catches. Seining in 20 fathoms at a station mid-way between Lismore, N.S., and Cape Bear, P.E.I., gave the best results. Catches averaged more than 900 lb. per haul with marketable plaice (mean length 41.5 cm.) being the most important species taken.

In none of the areas fished were the catches as good as those made in exploratory and commercial seining in Chedabucto Bay. However, by making six hauls per day the Cape George-Cape Bear area can probably provide profitable seining. Seining has been most effective for witch in Chedabucto Bay and it might well be profitable to fish the witch grounds off Cheticamp with the Danish seining method. The smoothest grounds for seining apart from Chedabucto Bay have been found in the most southerly part of the Gulf of St. Lawrence and there is best opportunity for extending commercial Danish seining in this area.

Captain Harris of the "Gay Rover" reports that he plans to continue with commercial Danish seining during 1954 and that two other draggers plan to convert to this method of fishing.

Fishermen at Richibucto, Summerside, Borden, Pictou, Lismore, Souris, Cheticamp and Mulgrave had an opportunity to see a commercial Danish seiner and discuss the method during this exploratory fishing.

L. H. Roberts carried out the field program and analysed the results.

W. R. Martin

Appendix No. 38

COD-WORM INVESTIGATION

Life history

One phase of the life history of Porrocaecum decipiens, commonly called the cod-worm, which is not yet known is the mode of transmission of the parasite from seal to fish. Bottom-dwelling invertebrates are suspected of being involved because they form the greater part of the food of young cod and also because investigators have shown that certain crustaceans harbour larval nematodes which have the morphological characteristics of the cod-worm larvae. In the summer of 1953 an attempt was made to infect invertebrates with the parasite, hoping, if this was successful, to compare the larvae with those found in mysids.

1. Survey at Richibucto in May and early June. The purpose was to discover whether larval nematodes occur in invertebrates in this region of New Brunswick, where cod are heavily infected with Porrocaecum. In specimens brought to the surface during bottom dragging operations for young lobsters by the M.B. "Gulf Explorer" only adult nematodes were found and these only in two crustaceans - Crangon vulgaris (8.5% infected) and Mysis stenolepis (27.9% infected). It was possible for the boat to make collections in only one area and these results are not necessarily representative of the whole Richibucto region.

2. Attempts to infect invertebrates at St. Andrews from June until September. Invertebrates (Crangon vulgaris, larval

Mysis stenolepis and clams) were held in wooden aquaria, having a sandy bottom, a filter screen to prevent larvae from escaping and circulating sea water. The animals were acclimatized for at least one week after which 50 per cent of those still alive were dissected to be sure they harboured no parasites; then attempts at infection were begun.

In attempts to infect shrimps and mysids, larvae and embryonated eggs of Porrocaecum were placed in such food media as faeces from seals held at the Station, ground clams and dissected Crangon. These were then put into the aquaria either by means of a dipper or a culture dish, not all being used in every aquarium. Eggs were obtained from the worms taken from freshly-killed seals; infective larvae were obtained when eggs were cultured in sea water.

Upon dissection, only two Crangon from one aquarium were found to harbour a larval Porrocaecum; the latter showed no growth. In the formalin used to kill the Crangon a number of larvae were found, some showing a slight increase in width and density but no increase in length. It appears that these escaped into the formalin. The formalin in which shrimps from another aquarium were killed also contained two larval cod-worms with no apparent growth.

No Porrocaecum larvae were found in the larval Mysis stenolepis and there were none in the formalin. This species had been infected experimentally in 1952 but the animals used at that time were adults (which could not be collected this year) and food habits of the adults possibly differ from those of the larvae.

Using eight clams (Mya arenaria) placed in a row down the middle of an aquarium, alternate individuals were injected with live infective cod-worm larvae both down the in-current syphon and via the muscle directly into the mantle cavity and the other four clams were used as controls. It was found that all four injected clams had both live and dead larvae (having no growth) in the mantle cavity and the syphons, thus showing that cod-worm larvae can live in this environment for a minimum of two to four days.

Attempts to infect invertebrates were successful only with Crangon in which the parasite has not been observed in nature. Further experiments are needed.

Dr. R. W. Wolfgang of the Institute of Parasitology gave valuable assistance in the supervision of this research program.

H. G. Baer

Removal of worms from fillets

A number of tests of the effects of physical stimuli on worm-infected cod fillets were carried out during 1953 in

co-operation with the Institute of Parasitology, Macdonald College, P.Q., in the hope that a more efficient scheme of worm removal might be developed to replace the present expensive candling technique.

Dr. R. W. Wolfgang made a number of observations on wormy fillets at the Institute of Parasitology and at the General Electric Laboratory in Schenectady, N.Y. The nematodes were remarkably resistant to dia-electric high-frequency transmission, high-voltage electrostatic transmission and ultrasonic irradiation, presumably because of the insulating effect of the fillets. Tests of the effect of light gave variable results. Emergence of worms from fillets was fair at 30°C. and good at 40 to 47°C. but dehydration produced a hard coating of coagulated protein on the surface of the fillets through which worms could not penetrate. Differential osmotic pressure was tested by placing fillets in cold fresh water. In freshly cut fillets the worms left the muscle within five hours but water penetrated the muscle, increasing the weight of the fillet and separating the myotomes. Older fillets, with coagulated protein surfaces, resisted water penetration but worm emergence was less complete. It has been suggested that the effects of high pressure nitrogen, followed by low pressure evacuation might produce a bubbling or "bends" stimulus to worm activity.

R. M. MacPherson reported in April that wormy fillets stored overnight in iced salt water became worm free. He followed this up in May by placing three fillets containing a total of 30 nematodes in ice water for 24 hours. Twenty worms left the fillets and the remainder appeared to have been damaged by the filleting operation. In June he placed one fillet with 12 worms in a salt-water bath, packed in ice, and after 24 hours none of the worms had left the fillet. A second fillet with nine worms placed in iced fresh water showed complete emergence of worms after 24 hours.

A. C. Kohler subjected five-day-old fillets (two worms each) to salt and fresh water (4°C.) at St. Andrews in September. Those in salt water showed complete worm emergence but high-water penetration and marked deterioration of fillets in 24 hours. Those in fresh water remained firm but worm emergence was less complete. Infected, gutted, whole cod were similarly tested in cold salt and fresh water but no emergence was observed.

Pressure effects and those of differential osmotic pressure seem to offer the most promise for removal of worms from freshly-cut fillets. In any further tests the quality and marketability of the fillets following worm removal must be examined more closely.

W. R. Martin

Appendix No. 39

UPPER LETHAL TEMPERATURES OF SOME GROUND FISH SPECIES

Some preliminary tests to determine upper lethal temperature levels for the smooth flounder (Liopsetta putnami), pollock (Pollachius virens), cod (Gadus callarias) and plaice (Hippoglossoides platessoides) were carried out between July 15 and September 15, 1953. Specimens were exposed to high temperatures in constant temperature baths which were aerated and supplied with a regular flow of water.

Smooth flounder

Smooth flounders seined from water at 16.5°C. and held in the laboratory at a temperature of approximately 16°C. were exposed in lots of seven to temperatures of 27°C., 28°C., 29°C. and 30°C. The upper lethal temperature, defined as that temperature which caused 50% mortality in 48 hours, was found to be between 27.0°C. and 28.0°C. Acclimation from 16°C. to 23°C. appeared to be complete in three days.

Pollock

Pollock taken from water at 11.5°C. and held at approximately 16°C. for a number of days were exposed in lots of seven to temperatures of 20°C., 21°C., 22°C., 23°C., 24°C. and 25°C. The upper lethal temperature, as defined above, was found to be between 20°C. and 21°C.

Cod

Difficulty in obtaining satisfactory specimens together with relatively high mortality in the holding tanks limited the number of this species tested to eight. The cod were taken from water at 11.5°C., held in water at 16°C. and tested in lots of one or two at 26°C., 25°C., 23°C., 22°C. and 21°C. These preliminary tests gave an upper lethal temperature between 21°C. and 22°C.

Plaice

Difficulties similar to those for cod were experienced in obtaining and holding plaice. Six fish held at 16°C. were tested, one each at 26°C., 25°C., 23°C., 22°C., 21°C. and 20°C. Above 22°C. the plaice died rapidly; at 21°C. the animals lived for 12 hours; and at 20°C. they were still living at the end of 72 hours. Results suggest that the upper lethal for this species, when acclimated at 16°C., lies between 20°C. and 21°C.

Comparison

While some of the data are of a very preliminary nature and intended as a framework for future experiments in this field, they do afford a comparison of the upper lethal temperatures for four groundfish species. This comparison is summarized in the following table:

<u>Species</u>	<u>Acclimation temperature °C.</u>	<u>Upper lethal temperature °C.</u>
Smooth flounder	16	27-28
Cod	16	21-22
Pollock	16	20.5-21.5
Plaice	16	20-21

It is interesting to note that the smooth flounder, which is found close to shore and concentrated where estuarial conditions exist, has a much higher upper lethal temperature than any of the other three species. The upper lethal temperatures of the cod, pollock and plaice lie close together although there is a suggestion that plaice have the least tolerance for high temperatures. These data indicate also that the upper lethal temperatures of this group are lower than those of the salmonoid fishes.

Summary of C. J. McFarland's
report by F. D. McCracken

Appendix No. 40

EXPLORATORY FISHING FOR HERRING IN THE GULF OF ST. LAWRENCE

Exploratory drift-net fishing for herring was carried on by the Atlantic Biological Station in 1950, 1951 and 1952. The results indicated that good drift-net catches (much better than those in the North Sea) could be made from June to September in the Gulf of St. Lawrence, especially in areas off Gaspé, and northeast and southwest of the Magdalen Islands.

Norwegian investigators, on the basis of drift-net catches and sonic-sounder records, expressed the opinion that herring in these areas could be purse-seined successfully. We believed, on the basis of the known diurnal vertical movements of herring, that in areas where herring were abundant at the surface at night they would be concentrated on the bottom by the daylight and could be caught successfully in bottom trawls. We further believed, from an examination of sonic-sounder records over a period of years, that herring could be taken successfully with pelagic trawls, especially at dusk and the early hours of the night.

In the light of these facts and opinions it was considered to be worth while conducting some further explorations and the opportunity to do so was provided in 1953 when representations on behalf of Canapro Ltd., a herring processing firm at Grindstone, M.I., were made to the Department of Fisheries for experiments to determine the commercial possibilities of herring fishing in the Gulf of St. Lawrence during the summer months. The company undertook to find a supply of bottom trawls especially designed for catching herring, to provide personnel experienced in

European methods of herring fishing and to purchase all of the herring caught during the operations. The Department of Fisheries undertook to provide boats and gear and, through the Atlantic Biological Station, to direct and record the results of the experiment.

Two boats were used for these experiments. The "Marion Crouse" a 98-foot dragger owned and operated by Crouse Fisheries Ltd. of Lunenburg, N.S., was chartered for a period of four months from June 4 to October 3. This vessel was equipped with bottom trawls of Dutch and French design and operated almost exclusively in the area between the Magdalen Islands, the Cape Breton shore and the eastern part of Prince Edward Island. One cruise was made in the area between Magdalen Islands and Gaspé and one on the outer coast of Nova Scotia. The "Harengus", a Department of Fisheries vessel 84 feet long and equipped for trawling (both bottom and mid-water), drift-netting and purse-seining, was made available during the latter part of May and was employed continuously until the end of September. Except for one cruise off the west coast of Newfoundland in July, the "Harengus" carried on explorations in the southwestern portion of the Gulf of St. Lawrence from Gaspé to Cape Breton.

The "Marion Crouse" carried a crew of 14 men and the "Harengus" a crew of nine men. In addition Mr. E. G. Sollows, Mr. M. Daneau and Mr. G. M. Greek were employed as technical observers. Mr. L. Vanderzwan was employed as a gear expert and supervised most of the fishing operations of the "Harengus" as well as making frequent trips on the "Marion Crouse" to instruct the crew in the proper methods of handling and maintaining the Dutch gear. Captain Francois Paillard was employed by Canapro Ltd. and spent two weeks on the "Marion Crouse" instructing the crew in the operation of the French trawls. Miss Phyllis J. Gibson was responsible for examining, assembling and summarizing the various records as they were sent in to the laboratory at St. Andrews.

Results of explorations

(a) "Harengus". The "Harengus" was employed chiefly as a scouting vessel to search for herring and to provide leads which could be followed up by the "Marion Crouse". This was done using a sonic sounder for detecting schools of pelagic fish and confirming their presence with drift-nets. Bottom trawling with Dutch herring trawls was also carried on and some trials were made with the Swedish Larsson or "Phantom" trawl. The vessel was also equipped with a purse-seine but there was no opportunity to test this gear.

Twelve sets were made with drift-nets in the vicinity of Magdalen Islands, three sets off the west coast of Newfoundland and one set off the Gaspé coast. In all but one of the sets near Magdalen Islands large quantities of herring were captured and the total catch amounted to an estimated 60,450 pounds of herring and 405 pounds of other species (chiefly mackerel). This is an average catch of 358 pounds per net (37 1/2 yards long and 360 meshes deep) for each night's fishing. In comparison, the North

Sea commercial vessels make catches averaging 100 pounds per net. The three sets made off the west coast of Newfoundland did not take any appreciable quantity of fish as only 45 pounds of herring and 80 pounds of other species were taken altogether. In the one set made in the Gaspé area 9,900 pounds of herring were taken in 15 nets, an average of 660 pounds per net.

Thirty-three tows, usually for about 90 minutes, were made with Dutch herring trawls and the total estimated catch was 29,020 pounds of herring and 17,177 pounds of other species. The average catch per tow was 879 pounds of herring and 520 pounds of other species. In view of the fact that the "Harengus" was used chiefly to explore the whole southwestern Gulf area, these results indicate that herring could be trawled successfully. The best catches were made between Margaree and Port Hood Island off the Cape Breton shore and the average catch in this area was 2,534 pounds of herring and 750 pounds of other species. These catches are almost identical to the average catches of the "Marion Crouse" in the same area although the latter vessel caught more herring per tow.

The Swedish mid-water or "Phantom" trawl was used eight times. In one tow on September 16 near Madgalen Islands 1,125 pounds of herring were taken. In the other seven tows only 75 pounds of herring were taken altogether. This trawl is of very light construction and apparently could not withstand the strains as tears appeared each time the trawl was used. On two occasions when the sonic sounder indicated large schools of herring the trawls were torn beyond repair. It is believed that this method of fishing would be very successful if suitable trawls could be made. The difficulty appears to be that the trawl must be light enough to be towed at a speed of from 3 to 4 knots and yet strong enough to withstand the strains of towing and the catches of large quantities of herring.

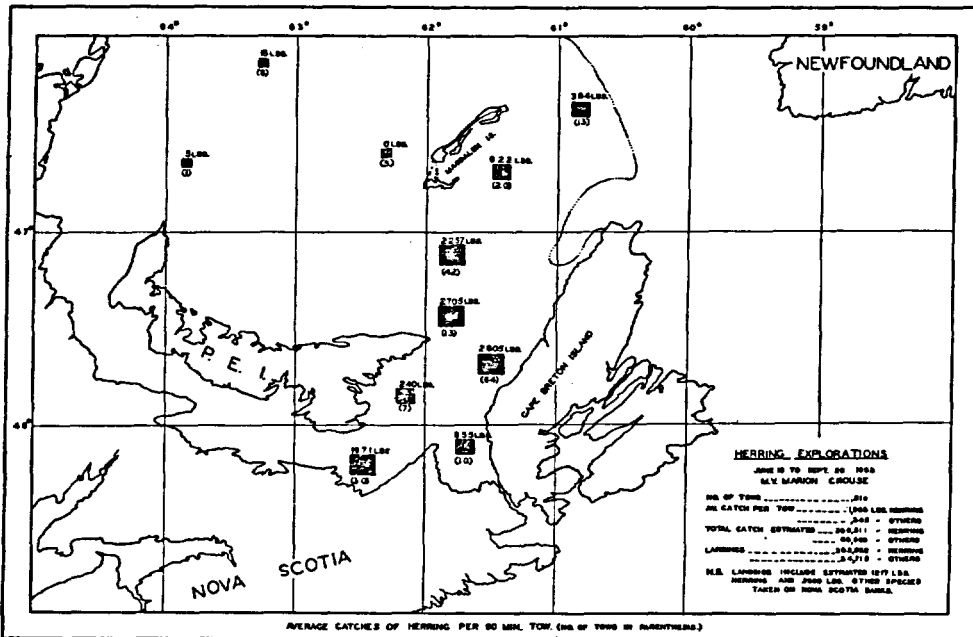
(b) "Marion Crouse". The "Marion Crouse" was equipped with Dutch trawls for the first month of the charter period and from then on used French trawls exclusively. No comparison between the two types of gear is possible because it was not until July 10 that large concentrations of herring were found and only the French gear was used after that date. Actually there are only minor differences between the Dutch and French trawls and it is believed likely that catches would be similar in both.

The accompanying table gives the approximate areas where fishing was carried on, the number of tows, the depths and the catches of herring and other species.

Summary of operations by the M. V. "Marion Crouse"

Area	Number of tows	Depth	Estimated catch	
			Herring	Other species
Le Fond George	42	22-45	91,871	11,195
East Point, P.E.I.	13	19-26	33,000	9,400
Cape Breton shore	64	21-36	168,025	12,925
East Coast, P.E.I.	7	19-24	1,778	3,520
Entry Island	20	17-39	14,225	2,186

Area	Number of tows	Depth	Estimated catch	
			Herring	Other species
Deadman's Island	5	20-28	1	3,725
Bird Rocks	13	28-34	4,916	1,035
Orphan Bank	6	45-53	78	1,550
North Pt., P.E.I.	1	24-25	5	100
Pictou Island	34	7-26	59,512	23,230
George Bay	10	17-26	7,100	100
Sable I.	13	16-40	1,216	5,200
Emerald Bank	2	50-59	1	325
Totals	230		381,728	74,491



The best catches were made along the Cape Breton shore between Port Hood and Margaree and more fishing was done there than anywhere else. Good catches were also made near Pictou Island, off East Point, P.E.I., and on Le Fond George about twenty miles south of the Magdalen Islands.

The accompanying chart shows the average catches and the number of tows that were made in the various areas. Tows were usually of 90 minutes' duration but were occasionally shortened by the net becoming fouled in the bottom. The average catches are based on 90-minute tows.

General

The total estimated catch of the "Harengus" for the whole operation was 100,615 pounds of herring and 17,662 pounds of other species. The actual landings and sales amounted to

96,403 pounds of herring and 8,513 pounds of other species. The total estimated catch of the "Marion Crouse" was 381,728 pounds of herring and 74,491 pounds of other species. The actual landings amounted to 361,582 pounds of herring and 34,715 pounds of other species. Included in the catch estimates for the "Marion Crouse" is an estimated 22,000 pounds of herring which was dumped off Cheticamp when weather conditions prevented landing at Grindstone. In the case of both boats it was estimated that 50 per cent of the catches of other species was discarded at sea because of small size and consequent unsuitability for market.

The overall results indicate quite clearly that offshore fishing for herring can be successful in the Gulf of St. Lawrence during the summer months if the prices paid are comparable to those paid for other species. Average drift-net catches for three seasons have been from two to six times the average of commercial catches in the North Sea. Trawl catches by the "Marion Crouse" after July 10, when the first large concentrations of herring were found, averaged slightly more than 2,400 pounds per 90-minute tow for 156 tows and with increased familiarity with the area, so that rough bottom could be avoided, the average catches could be improved.

Most of the catches made were sold for \$6.00 per ton and at this price the operation would not be profitable. Some catches, however, were sold for \$20.00 per ton at which price the prospects are encouraging. Further experiments are required before the true economics of this fishery can be established.

S. N. Tibbo

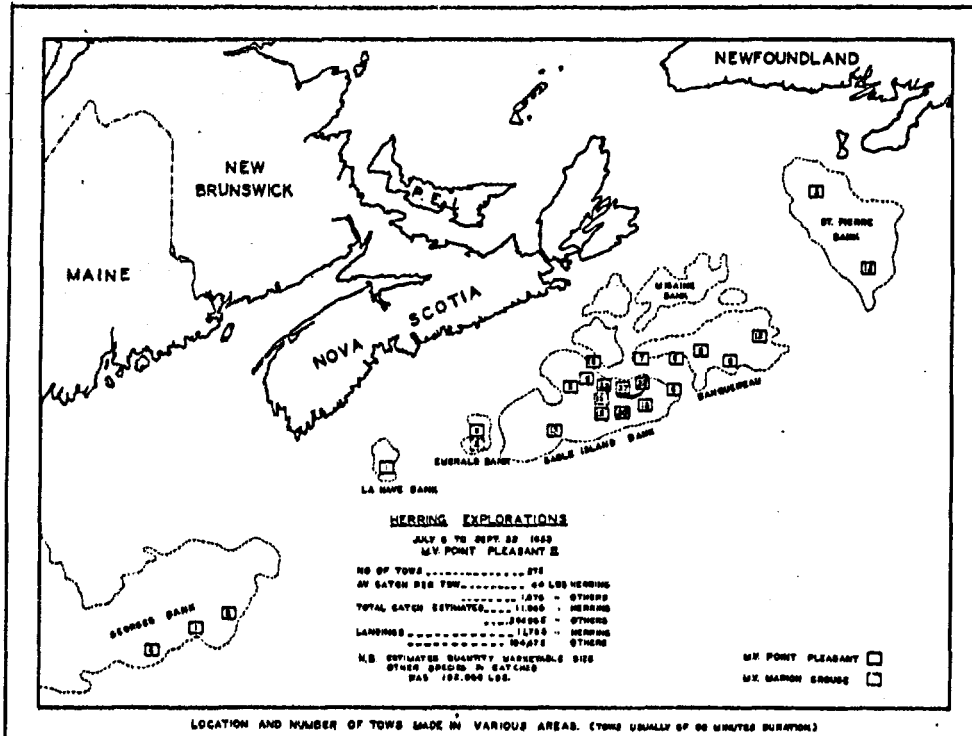
Appendix No. 41

EXPLORATIONS FOR HERRING ON THE NOVA SCOTIAN BANKS

The established Nova Scotian industry using herring for food and bait has suffered in recent years from some failures of present methods of fishing to supply the demand. This has led to frequent requests from the industry for explorations to discover how to catch herring more reliably and over a longer period.

To learn something of the offshore distribution of herring in this area drift-netting was carried out in 1950 at a number of stations covering the Scotian shelf and most of them were occupied three times during the period May to September. Practically no herring were caught in any of the sets and this is in sharp contrast to the success in the Gulf of St. Lawrence. In 1951 a few drift-net sets were made in May and they were equally unsuccessful. In July, August and September, 1952, the "Mallotus" used drift-nets that were twice the depth of the ones used previously, but again without success. During the same season the "Harengus" made a few sets with Dutch herring trawls and with ordinary groundfish trawls fitted with small-mesh cod-ends but no appreciable quantities of herring were caught.

In spite of the lack of success of these explorations there is reason to believe, from past history and from reports of herring seen or caught in recent years, that large stocks of herring occur in the Scotian Shelf area and further attempts to find them were made in the summer of 1953. The M.V. "Point Pleasant II" was chartered from the Maritime National Fish Company of Halifax, N.S., for the period from July 6 to September 24 and was engaged in a search for herring on the Nova Scotian banks during that period. The vessel was fitted with Dutch herring trawls and regular groundfish trawls and searched for herring over a considerable portion of the Scotian Shelf area from Georges Bank in the west to St. Pierre Bank in the east. The accompanying chart shows the approximate location of the sets that were made and the numbers in the rectangles show the numbers of tows that were made in each area. The tows were us-



ually of 90-minutes duration. Mr. L. Vanderzwan, who has had considerable experience with trawling for herring in European waters, accompanied the vessel on three trips to instruct the crew in the proper method of handling the Dutch trawls. Mr. G. Greek was employed as technical observer.

Summary of explorations by M.V. "Point Pleasant II"

<u>Area</u>	<u>Gear*</u>	<u>Number of tows</u>	<u>Depth</u>	<u>Catches</u>	
				<u>Herring</u>	<u>Other species</u>
Sable I.	D.H.	81	13-45 fms.	5,606	95,870
Sable I.	P.C.	108	15-41 fms.	5,556	116,905
Banquereau	P.C.	42	19-48 fms.	703	37,750
Banquereau	D.H.	2	21-22 fms.	100	2,000
St. Pierre	P.C.	20	20-43 fms.	1	37,700
Georges	D.H.	15	27-48 fms.	-	5,210
Emerald	P.C.	5	65-75 fms.	-	375
Emerald	D.H.	1	62-70 fms.	-	75
La Have	D.H.	1	50-52 fms.	-	100

* D.H. indicates Dutch herring trawl

. P.C. indicates ordinary groundfish trawl ("Peter Carey" type).

The accompanying table summarizes the fishing effort of the "Point Pleasant II". A total of 275 tows were made - 100 with Dutch herring trawls and 175 with ordinary groundfish trawls. The total estimated catch was 11,966 pounds of herring and 295,985 pounds of other species, about two thirds of the latter being unsalable.

The north side of Sable Island was the only area where herring were found at all consistently and some herring were taken in 52 out of 107 tows made there. However, the best catch was 1,500 pounds and in only four tows were more than 1,000 pounds of herring taken. The total catch of herring for 275 tows is less than the catch made in single tows of 90-minute duration on two occasions in the Gulf of St. Lawrence using similar gear. Further explorations are planned in 1954 over a larger part of the year.

S. N. Tibbo

Appendix No. 42

RELATION OF HERRING CATCHES TO HYDROGRAPHY AND PLANKTON

In association with the exploratory fishing for herring in 1953 studies were made of temperatures, light and weather, abundance of plankton and the distribution of pelagic fishes as indicated by sonic sounder recordings.

Temperature

Surface temperatures and bathythermograph observations were made daily during fishing operations in an attempt to determine whether any relationship existed between temperatures and the distribution of herring. A cursory inspection of these records has failed to reveal any such relationship and it is doubtful if any exists since catches were generally good in the Gulf of St. Lawrence and always poor on the Nova Scotia banks regardless of water temperatures. In all some 132 observations

were made and these will be examined more carefully during the coming winter.

Light

A pilot-house record of light and weather conditions was made for every hour that the nets were in the water when drift-netting, and four times daily when trawling. As in 1950 and 1952 the best drift-net catches were made on clear starlight nights and the poorest catches on bright moonlight nights. Other aspects of weather conditions appear to have little effect on drift-net fishing except that with winds greater than 20 m.p.h. the boat and nets drift too fast for effective fishing.

Light is an extremely important factor in trawling for herring. Catches made at night with bottom trawls were almost negligible and night fishing was abandoned early in the season in favour of a more concentrated effort on fishing during the daytime when the herring were close to the bottom. The largest concentrations of herring were found in depths of from 28 to 34 fathoms and most of the fishing was done there. Data are insufficient to indicate whether or not herring could be trawled successfully from more shallow depths during the night. Good catches have been made with drift-nets from the surface to 12 fathoms below the surface but no trials have been made at greater depths. A better understanding of the diurnal vertical migrations of herring would be very useful.

Plankton

Plankton tows were taken daily when the boats were fishing. In all cases these consisted of 10-minute horizontal tows with a net 30 inches in diameter and of #0 mesh (12 to 15 meshes to the centimetre).

During drift-net explorations in 1952 a relationship was established between the abundance of plankton and the catches of herring. It was shown that the best catches were invariably associated with large quantities of plankton and that the reverse was also true. This relationship was less obvious in 1953 when the efforts were directed mainly towards determining the commercial possibilities of trawling and drift-netting and the operations in the Gulf of St. Lawrence were confined to relatively small areas. Most of the tows in this area had large quantities of plankton and the average quantity per tow for 39 tows was 210 c.c.

The quantities of plankton in the tows on the Nova Scotia banks were far more variable than those taken in the Gulf of St. Lawrence. They varied from amounts too small to measure to 550 c.c. per tow. The largest quantities were taken on Georges Bank and Middle Ground on days when no herring whatsoever were caught.

The principal constituent of all of the plankton tows both in the Gulf of St. Lawrence and on the Nova Scotia banks was the copepod Calanus with smaller and varying amounts of fish eggs, fish larvae, Ctenophores, Chaetognaths, Amphipods and Decapod larvae also present in most of the tows.

Sonic-sounder recordings

All of the vessels used for herring explorations in 1953 were equipped with sonic sounders which were used as much as possible to find herring. Some excellent recordings were obtained from a new machine which was purchased especially for the work and installed on the "Harengus" at the beginning of the season. This instrument, a DR5B model Bendix, was used particularly as a guide for setting drift-nets and mid-water trawls. In the majority of cases good catches were associated with good recordings. Some of the largest schools of herring ever recorded offshore in the Gulf of St. Lawrence were located during September on American Bank in the Gaspé area and it is believed that with proper equipment these herring could be successfully purse-seined.

There is evidence to indicate that sonic sounders are also useful in bottom trawling for herring apart from the obvious use of distinguishing between smooth and rough bottom. On several occasions schools of herring were located at or very near the bottom and good catches were made.

S. N. Tibbo

Appendix No. 43

HERRING POPULATION STUDIES

During the period 1946 to 1949 the Atlantic Herring Investigation Committee conducted a large-scale study of herring populations on the east coast of Canada and established the fact that there are at least six separate groups of herring in the area which can be distinguished on the basis of differences in length- and age-composition, rate of growth and mean vertebral count. This study is being continued each year on a small scale to follow any changes that may occur within the various populations.

Samples of the commercial catches at Matane, P.Q., Caraquet, N.B., and North Rustico, P.E.I., were obtained in 1953 and were examined for length, age, sex and maturity of the gonads, abdominal and total vertebral counts and pectoral fin-ray counts. These data have not been fully examined but enough has been done to show that no significant changes have occurred in the length-composition or the mean vertebral counts. Age determinations have not been completed but there is evidence from the wide range of sizes that many year classes are represented in the catches, indicating a low total mortality and giving weight to the contention that an increased rate of exploitation is possible without endangering the perpetuity of the stocks.

Plans were made this year to start an intensive study of herring populations along the outer coast of Nova Scotia and two samples were obtained from Pembroke near Yarmouth. This work was discontinued 10 days after it was started because of the pressure of other phases of herring investigations, particularly exploratory fishing, and will be included in the plans for 1954. It is felt

that a better understanding of the biological characteristics of herring in this area may provide a background for explorations to determine the offshore distribution of these populations.

The drift-net and bottom-trawl catches made during exploratory fishing operations were sampled regularly and 49 samples were obtained. Included in these were measurements of 10,546 herring and detailed examination of 1,100 including lengths, ages, vertebral and fin-ray counts, sex and condition of the gonads. Examination of these data will provide information on two populations of herring in the Gulf of St. Lawrence which have not been sampled previously and whose existence was unknown until recently. Also included in the above samples are measurements of small herring 16 to 20 cm. long which would be called "sardines" in the Bay of Fundy. As far as is known this is the first record of herring of this size being taken in quantity in the southwestern part of the Gulf of St. Lawrence.

S. N. Tibbo

Appendix No. 44

CHARLOTTE COUNTY "SARDINE" FISHERY, 1953

For several years a small-scale watching brief has been held on the sardine fishery in the Bay of Fundy, and particularly in the Charlotte County area, to follow such matters as recruitment, fat content, and the incidence of the fungus disease which often affects herring in this area.

The season of 1953 has been unusual so far as catches of "sardine" herring are concerned. The weirs have made small catches throughout both the district and the season. During July to mid-October the fish - at least in the Passamaquoddy Bay area - have been abnormally small. The yearling group has been missing during much of the season.

Only nine samples, comprising 2,535 fish, were measured. All were from the western part of Passamaquoddy Bay. In three samples, only one of which came from a weir, fish from seven to eight centimetres in total length predominated. In sampling over the past twelve years this size of fish has not been encountered in the weir catches to any marked extent. It would appear, therefore, that these small fish have been unusually abundant during the past summer and fall. Their capture and sale for reduction purposes has caused some concern amongst canners and weir operators.

While it is true that some of the fish were very small, it must be pointed out that many now deemed too small to can would have been used for sardines 15 or 20 years ago and would have been taken without question.

What will be the effect on the subsequent fishery of the removal of large quantities of young herring below canning

size? Without data on the abundance of these fish and the proportion which has been removed by man it seems idle to speculate on the effect on future catches. Observation of the fishery in 1954 and of the size composition of the catches may give the answer.

There was far less evidence of herring disease in 1953 than there was in the previous year when in some samples more than 25% of the herring were affected. Seven out of the nine samples taken this year had some diseased fish but the maximum was 5% in a sample taken on September 15. Of the yearling and older fish in the samples a high proportion (70% in one sample) showed evidence of having recovered from the disease and it is not inconceivable that the relative scarcity of older fish this year may have been due to the high incidence of the disease in 1952.

A. H. Leim
S. N. Tibbo

Appendix No. 45

HERRING TRAWLING EXPERIMENTS IN THE BAY OF FUNDY

During the winter of 1951-1952 experiments were conducted by this Station with the two-boat, Danish, Larsen, mid-water trawl and it was demonstrated that this gear was effective when towed near the bottom during the daytime. Subsequently certain local, two-man boats carried out the first commercially successful bottom trawling for sardines in the Bay of Fundy. These boats used standard groundfish trawls with small-mesh cod-ends and made catches during the daytime of from 500 to 8,000 pounds in tows which were usually of 60 minutes' duration. Reports covering five weeks of operation were received from one boat and the average catch per week was 50,000 pounds. This was sufficiently promising to offer an alternative method to the purse-seining which has been carried on during the winter months for many years.

In 1952-1953 plans were made to test bottom trawls especially designed for capturing herring to determine whether this gear was more effective than ordinary groundfish trawls. Herring trawls differ from ordinary bottom trawls in that they are of very light construction and are designed so that they skip lightly over the bottom with the headrope raised by means of kites and floats to a height of from 15 to 20 feet. Mr. L. Vanderzwan of the Canadian Fisheries Supply Company Limited of Lunenburg, N.S., a subsidiary of a Dutch net-making firm, designed and constructed a trawl for the purpose.

Considerable scouting was done using sonic sounders and eight sets were made with the trawl but the results are inconclusive because the usual winter concentration of herring failed to appear. During the coming winter it is planned to test again bottom trawls of the Dutch type and also the single-boat, mid-water, Swedish Larsson or "Phantom" trawl.

In 1952 Mr. D. S. Johnson of the Drummondville Cotton Company requested assistance from this Station in the development of a mid-water trawl which he had designed. From time to time during December, January and February facilities were made available to him for construction and adjustment of doors and preliminary tests were made with the gear. The trawl appeared to work well but adequate tests were impossible because of the failure to locate the dense schools of sardines which are usually present in the area. Further tests are planned with this gear during January and February, 1954.

S. N. Tibbo

Appendix No. 46

FURTHER NOTES ON STOMACH CONTENTS OF SWORDFISH

During the summer of 1953, six swordfish stomachs were taken at random from fish harpooned in the area of Browns and Georges Banks and made available through the kindness of Captain Jules LeBlanc. Analysis confirms the findings from 11 stomachs provided by him last year from the same area (see Appendix 54 of the Annual Report for 1952).

Drained volume of contents varied from 2,273 to 9,092 c.c., the average being 4,877 c.c. Main diet consisted of large mature herring (Clupea harengus), medium size hake (Urophycis ?), large squid (Ommastrephes illecebrosus) and large argentine (Argentina silus) in that order. Squid and hake were present in all stomachs examined. Argentine were found in only two stomachs but made up over half of the contents of each. Unidentified nematodes were found in only two stomachs but in one made up one third of the total drained volume of 3,410 c.c. Deep cuts and slash marks, made apparently by the sword of the swordfish, were quite evident in the undigested specimens of argentine and herring. One lantern fish (family Myctophidae) was found.

L. R. Day
W. G. Carson

Appendix No. 47

SIZE OF SMELT RUN NOT WELL CORRELATED WITH RESULTING PRODUCTION OF LARVAE

Following a poor smelt fishery concern is often expressed over possible inadequacy of the number of fish left to form the spawning run the next spring. To throw light on this subject we have presented in the accompanying table the Miramichi commercial catch during the last six seasons, the relative abundance of the larvae produced in the following springs, and the relative abundance of the resulting year classes as adults. In the springs following two good commercial catches the larval production seemed poor (1948 and 1951 year classes) while after a third good season

Fishery	Commercial catch in thousands of cwt.	Year-class abundance from spawning in spring following the fishery	
		As larvae	As adults in fishery
1946-1947	11	? (1947)	Fair, never dominant
1947-1948	23	Poor (1948)	Good
1948-1949	20	Fair (1949)	Good
1949-1950	12	Excellent (1950)	Excellent
1950-1951	22	Poor (1951)	Fair
1951-1952	9	Very poor (1952)	?

a good year class (1949) appeared. The commercial catches of 1949-1950 and 1951-1952 were both poor but the larval production in the spring of 1950 was excellent while that in the spring of 1952 was very poor.

It is possible, thus, to have sufficient spawners left after a poor commercial season to provide a relatively large supply of larvae. Female smelt, according to size, spawn from about six to sixty thousand eggs and as a rule only a very small proportion hatch. Variations in this small proportion produce very great differences in the numbers of larvae (see Appendix 48). Experiments have, in fact, shown that extreme crowding of eggs on spawning grounds may so reduce the proportion hatching successfully as to reduce the total number of larvae produced on a given area. It is, therefore, natural that, as the table shows, there is no evident correlation between the size of the smelt run, as indicated by the commercial catch, and the size of the year class resulting from its spawning. The tremendous excess of eggs produced over those hatching successfully permits the changing environmental conditions for hatching and for survival and growth of the larvae to play the major role in deciding the abundance of year classes.

R. A. McKenzie

Appendix No. 48

FACTORS INFLUENCING PRODUCTION OF SMELT LARVAE

It has been found that there is great variation in the production of smelt larvae from year to year. Experiments on larval production from smelt eggs under different degrees of crowding, as commonly found below obstructions in spawning streams, have shown that the percentage hatch may be as low as .03% under very crowded conditions (e.g. 180,000 eggs per sq.ft.) while in less crowded conditions (e.g. 15,000 per sq. ft.) the percentage hatch may be as high as .7% or almost 25 times higher. If crowding of eggs is reduced the percentage hatching increases.

Reduction of crowding and consequent increase in percentage hatch can be brought about by increasing the spawning ground available and thus permitting the smelt to spread their eggs over a greater area. An increase in the spawning grounds occupied occurs when removal of obstructions permits the smelt

to go farther upstream and also when low spring freshets allow the fish to spawn across the full width of large unobstructed streams and as far upstream as they wish to go. Heavy freshets keep them close to the edges of the larger streams and prevent them from going far above the head of tide. It appears then that the best larval production should occur when streams are free from obstructions and freshets are moderate, thus reducing crowding on the spawning grounds, and when water levels do not drop suddenly and expose the eggs.

The accompanying table shows the rainfall during the spawning seasons of the last six years, the freedom of the spawning streams from obstructions, the size of the spawning run and the relative abundance of larvae produced. It is seen that the poorest production of larvae occurred in 1952 when the tributaries were obstructed to quite a degree and crowding resulted there even with a poor spawning run. At the same time there was an excellent run of spawners into the headwaters but high water forced the spawning fish to the edges of the streams where the eggs were left "high and dry" within three weeks by receding water. Larval production was best in 1950 when the tributaries were fairly clear and accessible to a good spawning run, and when water levels were so low in the headwater streams that the many spawners were able to spread their eggs all over the stream bed in places that did not dry before the eggs hatched.

Miramichi smelt spawning conditions and results, 1948-1953

Inches of rainfall April, May June	Freedom of spawning tributaries from obstructions	Size of spawning run		Larval production
		Tributaries	Headwaters	
1948 9.10	fair	poor	v. good	poor
1949 11.47	good	fair	fair	fair
1950 8.20	v. good	good	good	excellent
1951 13.48	fair	good	v. good	poor
1952 12.02	poor	poor	v. good	v. poor
1953 8.72	poor	fair	excellent	fair

It may be concluded that a combination of low spring freshets, unobstructed tributaries and good spawning runs favours high larval production.

R. A. McKenzie

Appendix No. 49

CATCHES OF SMELT YEAR CLASSES IN RELATION TO THEIR ABUNDANCE AS LARVAE

To determine the value of increasing smelt larval production it is necessary to discover the degree to which the relative

Table I Hundredweights of smelt taken by the Miramichi fishery from each year class
(Age of each year class in years in brackets)

Year class	Fishing seasons					Totals
	1948-49	1949-50	1950-51	1951-52	1952-53	
1945	845(4-)	43(5-)	47(6-)	0	0	935
1946	11,466(3-)	578(4-)	112(5-)	8(6-)	0	12,164
1947	7,812(2-)	4,760(3-)	2,368(4-)	148(5-)	62(6-)	15,150
1948	10(1-)	6,374(2-)	7,299(3-)	419(4-)	89(5-)	14,191
1949		20(1-)	11,887(2-)	1,750(3-)	662(4-)	14,319
1950			67(1-)	6,200(2-)	8,724(3-)	14,991
1951				10(1-)	6,697(2-)	6,707
1952					2(1-)	2

Table II Thousands of smelt individuals taken by the Miramichi fishery from each year class
(Age of each year class in years in brackets)

Year class	Fishing seasons					Totals	Larval Abundance
	1948-49	1949-50	1950-51	1951-52	1952-53		
1945	546.3(4-)	22.5(5-)	16.8(6-)	0	0	585.5	?
1946	10,132.7(3-)	367.3(4-)	51.5(5-)	2.6(6-)	0	10,554.1	?
1947	12,369.8(2-)	4,226.4(3-)	1,846.9(4-)	76.7(5-)	26.7(6-)	18,546.5	?
1948	54.6(1-)	10,106.0(2-)	7,078.1(3-)	277.0(4-)	44.7(5-)	17,560.3	poor
1949	0	114.6(1-)	16,848.3(2-)	1,568.3(3-)	414.3(4-)	19,245.6	fair
1950	0	0	280.0(1-)	10,197.0(2-)	8,174.4(3-)	18,651.4	excellent
1951	0	0	0	56.8(1-)	10,955.8(2-)	11,012.6	poor
1952	0	0	0	0	10.4(1-)	10.4	v. poor

abundance of successive year classes as larvae is correlated with the total catches taken from these same year classes during all the years they are in the fishery.

The ages and weights of the individual fish in the Miramichi smelt catch during the past five seasons have been determined through regular sampling. These data together with the monthly catch statistics for the three districts comprising the Miramichi area have been used to calculate the commercial take from each year class season by season. Similar records over a period of years will give the total yield from each year class that passes through the fishery. The results for the last five seasons are summarized in the accompanying tables.

Usually smelt approaching two, three and four years of age make up most of the commercial catch, though a few younger and some older are taken also. Since a year class usually contributes to the fishery for six years (ages 1- to 6-) this work will need to be continued for a number of years before the relative abundance of the larvae and the total catch from a number of year classes can be compared.

Tables I and II show almost the complete total yield from the 1947 and 1948 year classes, the 1- fish being missing from the former and the 6- from the latter. Two seasons' catches are missing from the 1949 year-class total and three from the 1950 year class, yet it seems quite probable that the 1950 year class (which was most abundant as larvae) may eventually contribute more to the fishery than any other year class examined to date.

R. A. McKenzie

Appendix No. 50

MIRAMICHI SMELT CATCH BY YEAR CLASSES AND PER UNIT OF EFFORT

Daily records by ten fishermen of the number of nets hauled, number of net-days fished, total catch, etc., were instituted in the Miramichi area beginning with the 1951-52 season. Similar records from three different points on Miramichi Bay since 1948 (Table I) show that there is great variation from place to place even when only a few miles apart. At Rocky Point the fishing was about the same in 1951-52 as in 1952-53 while at Neguac and Oak Point the 1952-53 season was twice as good as the 1951-52 season and this was also true of the average for all ten stations.

The last three lines of Table I show that very good seasons can follow very poor ones. The success or failure of a season is governed by the amount of fishing, by the size of the Miramichi smelt stock and by the availability of the stock to the fishery. The Miramichi smelt fishery is carried on through the ice and, if the fish remain outside in open water instead of coming into the fishing area under the ice, the season can be a failure even though the level of the smelt stock is high. At

Table I Miramichi smelt catches

District	Catch	1948- 1949	1949- 1950	1950- 1951	1951- 1952	1952- 1953
Neguac	per net haul (lb.)	17	?	15	8	15
	per net day (lb.)	12	?	?	4	12
Rocky Pt.	per net haul (lb.)	90	?	57	29	29
	per net day (lb.)	36	?	35	11	13
Oak Pt.	per net haul (lb.)	17	12	44	10	27
	per net day (lb.)	5	4	31	4	13
Total Miramichi area	per net haul (lb.)	?	?	?	11	20
	per net day (lb.)	?	?	?	5	14
Total Miramichi catch (cwt.)		20,133	11,775	21,780	8,535	16,235
Licenses issued		3,266	3,085	2,811	2,218	2,482
Av. catch per net (or license) per season (cwt.)		616	382	775	385	654

Table II A

Fishing seasons	Calculated total commercial catch, cwt.	Percentages of the catches contributed by the principal year classes					
		1946	1947	1948	1949	1950	1951
1948-49	18,480	57(3-)	39(2-)				
1949-50	11,430		40(3-)	54(2-)			
1950-51	23,220			39(3-)	55(2-)		
1951-52	11,544				20(3-)	73(2-)	
1952-53	19,620					54(3-)	41(2-)

B

		Thousands of cwt. of main year classes in season's calculated catch					
1948-49	18,480	10.5(3-)	7.2(2-)				
1949-50	11,430		4.6(3-)	6.2(2-)			
1950-51	23,220			7.8(5-)	11.1(2-)		
1951-52	11,544				2.4(3-)	8.4(2-)	
1952-53	19,620					10.5(3-)	8.1(2-)

the present state of knowledge reliable long-range (even 2-3 months) predictions of weather and hydrographic conditions are not possible. However, some information is accumulating in respect to stock and year-class abundance and a good stock of smelt is the primary necessity for a successful fishery.

Table II A shows that as a rule two year classes provide the greater part (usually over 90%) of a season's catch with each year class in turn being dominant for one year. The two year classes involved are fish approaching two years of age (2-) and fish approaching three years of age (3-). However, some year classes (e.g. 1947) are so poor that they never play the dominant role by weight; in contrast some good year classes dominate the catch for two successive years (e.g. 1950), both at 2- years and 3- years of age.

In the successful 1948-49 and 1952-53 seasons 3- fish dominated the catch whereas in 1950-51, also a successful season, 2- fish predominated. In the poor seasons, 1949-50 and 1951-52, 2- smelt dominated the catch. The 1948 and 1950 year classes yielded more pounds to the fishery as 3- than as 2- fish, whereas the 1947 and 1949 year classes yielded distinctly less.

In 1949-50 the actual fishing time was reduced because the ice went out a number of times, and though the licenses were issued a very large proportion of the nets were not fishing until the season was about half over. Because of this the 1948 year class was not fished as intensively as 2- as at 3- years of age. The 1951-52 season was about average in respect to ice conditions yet the catch of the 1950 year class was smaller as 2- than as 3- year olds in 1952-53. In this case it is believed that the fish did not come in to the fishing area during the season in the same proportion as usual due to more freshwater run-off through the fishing area than usual and consequent lowering of the salinity. It is seen thus that year classes are not always equally available or at least not caught to the same degree at different ages.

R. A. McKenzie

Appendix No. 51

SIZE OF MIRAMICHI SMELT AT MATURITY IN RELATION TO EARLY AND LATE HATCHING

In packing smelt on the Miramichi during the commercial fishery (Dec. 1 to Feb. 15) more trouble is experienced in grading and packing the fish according to size during some seasons than others. Smelt are packed in three grades by length: "No. 2" - 10.2 to 13.9 cm.; "No. 1" - 14.0 to 17.7 cm. and "Extra" - 17.8+ cm. Most of the grading is done by eye and in some seasons most of the fish are close to the borderline between the No. 2 and No. 1 grades. If, on Government inspection, a box of No. 1 smelt is found to contain over 5% No. 2 the box must be repacked, thus increasing production costs. To guard against this the packers are forced to work more slowly and actually measure many fish. This, too, takes time and increases the cost of packing.

Because of this variation in production costs from year to year the question is often asked, "Why are there so many fish in the catch close to the boundary line between grades some years and not other years?". A good part of the cause has been found in variation in the time of hatching of the individual year classes and this in turn is related in some degree to when the spawning runs reach the head of tide to when the spring "break-up" occurs and the ice goes out, and, ultimately, to the weather.

Table I shows the average sizes of smelt of the different ages sampled during the last five years during the first week of spawning. The 1949 year class is seen to have yielded the largest two-year-old fish as well as three-year-olds and four-year-olds, while as two-year-olds the 1948 and 1947 year classes were smallest and 1950 and 1951 year classes were intermediate in size.

Table I Average sizes (cm.) of smelt during first week of spawning

<u>Year classes</u>	<u>2-year-olds</u>	<u>3-year-olds</u>	<u>4-year-olds</u>	<u>5-year-olds</u>
1951	14.3	-	-	-
1950	14.2	16.5	-	-
1949	15.0	17.2	19.6	-
1948	13.8	16.9	18.8	22.0
1947	13.8	15.8	17.9	19.9

Table II

<u>Year</u>	<u>Ice went out</u>	<u>Smelt arrived head of tide</u>	<u>First collection totalling 100 larvae at Newcastle Bridge</u>
1951	April 8	April 19	May 19
1950	April 22	April 30	May 23
1949	April 13	April 22	May 15
1948	April 23	April 28	May 25
1947	April 25	May 4	May 25

Table II shows for the same five years the dates when the ice went out, when smelt first reached the head of tide and when the plankton tows at Newcastle bridge first yielded a hundred larvae or more.

Some correlation is seen between the size of smelts and the time of the spring break-up in the year they were spawned but the best correlation is between the size of the smelt and the actual time spawning commenced as indicated by the larval collections. The largest fish were produced when the larvae were earliest and the smallest when the larvae were latest.

The difference of 1.2 cm. in the average length of two-year-olds may thus be related to the ten-day difference in time of hatching.

R. A. McKenzie

Appendix No. 52

THE OLDER, LARGER MEMBERS OF EACH YEAR CLASS OF MIRAMICHI SMELT
SPAWN FIRST

During the Miramichi smelt season the average age of the fish in the commercial catch usually goes down, i.e. the proportion of younger fish increases (Table I). The table also shows that as spawning progresses the proportion of older fish increases and of younger decreases.

Within any one age group, however, the longer individuals spawn earlier than the shorter. Table II shows that the longer fish of the three main ages in the spawning run, i.e. smelt two, three and four years of age, regularly spawned earlier than the smaller.

In line with this the first-year scale ridges were found to be more numerous always in the early spawners of any one age than in the late spawners. Table III shows that this was so during the last four years. These longer smelt with more first-year scale ridges are believed to have been themselves the result of early spawning.

A possible explanation for the increase in the proportion of older year classes as the spawning season progresses is the fact that the early spawners are mainly the residue of the fishery from which a high proportion of the bigger, older fish have been taken by the nets. The later spawners, remaining outside the fishing area until the commercial season is about finished, are not screened to the same extent by the nets and thus contain a greater proportion of larger fish.

Table I Percentage age-composition of the commercial catches and spawning runs of smelt in the Miramichi area during the last four seasons

	Percentage of ages:		
	<u>2-</u>	<u>3-</u>	<u>4-</u>
Commercial catch:			
December	58	35	6
January	65	31	3
February	69	28	3
Spawning run:			
First quarter	70	25	5
Second quarter	68	29	3
Third quarter	58	37	5
Last quarter	57	37	6

Table II Changes in average length of smelt during spawning season

(Numbers in samples in brackets)

	Average length (cm.) in samples during			
	First quarter	Second quarter	Third quarter	Last quarter
<u>2-year-olds</u>				
1952	14.2(624)	13.6(119)	13.0(441)	12.7(325)
1951	15.0(376)	14.2(311)	14.2(250)	13.9(417)
1950	13.8(635)	13.5(517)	13.0(385)	12.8(339)
1949	13.8(483)	13.1(790)	12.7(735)	12.4(573)
<u>3-year-olds</u>				
1952	17.2(108)	16.5(81)	15.9(263)	15.4(255)
1951	16.9(185)	16.1(51)	16.2(57)	15.9(138)
1950	15.8(323)	15.2(480)	14.8(568)	14.7(527)
1949	16.4(172)	15.9(114)	15.6(273)	15.4(181)
<u>4-year-olds</u>				
1952	18.8(28)	17.8(17)	17.3(31)	17.1(47)
1951	18.0(39)	17.5(14)	17.4(38)	16.6(68)
1950	18.5(49)	17.2(28)	16.7(28)	16.5(30)
1949	17.7(27)	17.8(20)	16.9(38)	17.1(35)

Table III Changes in average number of first-year ridges on scales of Miramichi smelt during the spawning season

(Sizes of samples in brackets)

	First quarter	Second quarter	Third quarter	Last quarter
	<u>2-year-olds</u>			
1952	9.7(603)	7.4(119)	5.6(441)	3.9(325)
1951	10.8(376)	7.9(313)	6.5(249)	4.9(417)
1950	9.7(754)	7.1(518)	3.8(385)	2.8(290)
1949	8.6(483)	7.0(789)	4.7(735)	2.9(572)
<u>3-year-olds</u>				
1952	9.1(108)	5.6(81)	4.6(263)	4.0(255)
1951	8.6(186)	6.4(51)	5.1(57)	2.6(140)
1950	7.3(323)	3.6(480)	2.0(566)	1.8(409)
1949	7.7(173)	5.0(141)	3.5(273)	2.6(180)
<u>4-year-olds</u>				
1952	8.6(28)	5.4(17)	3.6(30)	2.8(47)
1951	7.5(39)	6.0(14)	3.8(38)	2.1(68)
1950	8.3(49)	4.3(27)	2.6(28)	2.6(28)
1949	6.2(27)	4.2(20)	2.5(38)	1.9(35)

R. A. McKenzie

Appendix No. 53

THE YIELD OF SPECKLED TROUT TO ANGLERS
FROM A PRINCE EDWARD ISLAND POND

For the last eleven years a creel census has been maintained on a 23-acre artificial pond on the North Montague River, P.E.I. The creel-census taker is resident at the pond and has for hire a number of boats from which almost all the fishing is done. The situation has lent itself to a thorough census.

In the spring of 1953 high waters swept away the superstructure of the dam. The pond area was reduced to about 15 acres, and, for the first time during the census period, trout were able to enter the pond from the salt-water estuary below. A good portion of the trout captured in the pond after the middle of July could be recognized as sea-run individuals.

The census data are summarized in the accompanying table. Their long-term character and probable representativeness of angling yields from many, if not most, P.E.I. artificial ponds provide important guides to the management of such areas. Certain features of the data are briefly discussed.

1. Although the yields to anglers fluctuated as much as 100 per cent over the period covered by the census, they affirm that artificial ponds on P.E.I. streams are highly productive of speckled trout and provide areas in which these fish are readily available. The yields, however, cannot be ascribed alone to the productivity of the pond but also to the tributary stream which provides excellent rearing conditions for young trout and from which the pond population is primarily recruited.

2. The annual fluctuations in catches are ascribed to natural causes. There is little evidence, if any, that one season's yield has affected that of the next. The trout population is as yet not thoroughly cropped. Consistently good catches of trout have been made near the close of each angling season. The number caught and the number per rod-hour have shown a trend from a high through a low to a second high, suggesting a cyclic nature in production and yield.

3. In 1953 sea-run trout were able to enter the pond and during the latter half of the season contributed materially to the catches. Although the yield in 1953 was among the highest for the eleven-year period it was not out of line with those realized in certain years when the sea-run trout were excluded. It is not inconsistent to contend that with a smaller pond area more trout left the pond in the spring to return later in the season with higher water temperatures in the estuary.

4. From time to time it has been advanced that angling in P.E.I. ponds would be improved by restricting the effort to fly-fishing and by raising the size limit from six to eight inches total length. The census at Montague pond in 1953

Yield of trout to anglers from Montague pond, P.E.I.

	<u>1943</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952*</u>	<u>1953</u>
Number caught	3731	3801	3533	3819	3061	2403	3097	3622	3730	4720	4031
Number of rod-hours	-	1516	1632	1634	1723	1351	2144	1868	2054	2026½	1805½
Number per rod-hour	2.5	2.5	2.2	2.3	1.8	1.8	1.4	1.9	1.8	2.3	2.2
Av. total length (in.)	-	8.2	8.5	8.1	8.4	8.0	8.1	8.2	8.1	8.0	8.0
Av. weight (oz.)	-	3.8	4.5	3.6	4.1	3.4	3.6	3.7	3.6	3.5	3.5
Pounds per acre	-	40.7	44.0	37.2	34.1	22.4	30.1	36.7	36.2	44.8	38.9**

* Records only from May 24 to Sept. 15; other years from April 15 to Sept. 15.

** On basis of a pond area of 23 acres; at reduced area of 15 acres, 59.6 lb. per acre.

showed that 51 per cent of the trout captured were less than eight inches in length and that 77 per cent of the catch was made by bait-fishermen. Changes in fishing regulations as suggested above would make for inefficient cropping of a trout population which our data indicate is not now over-fished.

M. W. Smith

Appendix No. 54

TROUT PRODUCTION IN ARTIFICIAL PONDS ON
PRINCE EDWARD ISLAND

That ponds formed on Prince Edward Island streams may support large populations of speckled trout is well appreciated. Under what conditions such ponds will provide the maximum production of trout is largely unknown, although information of this nature is required for their efficient management as angling areas. Investigations are in progress in three experimental ponds formed on small P.E.I. streams with the objective of establishing their maximum carrying capacities for trout of suitable angling size and the conditions under which these are realized.

The procedure involves the stocking of the ponds with varying densities of yearling trout and the determination of their survival and growth over one season. The experimental

Table I. Summary of data on survival and growth of introduced trout in experimental ponds

<u>Pond and year</u>	<u>Number planted</u>	<u>Days in pond</u>	<u>Number recovered</u>	<u>% recovered</u>	<u>Av. increase in weight (oz.)</u>	<u>Total recovered less planted weight in lb. per acre</u>	<u>No. of small native trout in pond when drained</u>
Simpson's							
1948	920	76	871	95	1.4	29	104
1949	920	95	643	70	1.7	21	996
1950	925	71	663	72	1.1	19	686
1951	1,838	76	1,504	82	1.4	48	1,073
1952	1,800	79	1,015	56	1.4	10	375
1953	1,864	120	764	41	1.2	0	795
Stevenson's							
1950	1,201	73	988	82	1.0	14	677
1951	1,100	69	650	59	1.5	0	197
1952	1,150	82	666	58	2.0	21	397
1953	1,210	120	918	75	3.0	51	253
Andrew's							
1949	1,311	84	939	72	2.0	27	636
1950	863	72	602	70	0.6	0	331
1951	1,219	67	1,021	84	0.5	5	508

ponds are (1) Simpson's (2.3 acres) formed in late 1947, (2) Stevenson's (3 acres) established in 1949, and (3) Andrew's (3 acres) first flooded in 1948. The last named was not available for investigations in 1952 and 1953 because of needed repairs to the dam, which however have now been made. The planted trout are prevented from escaping downstream by self-cleaning screens installed at the dams and upstream by barrier dams at the heads of the ponds. The populations of trout are assessed by draining the ponds.

Results, summarized in the accompanying table, are shown to be highly variable from year to year in each pond, without much relationship to density of stocking, although all ponds have exhibited a high productive capacity upon occasion, as much as 51 lb. per acre of trout flesh being produced in Stevenson's pond in 1953 over a period of 120 days (May to September). Seasonal differences in hydrographic conditions, the aging of the ponds (affecting the development of food organisms), and varying numbers of small native trout, are factors contributing to but not fully explaining the variations noted.

The benefits of bird control at Crecy Lake (Appendix 57) prompted a similar measure at Simpson's pond in 1953, since it had been observed that fish-eating birds, especially the great blue heron which in the years just prior to 1953 appeared to be on the increase, frequently visited the ponds. No bird control was exercised at Stevenson's pond. The results in 1953 are diametrically opposed to what may have been expected if bird predation was a dominant factor (accompanying table). Two circumstances are offered in part explanation of the observations. Firstly, the trout were heavily infested with parasitic copepods in Simpson's but not in Stevenson's pond. This infestation, not noted in previous years, may have resulted in a comparatively poor survival and growth of planted trout, perhaps not so much in causing mortalities directly as through secondary infections. Secondly, the heron population was seemingly much smaller in 1953, so that efforts directed toward its control had relatively little effect.

The program, including predation control at Simpson's pond, will be continued in 1954. Observations will be renewed at Andrew's pond.

Until 1953 the field operations were carried out by R. M. Spence, and in the past season by Cyril Williams, with assistance from Messrs. J. W. Saunders and C. R. Hayes. The pond areas are leased by the Government of Prince Edward Island, and the dams constructed and maintained by the Fish Culture Branch of the Dominion Department of Fisheries.

M. W. Smith

Appendix No. 55

POPULATION AND MOVEMENTS OF SPECKLED TROUT
IN ELLERSLIE BROOK, PRINCE EDWARD ISLAND

The normal habitats of the speckled trout on Prince Edward Island are the cool, but for the most part small, streams and the numerous contiguous salt-water estuaries. The trout appear to move within and between these habitats as more suitable living conditions develop in one situation or another and as may be occasioned by spawning activities. It is well appreciated that ponds formed on the streams provide excellent angling, as shown for instance by the anglers' catches from Montague pond (Appendix 53). Pond formation is indicated as one method of management to provide favourable angling areas but basic data are lacking to show whether curtailment of the movements of trout by a dam may adversely affect the angling in the stream system as a whole - stream and estuary. The objective of the investigations at Ellerslie Brook is to determine the effect of forming a pond upon the whole trout population of the system.

Since 1946 trout entering and leaving Ellerslie Brook have been captured near the head of tide in a two-way fish-trap which is operated throughout the year. The trap is tended daily and the captured trout enumerated, measured and tagged. In 1950 a similar trap was installed in the stream immediately above the proposed pond site to give information upon the movements of trout within the stream and later between stream and pond. During the summer of 1952 a dam was erected at an old site just above the lower trap, and a pond of about seven acres was completely filled by October of that year. For a period of at least two years the trout entering the up-trap from the estuary will be transferred to the pond; subsequently they will be barred. Since 1947 an annual creel census has recorded the number of trout taken not only in the stream and pond but in the estuary as well, and an attempt has been made to obtain records of tagged trout captured outside the Ellerslie system. Ellerslie Brook and a tributary provide an effective length for trout production of about $4 \frac{1}{2}$ miles.

Data in Tables I and II show the number of trout that moved through the traps including those fish that may have been recorded more than once in the designated interval. Prior to pond formation the principal inward movements of trout occurred in June and early July, in fall and early winter, and in April, excepting 1948 and 1951. The dominant downward movements were in fall and early winter, and, on occasion, in May. The major movements have appeared to be most influenced by changing water level and water temperature. Following pond formation, the number of trout moving into and out of the stream has declined. In the fall of 1952, over 1,100 trout moved into the pond from the stream above, but in the same period less than 100 passed through the lower trap into the estuary. The retaining influence of the pond upon the downward-moving trout, largely yearlings, is apparent. The pond appears to be acting in the capacity formerly

Table I Numbers of trout counted through the fish trap at the mouth of Ellerslie Brook (Trap A)

	<u>April-May</u>		<u>June-July</u>		<u>Fall-Winter</u>	
	<u>Up</u>	<u>Down</u>	<u>Up</u>	<u>Down</u>	<u>Up</u>	<u>Down</u>
1946	-	-	902	97	1,110	2,049
1947	629	197	879	81	1,100	1,038
1948	78	88	563	15	491	1,706
1949	952	1,463	876	153	447	1,315
1950	920	465	460	39	126	1,136
1951	131	186	316	55	263	389
1952	657	108	321	10	0	45
1953	58	211	187	131	92*	84*

* to November 2, 1953.

Table II Numbers of trout counted through the fish trap on stream above head of pond on Ellerslie Brook (Trap B)

	<u>April-May</u>		<u>June-July</u>		<u>Fall-Winter</u>	
	<u>Up</u>	<u>Down</u>	<u>Up</u>	<u>Down</u>	<u>Up</u>	<u>Down</u>
1950	-	-	-	-	240	1,596
1951	198	400	280	241	180	275
1952	465	45	161	42	59	1,139
1953	16	513	39	180	19*	208*

* to October 31, 1953

Table III Census of trout captured by anglers

	<u>Number caught</u>	<u>Number per rod-hour</u>	<u>Average total length (inches)</u>
1947	1,141	1.5	6.9
1948	1,086	1.5	7.0
1949	1,942	1.8	6.9
1950	1,608	1.9	7.0
1951	1,461	2.1	7.0
1952	1,628	2.3	7.6
1953	1,981	1.5	7.2

exercised by the estuary. Although the number entering the stream during the fall and early winter had been declining with the years, the complete failure of a run to materialize in the fall of 1952 cannot be explained, except that silting, which resulted from the dam-building operations, filled certain pools in the upper part of the estuary where formerly the trout congregated before entering the brook. These accumulations of silt are gradually being scoured away.

The results of the creel censuses are presented in Table III. In 1953, approximately 90 per cent of the trout

were taken from the pond. Population estimates of trout in the brook above the pond (Appendix 56) disclosed relatively few individuals of suitable angling size in those areas where formerly good catches of trout were made. The rate of capture in 1953 fell but the total catch was high. There is evidence that a good population of trout remained in the pond at the close of the fishing season and that it had not been exploited thoroughly by the anglers.

M. W. Smith

Appendix No. 56

ESTIMATES OF TROUT AND SALMON POPULATIONS
IN ELLERSLIE BROOK, P. E. I.

The trap and creel-census records for Ellerslie Brook do not give information upon the stocks of fingerling trout and salmon and are imperfect for the yearling fish. Investigations, begun in 1947, have been continued to date to evaluate the stocks of these younger fish and to determine ultimately the effect of pond formation upon them. The program carried out this past summer marked the beginning of the second phase, the study of the populations of trout and salmon after pond formation.

A 120-volt direct-current electric shocking apparatus was used to capture fish and each area was blocked by nets to prevent inward and outward movements of fish while an estimate was being made. To test the fishing efficiency of the electric shocking apparatus fish were captured in each area and after marking were released in the same area; the area was then re-fished. This has been done for all of the areas under study.

Twenty-one areas (usually 50-yard sections), representing 21% of the effective stream length in summer for the production of trout, were studied in 1953. In the past six years the effective stream length, determined by survey, has been 7,450 yards. The formation of a pond on Ellerslie Brook in 1952 has reduced it and in making population estimates for 1953, 6,750 yards were taken as the effective stream length in summer for the production of trout.

Population estimates were based on the total capture of trout and salmon in each area. Assuming that sampling areas are representative of adjacent sections of the brook, estimates of the total trout and salmon populations in the stream were made and are presented in Table I.

The fingerling population was reduced by one half in 1953 from that in 1952. In most of the streams in the western end of P.E.I., in which we had occasion to sample the populations, unusually small stocks of fingerlings were observed. No explanation can be offered for these observations at this time.

Table I. Estimates of the number of trout and salmon in Ellerslie Brook

<u>Year</u>	<u>Fingerling trout</u>	<u>Older trout</u>	<u>Salmon fry</u>	<u>Salmon parr</u>
1948*	15,500	5,350	-	-
1949*	10,500	9,600	5,050	3,450
1950*	6,450	5,670	410	2,680
1950**	8,700	9,220	1,620	10,680
1951**	4,362	5,536	505	1,976
1952**	10,016	6,172	-	1,469
1953**	5,403	6,717	-	197

* Estimates based on seining

** Estimates based on electrofishing

The most pronounced change in 1953 occurred in the stocks of older trout. In 1952 the average size of the trout comprising the older stocks was approximately 5.7 inches; the average size in 1953, however, was less at 4.5 inches. This reduction in average length of older trout in the stream resulted from the movements of large numbers of the older trout into the pond. Approximately 90% of the older trout in 1953 were yearling fish; in previous years this proportion had never exceeded 70%.

The same change occurred in the 450-yard section of Hayes Brook. This tributary, which has an average width of three feet, has been studied for the seventh consecutive year. The whole area was electrofished, and an attempt was made to capture all of the fish. The results, compared with previous years, are presented in Table II.

Table II. Estimates of the number of trout in Hayes Brook, tributary to Ellerslie

<u>Year</u>	<u>Fingerling trout</u>	<u>Older trout</u>
1947	588	351
1948	729	342
1949	850	380
1950	426	312
1951	176	413
1952	621	352
1953	317	347

As in the main brook the numbers of fingerlings were down from the previous year and the numbers of older trout remained constant while yearling trout became more dominant. Approximately 91% of the 347 older trout removed from the area were yearlings. In previous years they had never exceeded 70%. Trout are free to move from Hayes Brook into the pond and apparently the older trout moved from this 450-yard area as they did from the main brook.

Hayes Brook has displayed a constant population of older trout over the past seven years regardless of the numbers

of fingerlings and although the 1953 population was made up of smaller fish there was no upward swing in numbers. This suggests a constant and fully-used carrying capacity for older trout. A similar picture is presented by the brook as a whole and suggests the futility of planting fingerlings as a means of increasing the production of older trout.

J. W. Saunders

Appendix No. 57

FERTILIZATION AND PREDATOR CONTROL TO IMPROVE TROUT ANGLING
IN NATURAL LAKES OF NEW BRUNSWICK

Limnological studies and creel censuses on eight lakes of Charlotte County, New Brunswick, showed that a poor yield of trout to anglers was associated with low concentrations of nutrient salts in the waters. As a result of these findings commercial inorganic fertilizers have been added to two of these lakes - Crecy and Gibson - in an attempt to increase their fertility and the production of trout. As the work progressed at Crecy Lake, it appeared that the favourable effects of the fertilizers were being vitiated by trout predators, and accordingly control of these predators was introduced into the program.

Crecy Lake (50 acres; 7.8 ft. mean depth)

One ton of ammonium phosphate and 500 pounds of potassium chloride were added to Crecy Lake in June, 1946. The application amounted to 6.5 lb. of fertilizer per acre-foot, or 0.39 mg. of phosphorus, 0.21 mg. of nitrogen and 0.27 mg. of potassium per litre of water. The average pre-fertilization phosphorus content of the water approximated 0.015 mg. per litre.

The added phosphorus disappeared rapidly from the water, the concentrations falling to approximately pre-fertilization levels by late in the season of 1946. Eutrophication was manifest in the year of fertilizing by a heavy bloom of blue-green algae, which however did not recur until a second fertilization in 1951.

The improved growth rate and survival of planted fingerling, and to a lesser degree of planted yearling, trout resulted in a definite improvement in the yield to anglers in 1947.

During the next two years the higher growth rate persisted but yields to the anglers declined sharply, although stocking was maintained at the same level. It became evident that predatory birds and mammals were attracted to the lake in increasing numbers by the annual, quite heavy stocking of trout. Thus a program of controlling the number of these predators was started in 1949, and extended in 1950 to measures of reducing the number of eels which, aside from the trout themselves, are the only predacious fish in the lake (see Appendix 59). There

Table I. Growth and survival of planted trout

	Stock	Year of planting	Number planted	Av. length (ins.) when planted	Av. increase (ins.) to year after planting	% survival to anglers
Crecy	Yr.	1944	675	11.5	2.9(1946)	0.9
	Yr.	1945	812	7.5	2.6	10.1
	F.	1946	6,701	3.2	5.3	4.3
	Yr.	1946	659	8.4	3.0	16.8
	F.	1947	6,684	2.9	6.4	0.8
	Yr.	1947	675	8.4	3.8	3.9
	F.	1948	6,575	2.4	6.0	0.4
	Yr.	1948	675	6.4	5.5	1.8
	F.	1949	6,750	2.6	4.9	1.9
	Yr.	1949	675	7.3	3.2	28.5
	F.	1950	6,750	3.3	3.4	19.8
	Yr.	1950	675	7.3	2.5	45.3
	F.	1951	14,160	3.2	3.6	11.7
	Yr. (1)	1951	674	10.1	0.3	81.9
	Yr. (2)	1951	675	7.0	1.7	36.2
	F.	1952	13,438	2.6	4.0	13.0
	Yr. (1)	1952	675	10.5	0.8	85.0
Yr. (1)	1952	675	8.4	1.9	88.4	
Gibson	F.	1946	7,651	3.2	1.7	0.2
	Yr.	1946	772	8.4	2.0	12.0
	F.	1947	7,603	2.9	Only two recaptures	
	Yr.	1947	770	8.4	2.1	3.8
	F.	1948	7,700	2.4	No recaptures	
	Yr.	1948	770	6.7	3.8	2.1
	F.	1949	7,639	2.6	No recaptures	
	Yr.	1949	770	7.1	1.4	2.7
	F.	1950	7,645	2.6	No recaptures	
	Yr.	1950	770	7.3	2.5	2.2
	F.	1951	16,230	3.2	2.8	0.1
	Yr.	1951	1,538	10.1	1.5	10.2
	F.	1952	15,301	2.6	Only two recaptures	
Yr.	1952	1,540	10.5	0.2	30.9	

F. - fingerlings
Yr. - yearlings

Table II Yield of trout to anglers

	<u>1943</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>
<u>Crecy Lake</u>											
Number caught	167	148	-	143	425	110	39	264	1441	2418	3275
Number per rod-hour	0.4	0.5	-	0.6	1.0	0.3	0.2	0.6	1.4	1.6	1.9
Pounds per acre	2.1	1.3	-	1.5	3.6	1.6	0.8	2.7	6.4	12.5	16.2
<u>Gibson Lake</u>											
Number caught trout -	-	20	5	8	82	50	30	27	27	174	476
salmon -	-	44	47	57	21	17	5	3	0	0	4
Number per rod-hour (trout and salmon)	-	0.3	0.4	0.5	0.3	0.2	0.1	0.1	0.1	0.3	0.5
Pounds per acre (trout and salmon)	-	0.7	0.5	0.8	1.1	0.8	0.4	0.3	0.3	1.3	4.8

resulted a greater yield of trout to the anglers but a reduction in the growth rate, suggesting a dissipation of benefits from the fertilization in 1946. These observations prompted a second comparable fertilization of Crecy Lake in 1951 to establish whether both growth and survival could be improved by concurrent application of fertilizers and of predator control. Anticipating a greater trout-carrying capacity, the number of introduced trout was also approximately doubled in 1951.

The data showing results of these actions in Crecy Lake upon the growth and yield of trout to anglers are summarized in Tables I and II. The beneficial effects are apparent. Most noteworthy is the excellent survival of planted fingerling trout to the anglers' creels at a much higher level than has formerly been found for lakes of the area. Because of limited spawning opportunities the planting of trout was necessary to realize at all fully the benefits of fertilization and predator control.

Gibson Lake (59 acres; 13.2 ft. mean depth)

In 1947 Gibson Lake received fertilizers in amounts to provide one half of the concentration of nutrient materials employed at Crecy Lake. As in Crecy Lake, the phosphorus rapidly disappeared from the water. A bloom of blue-green algae developed but the quantity of bottom fauna did not increase (see Appendix 58) and there resulted little or no improvement in the trout angling. Predator control was not exercised at Gibson Lake which has served as a control in this respect, but to be comparable to Crecy Lake in other actions the lake was fertilized again in 1951, with concentrations as in 1947, and stocking with trout maintained upon a comparable basis.

Data for Gibson Lake are set forth in Tables I and II. Very few of the planted fingerlings were taken by the anglers and only when large yearlings were planted in October and recaptured the following April was an appreciable survival noted. The difference in results from Gibson and Crecy Lakes is primarily attributed to the lesser amounts of fertilizer and no predator control in the former.

M. W. Smith

Appendix No. 58

BOTTOM FAUNA IN FERTILIZED NATURAL LAKE

The bottom fauna of a lake is a major source of food for speckled trout. When Crecy Lake was fertilized in an attempt to increase the production of trout it was pertinent, therefore, to study the bottom fauna as one gauge of the effects of the procedure.

Crecy Lake was fertilized in June, 1946, and again comparably in June, 1951 (see Appendix 57). Beginning in September, 1945, and continuing in June, August and September of each subsequent year to date, 10 sampling stations have been occupied along the long axis of the lake. One haul with a 9 x 9-inch Ekman dredge has constituted the sample for each station. The organisms have been obtained by sorting the bottom materials through a set of sieves of which the finest has 20 meshes to the inch. The total dry weight of organisms, exclusive of mollusk shells, for each sampling date, i.e. in 10 hauls, are given in the accompanying table. Sampling was also done on other dates during the open-water season but not consistently from year to year. The results of these samplings are not given since they alter little the general picture herein presented.

Dry weight of bottom organisms in milligrams in 10 hauls of an Ekman dredge and yield of trout to anglers in Crecy Lake

	<u>About June 20</u>	<u>About August 1</u>	<u>About Sept. 20</u>	<u>Yield of trout to anglers by numbers</u>
1945	-	-	176	-
1946	292	335	485	143
1947	211	238	856	425
1948	362	658	1,153	110
1949	680	658	1,174	39
1950	329	200	259	264
1951	288	300	265	1,441
1952	360	773	1,097	2,418
1953	849	493	1,342	3,276

Two factors have been deemed most important in affecting the bottom fauna: (1) the fertilization which might affect some forms favourably, others adversely, and (2) cropping by the fish, which in the case of Crecy Lake were trout, eels and killifish.

Following the fertilization in 1946 there was a general rise in the quantity of the bottom fauna, most consistently shown by the September samples, to a peak in 1949. The amphipod, Hyaella, was the dominant organism numerically, with sub-dominants consisting of the snail, Amnicola; pea-clams, Sphaeriidae; and midge larvae, Chironomidae. During this period aquatic vegetation, especially Isoetes, increased to cover much of the lake bottom, and this growth favoured Hyaella and Amnicola. Coincident also was a declining population of trout. A sharp decline occurred in the bottom fauna from 1949 to 1950. It is probable that the favourable effects of the 1946 fertilization were being dissipated, but it is believed that a larger number of trout and a marked increase in the killifish population in 1950 were strongly contributory to the change. The bloom of blue-green algae which followed the 1951 fertilization was sufficiently intense and persisted over a long enough period to destroy much of the submerged rooted aquatic vegetation. The number of Hyaella decreased and the bottom fauna generally was depressed but in 1952 a very strong development of chironomids occurred which continued into 1953, interestingly enough in the face of a comparatively large population of trout.

On the whole the fertilization of Crecy Lake stimulated an increase in the bottom fauna, although differentially among the forms involved and this observation is in keeping with the greater trout-producing capacity of the lake, particularly manifest with control of fish-eating predators.

M. W. Smith

Appendix No. 59

CONTROL OF EELS AT CRECY LAKE, NEW BRUNSWICK

The program to control trout predators at Crecy Lake includes attempts to reduce the number of eels (1) by trapping them in the lake and (2) by preventing the entrance of young eels. Eels running from the lake are captured in a trap situated in the outlet and since the eel is catadromous the numbers taken in this trap serve as a gauge of the success of the venture. The numbers of eels that have been trapped in the lake and in the outlet are shown in the accompanying table.

Since 1950, three to six baited traps have been set and fished daily during July and August. Eels have been captured at an average rate of 0.8 per trap-day. Trapping in the lake has occupied much time not only in setting and hauling the traps but also in providing bait, for in Crecy Lake at least it has been found that unless the traps were baited with live fish, usually killifish, few eels were captured. In four summers 864 eels have been taken in this manner, yet apparently the eel population in the lake has not been seriously reduced since the runs from the lake have continued at approximately the same level. (In 1948 there was a barrier but no trap in the outlet. The 1949 catch in the outlet trap doubtless involved eels that would have left the previous year if it had been possible.)

The average size of the eels captured in the lake has been somewhat greater than that of those taken in the outlet trap. Probably most of these larger eels would have run from the lake a few months later. Fingerling trout have been introduced into the lake in early September of each year, and thus at least the predation by eels taken in the lake traps in the current year has been prevented during the period of adjustment by the planted fingerlings to a new environment, when they are considered most vulnerable to predators.

Number of eels captured at Crecy Lake

<u>Year and season</u>	<u>Number</u>	<u>Mean length (cm.)</u>
I. In outlet trap		
Fall, 1949	897	37.1
Spring, 1950	90	32.7
Fall, 1950	105	38.5
Spring, 1951	55	34.0
Fall, 1951	357	36.4
Spring, 1952	41	34.4
Fall, 1952	328	36.0
Spring, 1953	33	44.2
Fall, 1953	409	36.3
II. In traps set in lake		
Summer, 1950	237	42.4
Summer, 1951	78	38.0
Summer, 1952	405	40.7
Summer, 1953	144	40.7

Limnetic populations of eels are maintained by the young eels, or elvers, that enter the lakes in late spring and early summer. Long-term control of the eels in a lake resolves itself into barring the entrance of the elvers. In the spring of 1951 a dam was constructed in the outlet of Crecy Lake so that all of the outflowing water was channelled over a sluice and dropped about two feet. The majority of eels that leave Crecy Lake are 6 to 8 years of age. Accordingly it is yet too soon to judge the effectiveness of the barrier in eel control.

M. W. Smith

Appendix No. 60

THE PRESENT SCOPE OF THE ATLANTIC SALMON INVESTIGATION AND ORGANIZATION OF SUMMARY REPORTS

Recently the research on salmon for which the Atlantic Biological Station is responsible has increased in scope and complexity. Before 1947 when the work was conducted independently of the Station and from then until 1949 the main part of

the research in any year occurred on one river system and there was one main objective. For a few years starting in 1942 this objective was to develop means of increasing smolt production through utilization of hatchery stock, and field headquarters was on the Petitcodiac River, N.B. In 1950 the programme was augmented to include investigation of the utilization of salmon stocks produced by representative rivers in the various sea and inland fisheries. Smolt trapping and marking was started in the Miramichi River, N.B., chosen as the initial source of stock for the new investigation. Several other topics of salmon investigation were included in the Miramichi programme, such as a predatory bird control experiment. Because of increasing concern, particularly among anglers, over a widespread decline in salmon abundance since 1930 (a peak year of commercial production) a Federal-Provincial meeting was held in Ottawa in July, 1952, to review the whole Atlantic salmon situation. It was decided that research projects then under way should be continued but that there should be increased activity in both research and fish culture development work on Atlantic salmon. Now, in close co-operation with us and following our suggestions, the Quebec Government is investigating salmon on the Port Daniel River of the Gaspé coast in a programme paralleling that on the Miramichi River. In Newfoundland a search for marked fish from the mainland was made in 1953 at the counting fence operated by the Newfoundland Station on the Baie du Nord River, and plans are being made for inclusion of a Newfoundland stream in the general smolt marking programme. The Department is co-operating with the research programme in many ways including (1) operation of a new trap on Rocky Brook, N.B., to provide stock for an experiment to determine the extent of inheritance of a tendency for adults to run early or late; (2) checking runs of salmon through traps installed in various fishways throughout the Maritime Provinces; (3) assistance with removal of predatory birds from experimental streams; (4) providing hatchery stock for salmon planting experiments; (5) reporting statistics on catches, assisting with the reporting of marked fish taken in the fisheries of the Maritime Provinces and Newfoundland.

Because of the diverse nature of the data having significance to the research programme which are now accumulating rapidly from various sources, a new method of presentation of the summary reports seems desirable to prevent confusion of the reader. An attempt is made to discuss the work under three main topics as shown below, and in this break-down no significance is attached to the geographical area in which the work was carried on.

- A. Requirements for adequate stocking of streams by hatchery plantings and by natural reproduction.
- (i) Smolt production from hatchery plantings and natural spawnings of varied densities.
 - (ii) Control of predatory birds.
 - (a) Greater production of native young salmon apparently associated with merganser control in the Miramichi River system.
 - (b) Merganser life history and food on the St. Mary River, N.S., Coverdale River, N.B., Sevogle River, N.B., and Port Daniel River, P.Q.

- (c) Technique of bird control as demonstrated on the St. Mary River, N.S.
- (d) Probable effect of 1953 bird control on St. Mary River, N.S., fish populations.
- (iii) Do salmon inherit a tendency to run early or late as adults?

B. Assessment of the value of present fishery regulations for Atlantic salmon and development of most effective administration of the fisheries.

- (i) Annual production of smolts by typical streams and their utilization as adults.
- (ii) The runs of salmon in representative areas and the factors affecting them.
- (iii) Salmon angling success and some factors affecting it.

C. Additional growth and migration studies.

- (i) Review of data on recaptures of salmon tagged as kelts by the Department of Fisheries, 1913-1944.
- (ii) Growth and migration of Pollett River salmon.
- (iii) Homing of salmon to Petitcodiac River.

The places mentioned in the reports may be found on the map just preceding Appendix 1.

C. J. Kerswill

Appendix No. 61

SMOLT PRODUCTION FROM HATCHERY PLANTINGS AND NATURAL SPAWNINGS OF VARIED DENSITIES

The Board's studies of salmon production in the Pollett River were begun eleven years ago. While within recent decades the Petitcodiac and its tributaries have not been important producers of salmon, it is said that a little over one hundred years ago the abundant stocks were a decided attraction to the first settlers. The Pollett is the largest tributary of the system and even now appears well adapted to rearing the salmon which have persisted, in reduced numbers, in all branches of the Petitcodiac. It was selected as an experimental stream for studying productivity in terms of smolt yield because of this apparent suitability and because of its general accessibility as compared with most salmon streams. A lack of organized and legitimate interest in its salmon, resulting from their recent scarcity, meant that experimental control of stocks could, when required, be undertaken without serious interference with local values.

The work which has yielded information here, and plans for continuing investigation of salient problems, can be divided into five progressive phases, three of which have already been completed; the procedure setting up the fourth was terminated this year and the fifth phase is now being entered.

First phase (1942-1949). The objective was defined as determining the planting procedure for getting the best smolt production under existing conditions. Eleven miles of the river, bounded below by an impassable dam and above by a barrier falls, and hereinafter called the middle Pollett, was planted with hatchery stock and the resulting smolt crops measured using a counting fence. Five different plantings were made, varying in numbers from 16 thousand to 1/4-million, given widely varying degrees of dispersal at planting and variously liberated in the main river and its tributary brooks. The plantings, in their various modifications, were the only procedure applied. The resulting crops varied from 1,000 to 4,300 smolts, with an average annual production of about 2,000. This yield was believed very low for the capacity of the river and the lowness was believed to be a result of depredations on the parr by bird predators.

Second phase (1947-1952). The objective was to assess the effect of controlling depredations by mergansers and kingfishers. For three successive years the middle Pollett was planted with the same number (about 250,000) of hatchery fingerlings, employing the same scheme of dispersal as gave the largest yield under phase 1. Mergansers and kingfishers were controlled by shooting, trapping and frightening away, based on semi-weekly year-round patrols of the experimental stretch. The average annual yield under these conditions was 19,000 smolts, an increase of about 9 times.

During this period procedures were developed for assessing populations of young salmon in the river at stages intermediate between the planted fingerlings and the descending smolts, as well as populations of other species of fish present. While the other species did benefit from the removal of the birds, they did not show an increase proportionate to that of salmon, nor were these increases noticeably detrimental to the salmon over the several-year period.

Third phase (1948-1953). The objective was to assess the value of giving fingerlings wide dispersal at planting. In order to speed progress for the next phase, which is in reality a reversion to the first phase but with bird control added, an experiment on the value of different degrees of dispersal at planting was set up on the upper Pollett, 5 to 10 miles above the middle Pollett. Three separate parts of the river, separated by 2 miles, were used. The fish planted in each plot were given a distinctive fin clip - the same mark for any one area throughout the experiment. Four thousand hatchery fingerlings were distributed at rates of 5, 50 and 500 per yard of stream length and over a 3-year period each plot received each degree of dispersal. The results were assessed on the total number of marked smolts, both 2- and 3-year olds, from each planting as they were counted at the fence at the lower end of the middle Pollett. These data have been subjected to treatment by analysis of variance. It seems clear that the principal causes of variation in yield are those connected with good and bad seasons which the planted fish experienced (1948 - 3,279; 1949 - 5,111; 1950 - 2,458) and with plots or the associated marking, the

middle area (both pelvic fins removed) giving lowest yields.

Table I Degree of dispersal at planting and resulting smolt production from 9 plantings of 4,000 hatchery fingerlings

Number of fingerlings per yard	Number of smolts from planting			Totals
	Upper section	Middle section	Lower section	
5	1,183	618	1,911	3,712
50	868	1,407	1,329	3,604
500	1,793	767	972	3,532
Totals	3,844	2,792	4,212	10,848

The likelihood that the various degrees of dispersal at planting had anything whatsoever to do with the variations in yield is negligible (for these data $F = 0.7$; for associated 20% point $F = 4.00$).

The overall survival rate from fingerlings to smolts for the nine plantings was 30%, more than three times as good as the rates pertaining to the plantings in the middle Pollett. The only protective measure given directly to these fish was removal of merganser broods in the area, although the general bird control on the middle Pollett may have had beneficial effects up here. Other possible factors in the high survival are a relative dearth of eels above the barrier falls and a lack of excessively heavy planting for the total rearing area available to the fish.

Fourth phase (1950-1956). The object is to determine the optimal productivity of smolts for the middle Pollett using hatchery stock and bird control. When this phase was begun the incomplete data available from phase 3 already indicated that wide dispersal of fingerlings was unnecessary but that possibly some advantage might accrue from moderate dispersal. Since it would not greatly increase the labour of planting, nor reduce the capacity of the stream for fingerlings to a low level, the moderate dispersal of phase 3 was employed for all plantings in this series. The first planting (1950) used one quarter million fingerlings, the second about four times as many and the third about one fourth as many. All were planted from the same stations used in the comparable phase 2 planting, but with the new dispersal rate different sized areas were seeded with fish each year. Only the smolt run from the first planting has been measured to date; the principal runs (2-year smolts) from the heavy and light plantings will be measured in 1954 and 1955. Parr populations from the medium and heavy plantings have now been estimated and that from the light planting will be estimated in 1954. No experimental seeding of the area was made in 1951 because of the inadvertent escape of a few adults into the area. Consequently the 1952 parr estimate and 1953 smolt count deal with the 2-year parr and 3-year smolts from the first (medium) planting. The estimates of parr populations are based on the results of all seinings made in any one year; the smolt counts are derived by taking the appropriate percentage of the number of smolts actually counted at the weir

as shown by scale examination of 100 or more smolts each year. The results to date are as follows:

Table II Productivity of the middle Pollett from different plantings of hatchery-raised Atlantic salmon fingerlings

Year	1950	1951	1952	1953
Number of fingerlings planted	246,000	-	925,000	65,000
Parr next year per 100 sq. yds. for river		12 50,000	1 4,000	16 65,000
Smolts counted, 2-year-olds 3-year-olds			21,709	2,738
Total				24,447

The very heavy planting has not given a proportionately greater number of parr; in fact, as judged by one series of samples, the parr populations from the medium and heavy plantings were nearly identical in size. Any large discrepancy in smolt production from these two plantings will probably be attributable to conditions between yearling parr and smolt stages rather than to numbers planted. The tentative conclusion is thus reached that the capacity of the stream for parr is in the vicinity of 50,000 to 70,000 per year, and for smolts about 20,000 to 30,000.

The results from the light planting should indicate the maximum level of survival rate which may be expected from worthwhile plantings here. By combining this rate with the demonstrated capacity for parr the optimal productivity of the area when stocked with hatchery fingerlings should be approached.

Fifth phase (1953-1960). There are three principal objectives.

(1) To determine the maximum productivity of the middle Pollett when using natural spawning as compared to hatchery stock. While, on the surface, there would not appear to be any reason why proper planting of hatchery stock should not result in as many smolts as natural spawning, the comparison is worth establishing by experiment.

Data on densities (obtained by seining) of parr in their pre-smolt year (over about 10 cm. long) derived from hatchery stock in the Pollett and from natural spawning in the Northwest Miramichi River show similar productivities for the two streams when protection from birds was afforded. However, the above comparison leaves something to be desired since (a) the Pollett receives more thorough protection from birds and (b) growth of Pollett fish is more rapid so that about 90% descend as 2-year-olds whereas about 85% of the Northwest smolts descend as 3-year-

Table III Relative densities of parr over 10 cm. long from hatchery stock and from natural spawning.

<u>Year</u>	<u>Estimated number of parr in 100 sq. yds. of stream</u>	
	<u>From hatchery stock (Pollett River)</u>	<u>From natural spawning (NW. Miramichi River) (1 - no bird control)</u>
1950	9	
1951	12	8
1952	(1 - no seeding)	10
1953	<u>16</u>	<u>8</u>
Average with bird control	12	9

olds. A more useful comparison can result from trying both procedures on the same stream, and the Pollett, with its accumulated information on hatchery stock, is an obvious choice for this.

In 1952 counts of eggs carried were made for 47 females entering the Board's trap at the foot of the middle Pollett. Enough females entered here to supply about 300,000 eggs (although none were allowed to spawn) as compared with 250,000 hatchery fingerlings used for the medium dense planting which seems to have stocked the river nearly to capacity. At the time of writing it appears that this year the adult run will be quite as large as last year and enough females and attendant males have already been admitted to the lower 3 1/2 miles (up to Forest Glen dam) to stock that part with a number of eggs similar to the number of fingerlings used in the medium planting of this part. As more fish enter the trap below the area they will be transported overland to the section between Forest Glen and Elgin until enough have been placed there to give a similar density of eggs. Thereafter any additional fish will be divided proportionally between these two parts of the middle Pollett to obtain as dense a spawning as possible. The results as measured by parr populations and smolt runs should give the capacity of the area when seeded by spawning of adult salmon.

(2)- To determine the minimal number of spawners for optimal productivity. In order to determine the necessary extent of spawning escapement to obtain maximum productivity it is desirable to set up an entirely new experiment. This should be designed so that variations in yield resulting from annual differences in climatic conditions will not obscure the result, but also so that a useful result will be forthcoming within a relatively few years. It is believed that this can be achieved by commencing an experiment on the Pollett resembling in principle the study of value of dispersal at planting. The combined middle and upper Pollett includes three parts similar in general physical character but separated from each other by the high dam at Forest Glen and the barrier falls at Elgin. It is tentatively proposed that widely different densities of spawning should be allowed in each of these three sections in any one year, and that each section should have

a different density in different years.

Assuming the first spawning of such a series in 1954, the 3-year-old smolts giving the total production from the third spawning would descend in 1960. It is believed that the data then available would permit of practical conclusions on the number of spawners necessary to maintain high productivity of smolts (and as a corollary, the permissible size of harvest from the adult salmon of the system).

(3) To determine the effects of other fish on the production of salmon smolts. Although the three parts of the Pollett are similar in physical characters, the barrier falls at Elgin results in differences in abundance of other species. The two lower sections have large numbers of suckers, minnows and eels; above the falls there are no suckers, only one small minnow and few eels. Data on these populations will be collected while seining for young salmon. Results from the bird control experiment on the middle Pollett show that a stream can have quite large populations of suckers and minnows and still rear several times more parr per unit area than happens in some well-known salmon streams. There seems no reason to suspect that such species tend to be limiting factors for salmon production under natural conditions. Eels, however, are known to prey on young salmon in all stages beginning with the unhatched young in their redds; because they are abundant in some streams (most abundant single species in the middle Pollett) their activities as competitors for food appear to be more important than such competition by other species. The relative abundance of eels in the various parts of the Pollett is therefore of particular interest and it is hoped that the final analysis of data for this fifth phase will throw some light on the value of attempting control of eels.

P. F. Elson

Appendix No. 62

GREATER PRODUCTION OF NATIVE YOUNG SALMON APPARENTLY ASSOCIATED WITH CONTROL OF MERGANSERS IN THE MIRAMICHI RIVER SYSTEM

The increased production of salmon smolts derived from hatchery stock planted in the Pollett River and given systematic year-round protection from mergansers and kingfishers has been dealt with in previous annual reports of this Station. The relative levels of production under the two sets of conditions can be summarized as below. Although there was considerable

Salmon smolt production for 11 miles of the Pollett River

	<u>With no protection</u>	<u>With protection from bird predators</u>
Smolt crop years	1944-1948	1949-1952
Mean annual crop	2,200 smolts	19,000 smolts
Standard error	±600	±2,000
Average increase		9 times

variation in the size of crops, the smallest protected crop was still three times as good as the best unprotected.

The next step was to find out whether stocks of native salmon would benefit from protection limited to a degree compatible with long-term, practical management. An attempt to develop practical control, and to study its results, has been undertaken on the Miramichi River. Two similar tributaries are being used for this. The work of H. C. White has indicated that control of kingfishers is of doubtful importance on such streams, and their control has not been included in this program.

On the experimental stream, the Northwest Miramichi, merganser control has been carried on for four years, beginning with elimination of broods in the summer of 1950. Studies of populations of young salmon, undertaken each year, and of the incidence of mergansers at various seasons of the year have led to the conclusions that control operations should be carried on throughout most of the open-water season (mid-April to late November) and that a crew of two men, given assistance for some transportation to headwaters, can reduce mergansers to a low level. On the control stream, the Dungarvon River, no regular bird control has been practised, although there has been some casual removal of mergansers by owners of fishing camps. Beginning in 1951 annual summer inventories have been made of mergansers being raised on the river and during the last two years there have been systematic studies of young salmon populations. The conditions here thus serve to indicate, by comparison, any benefits which accrue to the Northwest parr populations as a result of the regular program of protection.

Merganser populations and degree of control obtained.

The merganser inventories have shown that both streams supported, under uncontrolled conditions, similar summer brood populations of about a dozen birds per 10 miles of stream. In addition, on the Northwest there have been 100 to 200 sight records of birds each year in the pre-brood season and at least as many after the young birds have taken wing in late summer. While inventories of broods have been made on the Dungarvon only in summer, casual observation indicates that the incidence of mergansers at other seasons is similar to that for the Northwest. Control on the Northwest has involved the elimination of over 100 birds each year; this is, of course, reinforced by other birds being frightened away.

Abundance of young salmon. The studies of young salmon abundance have involved population estimates on several short sample areas, using a combination of seining and electrofishing techniques. The estimates have been developed from the raw data in two ways, (a) by considering the proportions of previously marked fish recaptured in subsequent attempts and (b) by considering the total and proportionate numbers removed in successive coverages of a sample area when similar efforts are employed. The same sample areas have been used in succeeding years.

To get a clearer picture of the relative production from the two streams, the figures above can be reduced to values per unit area. Since the Dungarvon is a little smaller than the

Table I Estimates of young salmon present in sample areas of two tributaries of the Miramichi River; Dungarvon - without organized control of mergansers; Northwest Miramichi - with such control.

River	Year	Number of areas	Total length of areas in yds.	Estimate of total parr in areas	Number of specimens measured	% of parr over 10 cm.	Estimate of fingerlings	Estimate of small parr	Estimate of large parr
Dungarvon	1952	6	300	1141	193	18	1480	936	205
	1953	6	302	1310	197	24	2438	996	314
Northwest	1951	8	364	2724	413	37	2160	1716	1008
	1952	10	508	4098	296	33	2246	2746	1352
	1953	10	507	4919	250	24	2474	3738	1181

Table II Effects of organized merganser control as shown by estimates of young salmon populations on 100 sq. yds. of stream bottom.

Merganser control	Year	Estimated number of young salmon		
		Under-yearlings	Small parr (10 cm. and under)	Large parr (over 10 cm.)
No (Dungarvon)	1952	22	15	3
No "	1953	21	15	5
Yes (Northwest)	1951	19	14	8
Yes "	1952	21	20	10
Yes "	1953	22	27	8

Northwest, this is desirable. The estimates for parr have been broken down into those of 10 cm. and under and those over 10 cm. in length because this size reached in late summer or autumn appears to be the approximate point at which there is a differentiation into those (the larger) which will become smolts in the following spring and those (the smaller) which will remain in the river another year or longer before undergoing metamorphosis.

It will be noted from the table above that the production of underyearlings is similar in both streams. But the average production of large parr in the stream where protection was afforded was twice as good as in the unprotected stream. Even this does not tell the whole story, for the fish in the unprotected stream would presumably be further reduced by autumn and spring predation before they descended as smolts, while in the protected stream such additional loss should be largely prevented.

It is not necessary to judge the results of protection solely on comparison between Northwest and Dungarvon parr densities; the Northwest, itself, shows an improvement since the beginning of bird control. In 1950, within about a month of the initial removal of mergansers, parr densities were measured on the lower reaches of the river. In general, densities in the lower reaches for both streams are noticeably less than on the upper parts but a comparison of populations over four years for the lower reaches only shows that in the first year, before control could have much effect, parr densities on the lower Northwest were similar to the current conditions on the lower reaches of the Dungarvon.

Table III Densities (estimated number per 100 sq. yds.) of young salmon found on the lower 15 miles of river, without and with control of mergansers

	<u>Year</u>	<u>Estimate of underyearlings</u>	<u>Estimate of small parr</u>	<u>Estimate of large parr</u>
<u>Without control</u>				
Dungarvon	1952	37	9	1
"	1953	15	9	1
Northwest	1950	14	9	1
<u>With control</u>				
Northwest	1951	8	7	4
"	1952	16	18	6
"	1953	8	12	3

With no initial advantage in numbers of underyearlings present, protection has been followed by about 4 times as good production of large parr as without protection. Again, the remarks about predation in autumn and spring immediately preceding smolt descent apply, and the table shows a minimum estimate of the benefit probably accruing - an increase of 4 or 5 times.

Conclusion. An increase of about 2 to 4 times in production of large parr, and probably smolts, has followed the application of merganser control on the Northwest Miramichi; the attainment of a practical procedure cannot, however, be claimed until commensurate increases in harvestable adult salmon have been demonstrated.

P. F. Elson

Appendix No. 63

MERGANSER LIFE HISTORY AND FOOD ON ST. MARY RIVER, N.S., COVERDALE AND SEVOGLE RIVERS, N.B., AND PORT DANIEL RIVER, P.Q.

This past year additional merganser stomachs have been obtained from some areas where collecting had been done previously and stomachs have also been collected from new areas.

Lakes in St. Mary River system, N.S. On lakes where loons rear their young the parent loons harass the merganser broods by attacking them from under water. In 1952 this was observed

on Eden Lake. This year on the same lake we found an adult loon herding a brood of mergansers along the shore. These ducks were so conditioned to staying in shallow water that when Mr. Coates, in clear view of the brood, shot part of them, the remaining ducks refused to leave the shore and were easily shot and collected. Feeding of the non-flying mergansers on such lakes is generally confined to the shallow shore waters. Evidently the behaviour of the loons is a form of merganser control which conserves fish for the use of the young loons.

Previously we had only a few stomachs of mergansers taken from lakes but this year we have secured 17 specimens from two lakes, Long and Eden of the St. Mary River drainage in Nova Scotia. The seven ducks from Eden Lake, including the adult female, contained the remains of seventy fishes as follows: 7 suckers, 26 minnows (17 red-finned shiners), 29 killifish, 8 yellow perch. As might be expected in such an area the stomachs contained no salmon or trout. The stomachs of 10 ducklings from Long Lake, collected by J. Catt and M. Butler, contained the remains of 102 fishes as follows: 24 suckers, 36 minnows (24 shiners), 32 killifish, 7 yellow perch, 1 white perch, 1 stickleback, 1 elver.

On both lakes killifish, which inhabit the shallowest water, were taken in greatest numbers. On Eden Lake the young ducks contained from 3 to 8 each and averaged 5 but the adult female contained no killifish. Elsewhere in our stomach analyses we have found that where the young ducks have contained killifish the accompanying female has had none in its stomach. The mergansers which we reared in captivity ate a few killifish at first but afterwards they refused to eat them.

These food analyses of merganser broods on lakes show that when feeding in such areas they are not interfering with salmon production. However, observations on Moose River above Eden Lake indicated that they had already depleted that small stream of salmon and other fish and had probably been forced to seek food elsewhere.

Coverdale River, N.B. The Coverdale River, also a tributary of the Petitcodiac River, is smaller than the Pollett but equally as rich in parr food. It has provided good trout fishing and salmon for the local population. At the time of our visit on July 16 the stream was low and was easily waded at nearly all points. The water was clear and visibility good. We were informed by local residents that there were many mergansers on the stream. Estimates of the numbers in a single flock ranged from 25 to 40 ducks. Others spoke of seeing a brood of 8 ducks. The larger flock had been seen over a length of 20 miles of stream.

Visual examination of the stream indicated a severe depletion of all fishes of the sizes taken by mergansers and the only ones remaining which we saw were fry - too small for mergansers to feed upon, and suckers - too large for them to swallow, but even some of the latter showed markings indicating that they had been mauled by mergansers. The ducks had depleted

the Prosser Brook tributary as far as the gorge where the highway borders the stream through the gorge. Above this area the brook contained a normal population of fishes of various species. The upper limit of the mergansers on the main river had been the two Parkindale bridges which are close together on the main highway. It was a clear case of an over-population of merganser ducklings which were limited to the part of the stream between the muddy waters of the Petitcodiac estuary and traffic over the bridges at Parkindale.

In company with H. W. Coates and R. Lemon drives were made over an area of about ten miles of stream. We encountered only the smaller flock of seven well-grown young and the adult female. The stomachs of these eight ducks have been analysed and the analyses reflect the condition of their feeding area. The seven ducklings contained remains of three fishes - one dace ca. 60 mm., one sucker ca. 75 mm. and one eel ca. 20 cm. The adult female contained the remains of four suckers about 13, 7, 7 and 7 cm. Evidently she was more experienced in finding the hiding fish which had survived. All of the young contained more green grass fragments than we have found in other collections. The young, although more than half-grown, had reverted to the feeding habits of the downy ducklings and had been taking aquatic insects, the food value of which was an extremely small fraction of their requirements.

Sevogle River, N.B. This is a large branch which enters the Northwest Miramichi some five miles above tide water. Young ducks, shot on August 7 about six miles up the river, were nearly full-grown and consisted of five males and one female. The stomach analyses are as follows for the entire lot: 29 salmon parr (51.8%), 12 suckers (21.4%), 4 minnows and 15 sticklebacks (26.8%). The food shows a high percentage of salmon parr and is of the same order as that taken by mergansers on most areas of the Northwest Miramichi.

Port Daniel River, P.Q. This small stream, of the typical Canadian zone, has a rapid descent, is crystal clear and has a short growing season. Its fish fauna consists of only three species: salmon, trout and eels. In the lower part salmon parr are the dominant fish and eels are rare. A cursory examination at a number of points along the stream indicated that although it contains some mayflies and other insect life it is not rich in food organisms. Mr. Vaillancourt, who was in charge of the counting fence, stated that throughout the summer he had noticed no rise of mayflies. Our food studies elsewhere have indicated that the mayfly is the most important food of the salmon parr and good mayfly streams are generally good producers. Since in the Port Daniel salmon parr have few competitors, the stream might nevertheless produce enough parr to provide a good run of salmon but it is not rich enough to support many fish-eating birds.

The scarcity of nesting sites precludes the possibility of nesting kingfishers using much of the stream and only one kingfisher was seen during our visit. One pellet found contained

the bones of one salmon parr.

At least two broods of mergansers had been hatched on the river. In mid-July, one brood of seven quarter-grown ducklings was caught in the trap at the counting fence and another brood of more advanced young was foraging over the five miles from the trap upstream to an old dam and were evidently using also part of the stream above the dam. Faecal splashes on their roosting rocks indicated that there were six or more ducks in this flock. A duck drive was organized from the dam to the trap and the method of merganser-brood control was demonstrated to Mr. Vaillancourt and his assistants. Two days before our arrival a brood had been seen a short distance above the trap but none was found below the dam during the drive.

The stomachs of the mergansers taken in the trap had been saved for our analyses. The seven stomachs contained the remains of eleven salmon parr, one trout and one caddice fly, indicating that in this stream salmon parr constitute the main food of the merganser.

H. C. White

Appendix No. 64

TECHNIQUE OF BIRD CONTROL AS DEMONSTRATED ON THE ST. MARY RIVER, N.S.

This year, accompanied by H. W. Coates, we spent the period July 7 to 11 at the St. Mary River and demonstrated the method of merganser-brood control. A drive on the lower 45 miles of the West branch was organized with Mr. Lawrence Demmons and others who might later take part in bird-control operations. The points demonstrated included the method of driving, the necessity of careful hiding of the shooters waiting for the brood, the advantages of not injuring the adult female until all the ducklings of each brood have been killed and the method of using the bird net.

When broods of ducklings are hurried or driven too far, or driven beyond their normal feeding range, they will go into hiding. The older broods can be driven longer distances than the younger. Downy ducklings may go into hiding very quickly and sometimes the female may take them into hiding when she sees a person or boat approaching. If, when being driven, a brood sees unusual objects ahead it may attempt to turn back or leave the stream and go into hiding. For this reason the waiting shooters must be well hidden.

If the mother duck is killed first the young will generally go into hiding and will not come out for hours. If, however, the female is not injured she will return and, if the hunters are not visible, she will call her ducklings from hiding. If the young are killed, an uninjured duck will always return to the place where she has last seen the ducklings. Motherless ducklings are extremely difficult to shoot as they go directly into hiding at the first sign of danger.

Driving broods on a river requires many man-hours and when clearing a river of mergansers an attempt should be made to get all the ducks in a single sweep. To do this advantage must be taken of a full knowledge of their habits.

During our demonstration on the West St. Mary, 36 ducklings and two adult females were secured and several others mortally wounded. After our demonstration on the river, Mr. Demmons made two canoe trips down the river and found only one duckling which both times went into hiding before he could shoot it.

According to Protection Officer M. M. Manson about 150 mergansers had been killed on the river system up to the time of our visit in August and at that time there were still about 50 known to be on the system. This gives a total corresponding with our estimation of about 200 ducks for the previous season.

H. C. White

Appendix No. 65

PROBABLE EFFECT OF 1953 BIRD CONTROL ON ST. MARY RIVER, N.S. FISH POPULATIONS

In August, 1952, three sections of the West St. Mary and three sections of the Main East River were selected for quantitative seining before bird control (1952) and after (1953). In both years the seining was done in the last week of August and the first day of September. In 1952 the water was low but in 1953 it was mostly high and at only one section, the lower section of the West River, was it comparable at the time of seining to the height in 1952. Since the seining was less effective in high water than in low, the actual increase in the abundance of parr is probably greater than results of the seining suggest.

This year on the West River in both the upper and middle sections by fishing with small artificial flies immediately after the seining and while the seined fish were retained in the holding pontoons parr were readily taken and there were many rises to the fly. In the previous year we could not get a single rise in either section. This confirms the inefficiency of the seining of these sections this year.

Up to the time of seining this year there had been fairly complete merganser control on the West River in late August, 1952, and in July, 1953, but in neither year have there been any mergansers on the main East branch. In the following tables the results of the two years' seining are given for comparison.

		<u>Salmon fry</u>	<u>Parr</u>	<u>Suckers</u>	<u>Minnows</u>
<u>West River:</u>					
Upper section 110 yds.	1952	58	4	0	0
	1953	12	10	0	9
Middle section 140 yds.	1952	86	1	0	3
	1953	20	4	0	3
Lower section 70 yds.	1952	11	4	0	0
	1953	79	17	85	72
<hr/>					
<u>East River:</u>					
Upper section 129 yds.	1952	8	1	0	0
	1953	4	4	0	5
Middle section 141 yds.	1952	21	3	0	0
	1953	11	3	0	0
Lower section 75 yds.	1952	32	1	0	0
	1953	19	0	0	0

On the West River the numbers of fishes taken in the seining, except for fry which are not often taken by mergansers, are considerably larger for all three sections and the gains are doubtless due to control of mergansers. In order to get more comparable water levels for the two seinings H. W. Coates remained at the St. Mary until the water level dropped before seining the lower section on the West River and this section shows a more than fourfold gain in parr and large increases in suckers and minnows of the sizes taken by mergansers. On the East River, where there had been no direct merganser control, there are no significant differences in the catches.

H. C. White

Appendix No. 66

DO SALMON INHERIT A TENDENCY TO RUN EARLY OR LATE AS ADULTS?

This question has aroused much discussion for many years. Some people have questioned the usefulness of planting hatchery-reared offspring of late-run parents in streams where an increase in the size of the early run is desired by anglers. One experiment from 1932 to 1936 involving the planting of supposedly early-run Restigouche River, N.B., stock in the late-run Apple River, N.S., gave no evidence that the two stocks behaved differently in time of returning to Apple River. To settle the question further data are needed and a new experiment was started in 1953 jointly by the Board and the Fish Culture Branch of the Department.

In 1952 arrangements were made with the International Paper Company which controls angling on Rocky Brook, a branch of the Southwest Miramichi River, N.B., to permit only early-run fish to ascend in 1953. This year the Department installed a trap near the mouth of the stream (Figure 2) through which 622 fish (391 grilse, 231 older salmon) passed by July 31 when the mouth of the stream was blocked off. In October, salmon seined in pools above the trap were stripped

ATLANTIC SALMON INVESTIGATION

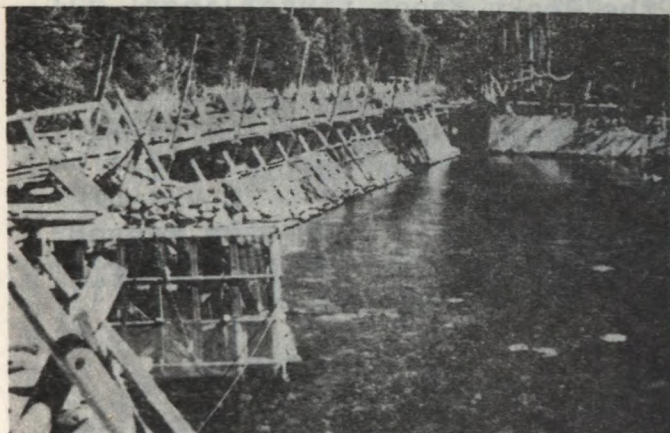


Fig. 1. Smolt and adult fence, Port Daniel River, Gaspé Peninsula; looking downstream. (Installed by Quebec Government in 1953)

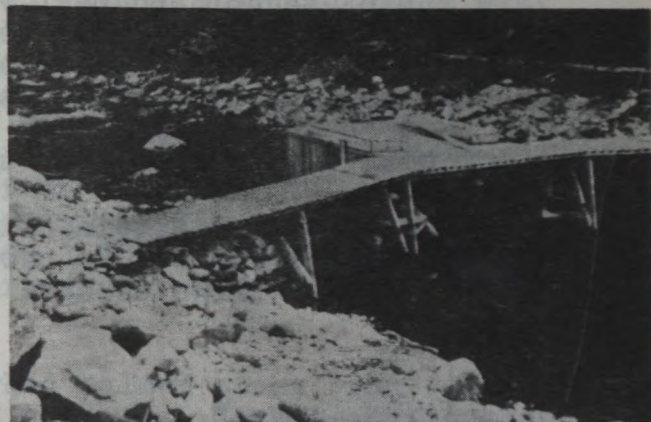


Fig. 2. Trap near mouth of Rocky Brook, Miramichi River, N.B., to allow only early-run salmon to ascend. (Installed by Dept. of Fisheries in 1953)

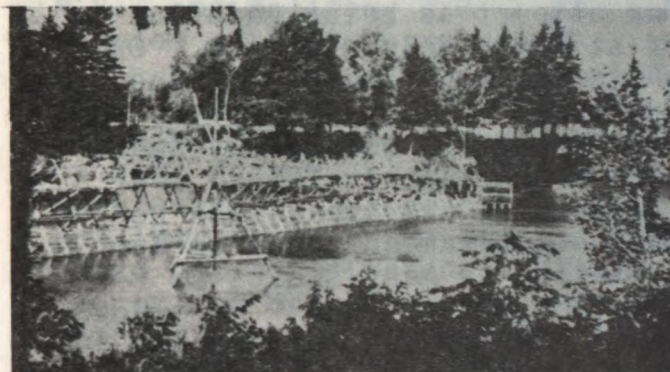


Fig. 3. Smolt and adult fence, Northwest Miramichi River, N.B.; adult trap shown. (Installed and operated annually since 1950)

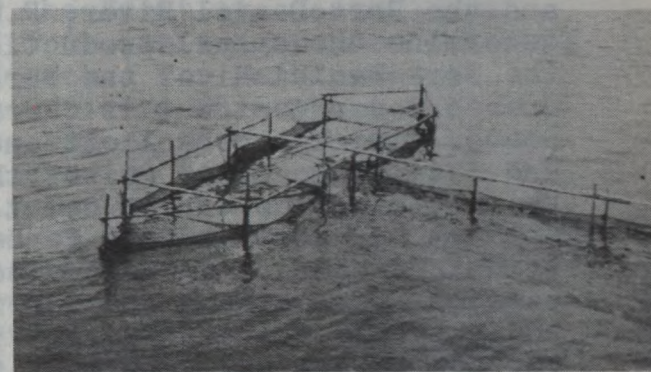


Fig. 4. One of smolt sampling traps operated in Miramichi estuary just below Chatham, N.B.



Fig. 5. Pulpwood and logs diverted by finboom to pass partial N.W. Miramichi fence during early part of smolt run, 1953.



Fig. 6. Pulpwood piled along upper N.W. Miramichi River, summer 1953, to be floated down next spring.

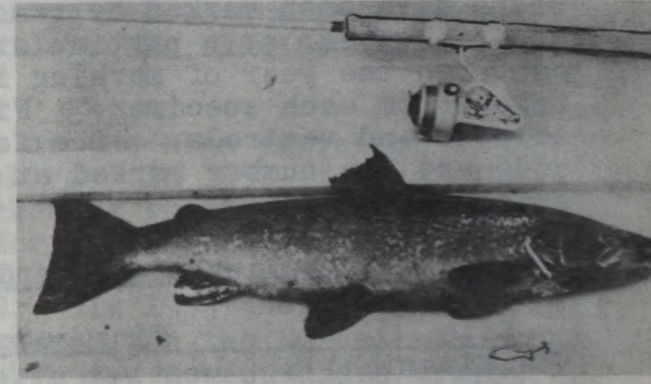


Fig. 7. $4\frac{1}{2}$ -lb. grilse caught Oct. 15, 1953, on Digdeguash River, N.B., by experimental angling with spinning tackle ("Goldfish" wobbler lure).

and the fertilized eggs are being reared in the River Philip, N.S. hatchery. River Philip is characterized by a large late run of salmon and next year the Rocky Brook fingerlings marked distinctively (left ventral) will be planted here, to run to sea later as smolts; bird control is to be provided during the parr development stage to assure maximum production. The time of return as adults to River Philip of the Rocky Brook stock will be compared with that of native River Philip fish.

The adults seined in Rocky Brook this fall were tagged before being released, to provide information on the behaviour of adult stock known to have entered the stream early.

C. J. Kerswill

Appendix No. 67

ANNUAL PRODUCTION OF SMOLTS BY TYPICAL STREAMS
AND THEIR UTILIZATION AS ADULTS

On the Miramichi River, N.B., the Pollett River, N.B., and the Port Daniel River, P.Q., an attempt is being made to determine the annual production of Atlantic salmon smolts. On the Port Daniel River the work is staffed and financed by the Quebec Government but is carried on in co-operation with the Board. Since the Pollett and Port Daniel are relatively small and free from lumber drives they can be completely fenced near the mouths for a direct count. Because of its great size no attempt has been made to fence the whole Miramichi, but on two tributaries traps are operated to provide as many smolts as possible for marking and for information on the run. Here log and pulpwood drives (Figures 5 and 6) have prevented complete capture of the early part of the run every year. Sampling traps (Figure 4) operated in the Miramichi estuary below Chatham throughout the period of smolt descent give the proportion of marked to unmarked smolts from which an estimate of the total Miramichi production can be calculated.

The smolts taken at all but the Miramichi estuarial traps have been marked by removal of fins, the same code being used each year at a particular trap. When marked adults are captured the year of marking is determined by reading scales taken from each specimen. Fin removal is limited to the adipose and ventrals. The following table gives the marking code and the number marked at each site over the past four seasons.

Table A Marking of descending smolts, 1950-1953

Site	Fins removed	Number marked			
		1950	1951	1952	1953
N.W.Miramichi R.	LV + Ad.	7,969	33,407	848	25,218
Dungarvon R.	RV + Ad.	253	14,966	461	19,966
Port Daniel R.	Ad.	-	-	-	4,063
Pollett R.	Ad. (to 1952)	13,190	25,187	26,297	3,639
	Ad. + RV + LV (1953 on)				

Figure 8 shows the 1953 Miramichi smolt run as recorded at the two upriver traps and in the estuary. The calculation of the total Miramichi smolt run, 804,760 with a standard error of 24,588, is shown also. Also shown is the proportion of Northwest Miramichi marks to Dungarvon marks as applied at the upriver traps and as counted at the estuarial traps; these ratios are almost identical (1.26 and 1.22) indicating that a good sample was obtained in the estuary. The estimate of total smolt production obtained this year is probably closer to the absolute value than was the estimate of 1,650,000 obtained in 1951 when only 48 marked smolts were taken in the estuary among 1,604 captured. The efficiency of operation of the estuarial gear has increased greatly in the past two years.

In 1953 the search for marked salmon among commercial and sport fisheries was organized as follows. Special observers were stationed at five strategic points to examine commercial catches, record the proportion of marked to unmarked fish and obtain scale samples from a representative sample of the whole catch. The commercial catch from the Newfoundland coast including Labrador was sampled at Saint John, N.B., North Sydney, N.S., and Halifax, N.S. At each of the first two ports large samples of 20,000 and 65,000 fish of 5 lb. in weight were examined while the fish were being sorted and packed for reshipment to distant points. Fishery Protection Officers throughout the Maritime Provinces were instructed to report marked salmon taken by both commercial fishermen and anglers; in Newfoundland they were asked to report captures of only marked salmon taken by angling, so that the samples examined by observers on the mainland would not be affected. At all research counting traps including one on the Baie du Nord River, Newfoundland, marked salmon were distinguished from unmarked and recorded. In northern New Brunswick Mr. R. J. Wiley circulated among angling camps, particularly on the Miramichi River system, and among shore netters, to stimulate interest in marked fish and pay some of the rewards of one dollar per marked salmon. The balance of the rewards were paid by mail from St. Andrews upon receipt of reports from observers and fishery officers. The following tables give a preliminary analysis of the data on recaptures of marked Miramichi grilse and larger salmon at the counting fences and as reported by special observers and fishery officers who examined salmon catches made by the public in 1953.

Of particular significance is the high degree of "homing" demonstrated by the data below. In 1952 at the Northwest Miramichi trap among grilse marked as smolts in 1951 only 1 Dungarvon mark was found but 225 Northwest Miramichi marks were recorded; at the Dungarvon trap only 3 Northwest Miramichi marks but 91 Dungarvon marks were recorded. In 1953 there was no exchange of Miramichi marked fish between the two Miramichi traps and none were taken at the Quebec and Newfoundland traps.

This year it was expected that the recaptures of marked 2-sea-year salmon resulting from the first large marking of

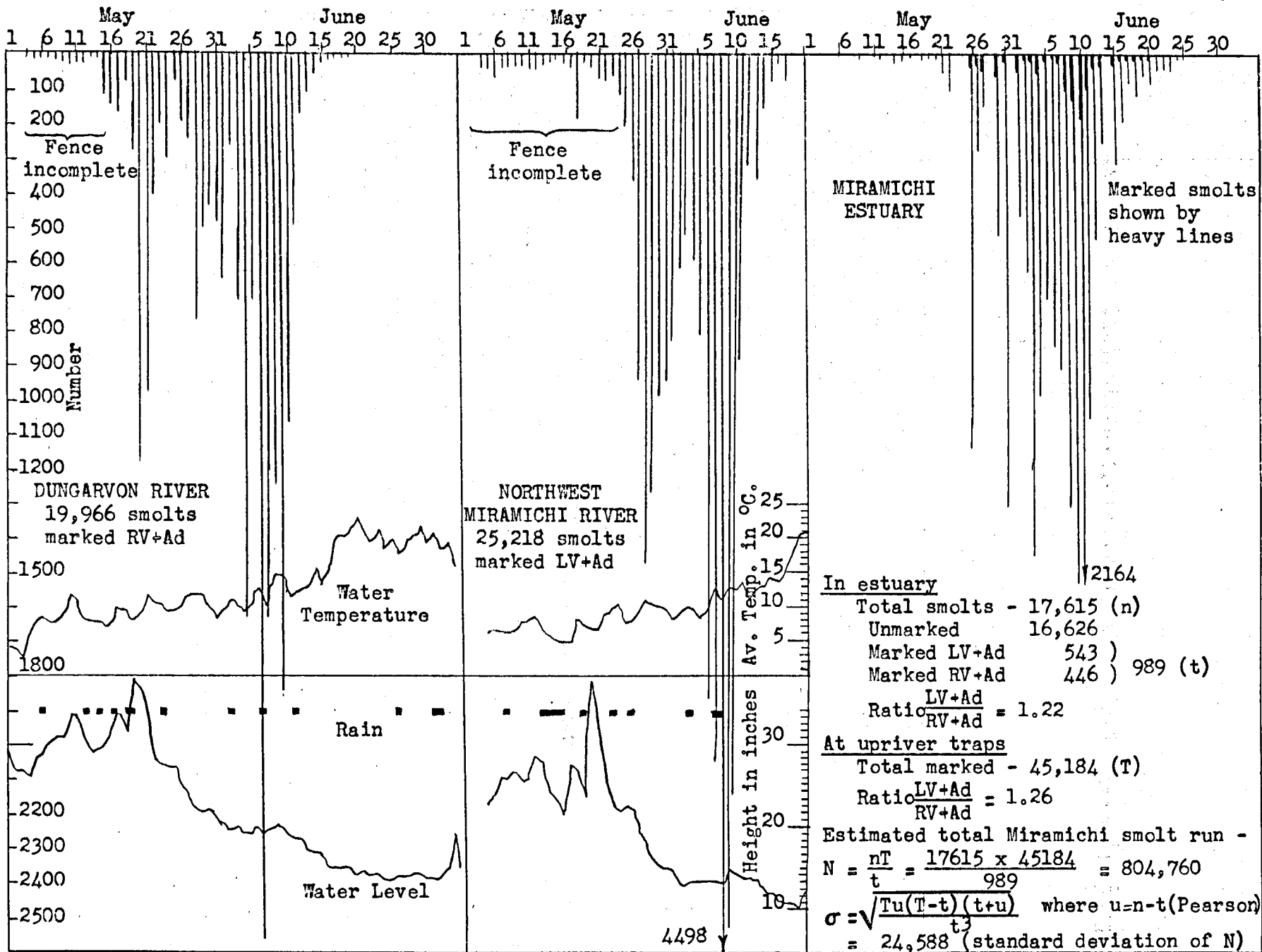


Figure 8. Miramichi River smolt run, 1953, as indicated by upriver and estuarial trapping.

Table B Recaptures of marked Miramichi grilse and larger salmon in research traps 1951-1953

(Fish examined carefully for marks shown in brackets; slight error possible in some cases because all 1953 scale samples from general runs not examined yet.)

Recaptured	N.W.M. mark applied in			Dungarvon mark applied in		
	1950	1951	1952	1950	1951	1952
<u>At N.W.M. trap</u>						
1951	36(1900) 1.9%			0(1900)		
1952	29(629) 4.6%	225(2048) 11.0%		0(629)	1(2048)	
1953	1(1?) 0.1%	140(1028) 19.6%	14(2147) 0.6%	0(1?)	0(1028)	0(2147)
<u>At Dungarvon trap</u>						
1951	0(400)			0(400)		
1952	0(1014)	3(817) 0.4%		0(1014)	91(817) 11.2%	
1953	0	0(365)	0(544)		36(365) 9.9%	0(544)
<u>At Miramichi estuarial trap</u>						
		7(1848)	0(2042)		10(1848)	0(2042)
<u>At Port Daniel trap</u> (105 fish examined by October 23 - no information yet on proportion of grilse to larger salmon)						
1953	0	0	0	0	0	0
<u>At Baie du Nord trap</u>						
1953	0	0(76)	0(77)	0	0(76)	0(77)

Miramichi smolts (48,373 in 1951) would be of particular interest. Previously no organized search for marked salmon was undertaken in commercial catches because only 8,222 Miramichi smolts were marked in 1950, the first year of Miramichi operations, and in 1952 sizable quantities of only marked grilse (1-sea-year fish and mostly below legal commercial size) were available in the sea. It was a pleasant surprise to encounter among the large numbers of commercial salmon examined this year, particularly from around Newfoundland, considerable numbers of fish lacking only the adipose fin. These are identifiable as originating in the Pollett River from which over 60,000 marked smolts from hatchery plantings went to sea from 1944 to 1951, but of which only a few have been recaptured heretofore as salmon in the Bay of Fundy watershed. The recaptures of marked Miramichi stock in the sea fisheries around Newfoundland and elsewhere were gratifying. The present method of marking smolts and reporting the recaptures of marked salmon appears to be satisfactory for following the fate of the stock produced by certain rivers in the Atlantic coast area.

From such data collected over several years it should be possible to estimate the mortality of the salmon produced by

Table C Recaptures of marked Miramichi grilse and larger salmon by fishing public 1952-1953

	Marked at N.W. Miramichi down-trap		Marked at Dungarvon down-trap		Marked at Pollett down-trap	
	2-sea-yr.(+)	1-sea-yr.	2-sea-yr.(+)	1-sea-yr.	2-sea-yr.(+)	1-sea-yr.
	fish	fish	fish	fish	fish	fish
<u>Reported 1952 (Bright fish)</u>						
Miramichi drift-nets	47	-	1	-		
Shore nets						
Main Miramichi	24	14	-	5		
N.W. Miramichi	1	-	-	-		
S.W. Miramichi	1	-	-	-		
Baie Chaleur	3	1	1	-		
Anglers						
N.W. Miramichi	4	88	-	1		
S.W. Miramichi	<u>1</u>	<u>21</u>	<u>1</u>	<u>29</u>		
Total	81	124	3	35		

Reported spring 1953 (Black salmon and grilse to be included with 1952 reports)

Anglers				
N.W. Miramichi	7	41	3	13
S.W. Miramichi	<u>-</u>	<u>1</u>	<u>3</u>	<u>6</u>
Total	7	42	6	19

Reported 1953 (Bright fish)

Miramichi drift-nets	100	-	83	-	17	-
Shore nets						
Main Miramichi	175	1	44	1	9	1
N.W. Miramichi	7	-	2	-	-	-
S.W. Miramichi	2	-	6	-	3	-
Baie Chaleur (incl. Que.)	3	1	4	1	-	-
Saint John Harbour	-	-	-	-	5	-
Cape Breton, N.S.	2	-	-	-	18	-
N.S. mainland	-	-	-	-	1	-
Newfoundland	117	-	84	-	79	-
Anglers						
N.W. Miramichi	27	-	-	-	-	-
S.W. Miramichi	<u>7</u>	<u>1</u>	<u>13</u>	<u>-</u>	<u>1</u>	<u>-</u>
Total	440	3	236	2	133	1

various rivers between the smolt stage and the grilse and older stages which are available to the various fisheries. The proportion of marked to unmarked specimens occurring in samples taken at various places will be the best source of data for such calculations. It will be possible also to estimate in the different commercial and sport fisheries for salmon around the Atlantic coast the total take of salmon produced by the various rivers. Such calculations have not been undertaken yet, except in a rough manner, because a sufficient number of the scale samples from marked fish have not been read and because complete statistics on the commercial and angling catches in 1953 are not available.

Mr. R. J. Wiley gave invaluable assistance with the compilation of the data presented in this report.

C. J. Kerswill

Appendix No. 68

THE RUNS OF SALMON IN REPRESENTATIVE AREAS AND THE FACTORS AFFECTING THEM

(a) Miramichi River, N.B.

1. At upriver counting fences. Since 1950 the Board has operated counting fences for ascending fish during the open-water season on two branches of the Miramichi River: (i) the Northwest Miramichi just above the mouth of the Sevogle River (Figure 3) and (ii) near the mouth of the Dungarvon River (see map preceding Appendix 1). The fish are distinguished by sight as "grilse" and "salmon", the former being the small fish usually under 5 lb. in weight which have spent only one winter in the sea; the salmon having spent two years or more in the sea generally weighed from 8 to 12 lb. The counts by months for each of the past four seasons are shown graphically in Figure 9. With one or two exceptions there is remarkable similarity year after year among the counts at the same trap for any particular month. Figures 10 to 12 show the daily counts of fish at the two traps in 1952 and 1953 accompanied by records of water level and temperature.

Of particular interest is the run of grilse this summer at both traps. On May 13, 1953, a change in the commercial salmon fishery regulations for New Brunswick was announced, to be effective immediately, lowering the legal size limit for grilse from 5 lb. to 3 lb. but not affecting the requirements of capture. Anglers complained that their catches of grilse were much poorer than in previous years, believing that fewer grilse than usual were allowed to escape the nets. Our records (Figure 9) show more grilse this year than last year in the Northwest Miramichi trap in each month through September, and at the Dungarvon trap more than last year from July through September. Apparently the commercial fishermen were unaware of the change in regulations until late June and effects on the number of fish

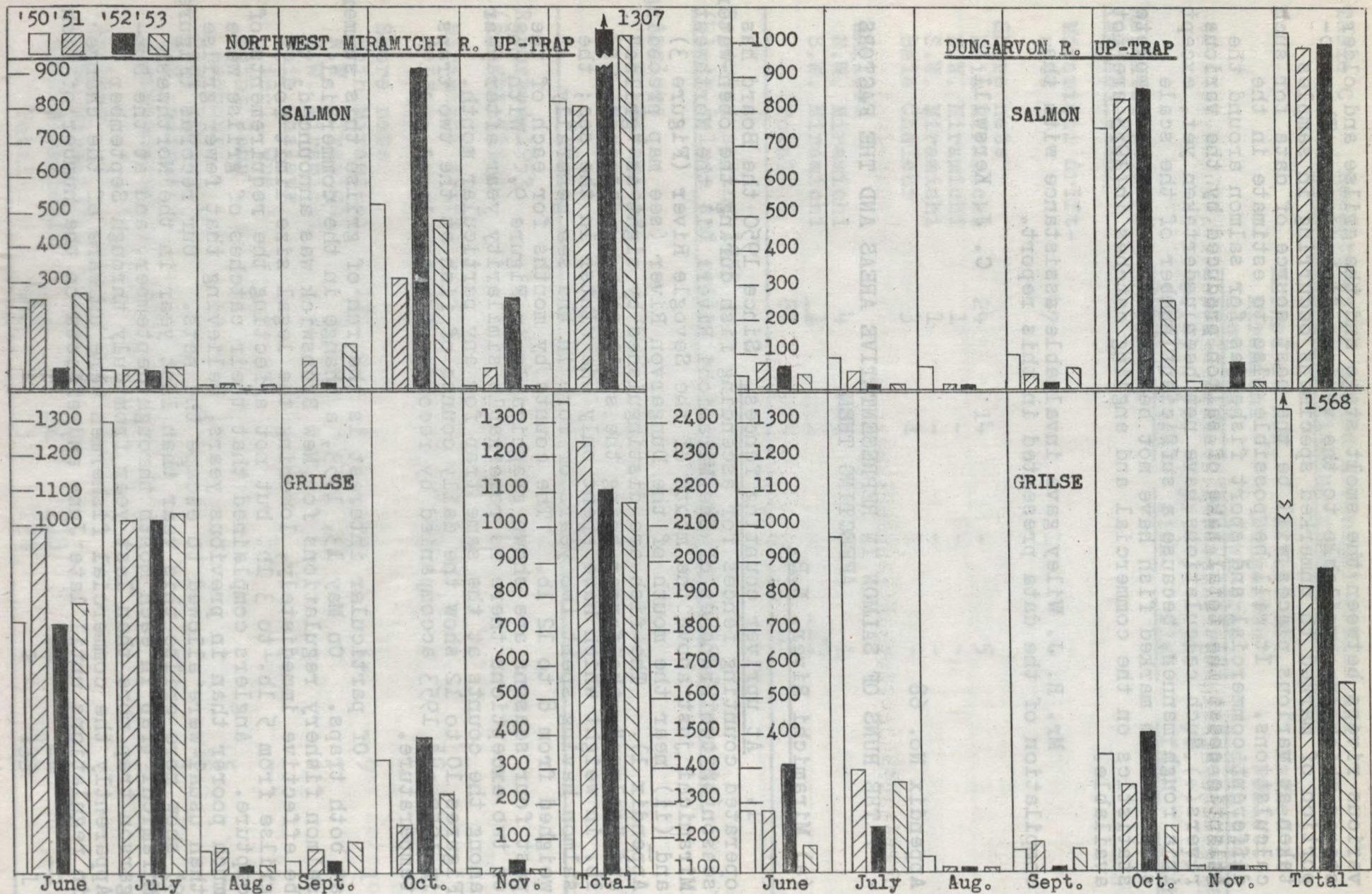


Figure 9. Monthly records of ascending fish at Miramichi River salmon counting fences, 1950 to 1953.

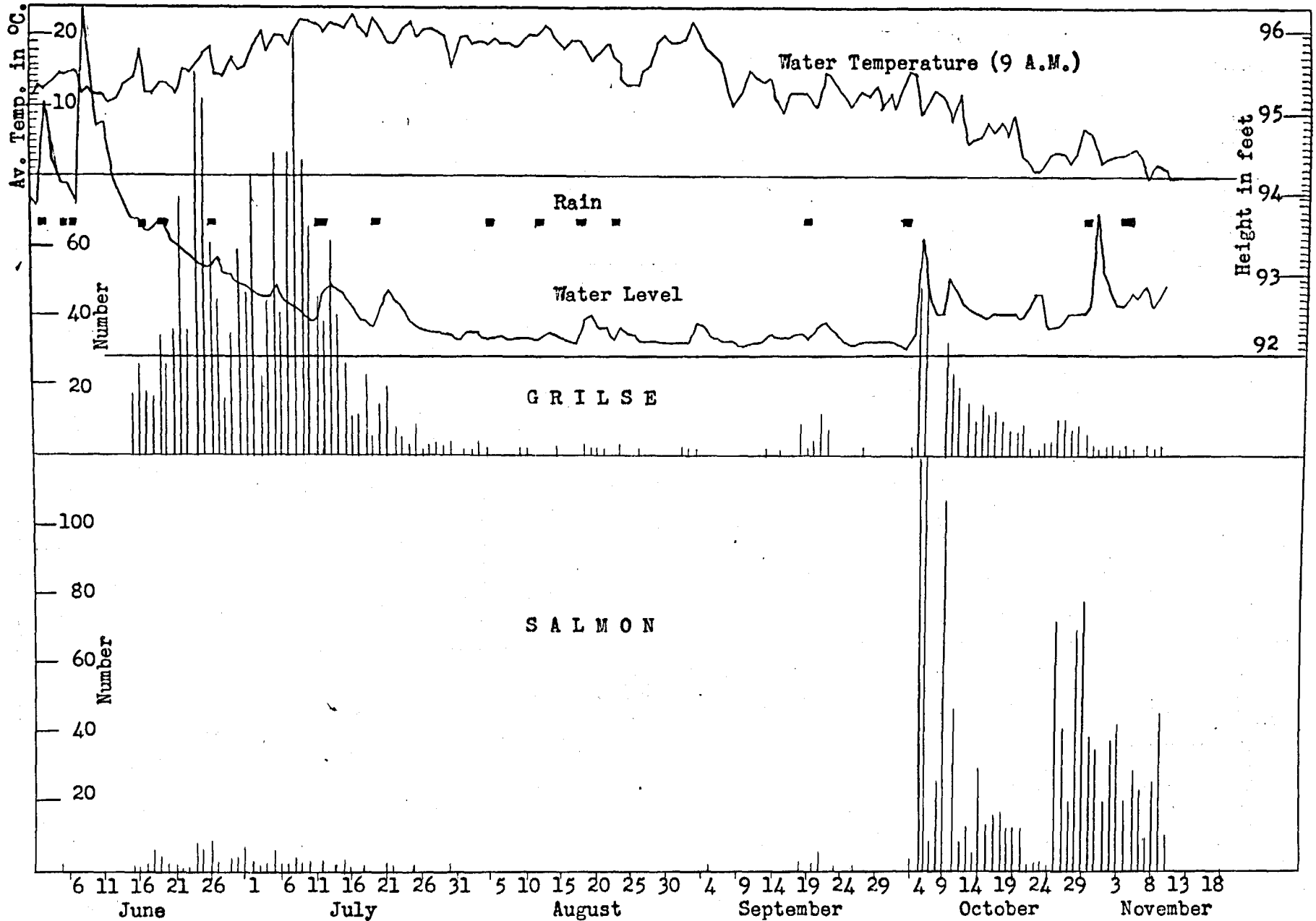


Figure 10. Daily records at Northwest Miramichi River salmon counting fence, 1952.

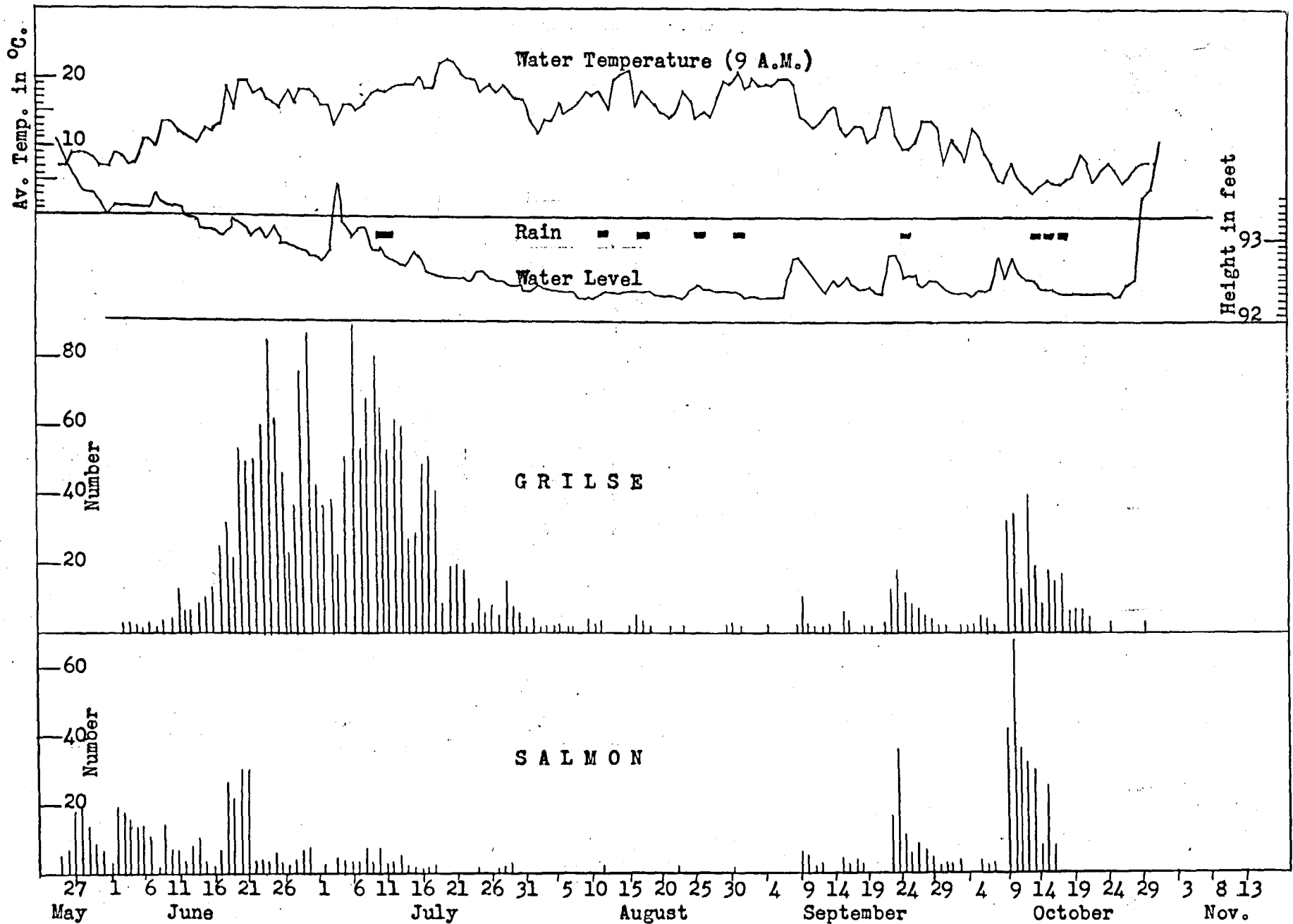


Figure 11. Daily records at Northwest Miramichi River salmon counting fence, 1953.

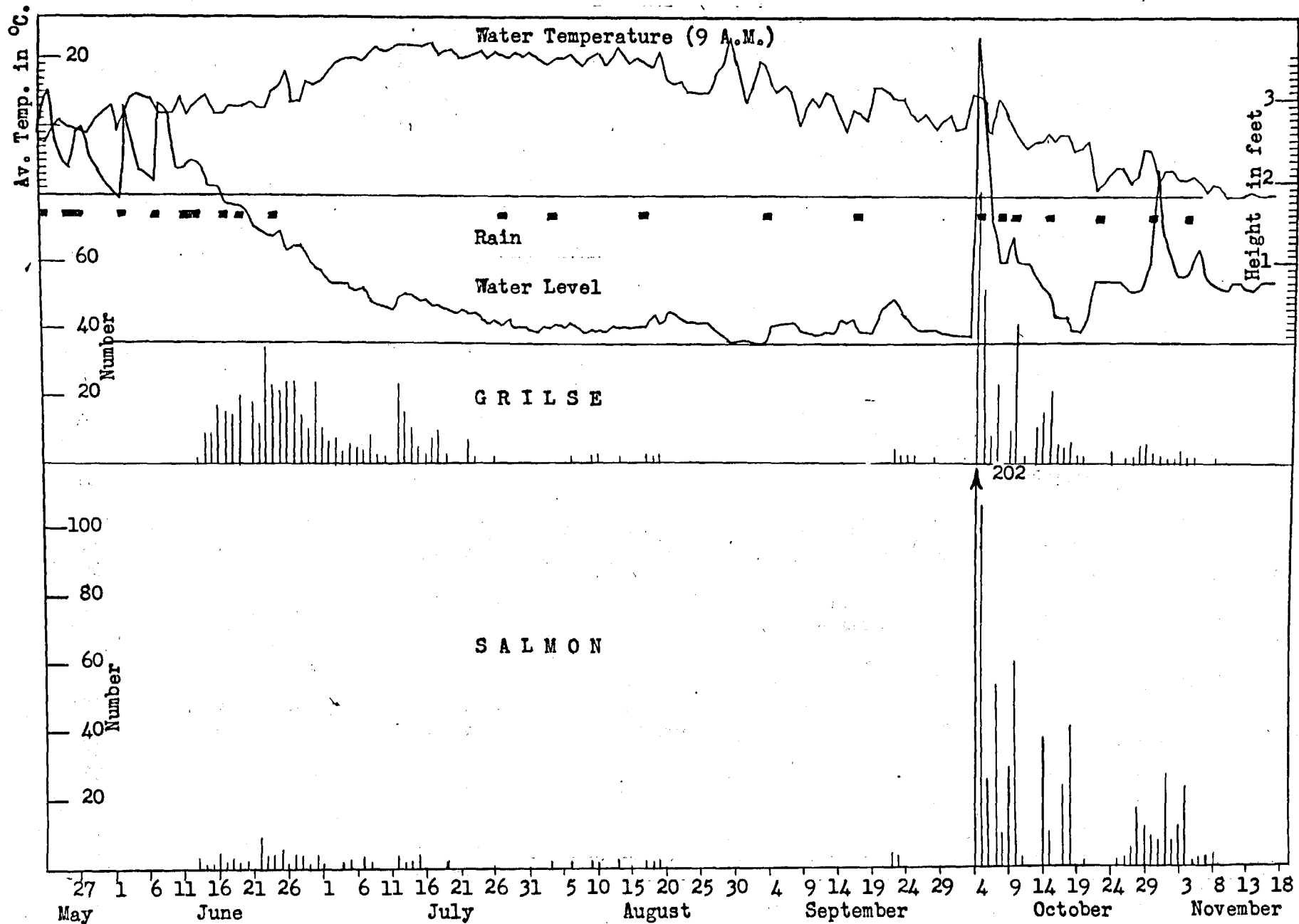


Figure 12. Daily records at Dungarvon River salmon counting fence, 1952.

reaching the anglers and our traps could not be expected until July.

The marked decrease in salmon and grilse counted at both traps in October, 1953, was likely the result of unusually low water from lack of rain during late September and early October when the large fall run of fish usually ascends. Figures 10 to 13 shows a striking correlation between water level and ascent of both salmon and grilse in September and October of both 1952 and 1953. For example, in 1952 an increase in water height of 18 inches on October 5 at the Northwest trap was followed by an increase in the daily run of salmon from 2 to 49, and of grilse from 3 to 120. Slight rises in water level of 4 to 6 inches on September 9 and 22 and October 8, 1953, were followed by clearly defined but relatively small increases in ascent of fish. A heavy rainfall around October 1 would likely have induced the ascent of many of the fish which were plentiful in lower stretches of the river as shown by their availability to anglers. The salmon which would ordinarily have ascended the trap may have gone up other branches which do not have as low water at their mouths as does the Northwest Miramichi near the Sevogle River tributary and the Dungarvon River where it joins the Renous. It is unfortunate that such low water occurred this year when it was hoped that the first effects of Northwest Miramichi bird control on returning fish might be apparent in the trap records. Up to the end of September the monthly runs showed considerable improvement over those of previous years and there was no similarly consistent improvement on the Dungarvon River where predatory birds have not been removed. Another complicating factor in this connection is the unknown extent of poaching in the waters below the traps. The local Protection Officers have advised that they had a very serious problem this fall in coping with poachers who were possibly more active than usual owing to lack of employment in the Miramichi area and also to the low water which facilitated illegal netting in angling pools.

2. At estuarial adult salmon trap. In 1952 after operation of four traps for descending smolts had ended for the season in mid-July, a trap for adult salmon was installed just below Chatham and fished continuously into November. This year only two smolt traps were used and it was possible to install and operate the salmon trap earlier, from June 15. Since this trap gives a very useful sample of the fish passing through the estuary, it is planned to install it next year as soon as the ice goes out so that both descending kelts and ascending salmon can be sampled throughout the entire open-water season. The fish caught are all examined quickly for marks and tags, recorded as salmon or grilse, and released. Scale samples are removed from a small proportion.

The trap is patterned after the typical shore nets used locally, with a long leader extending from shallow water out to the double-ended pound. The webbing of the trap is only 3 1/2-inch stretched mesh to retain grilse, whereas 5 1/4 inches is the minimum stretched mesh size allowed in commercial gear.

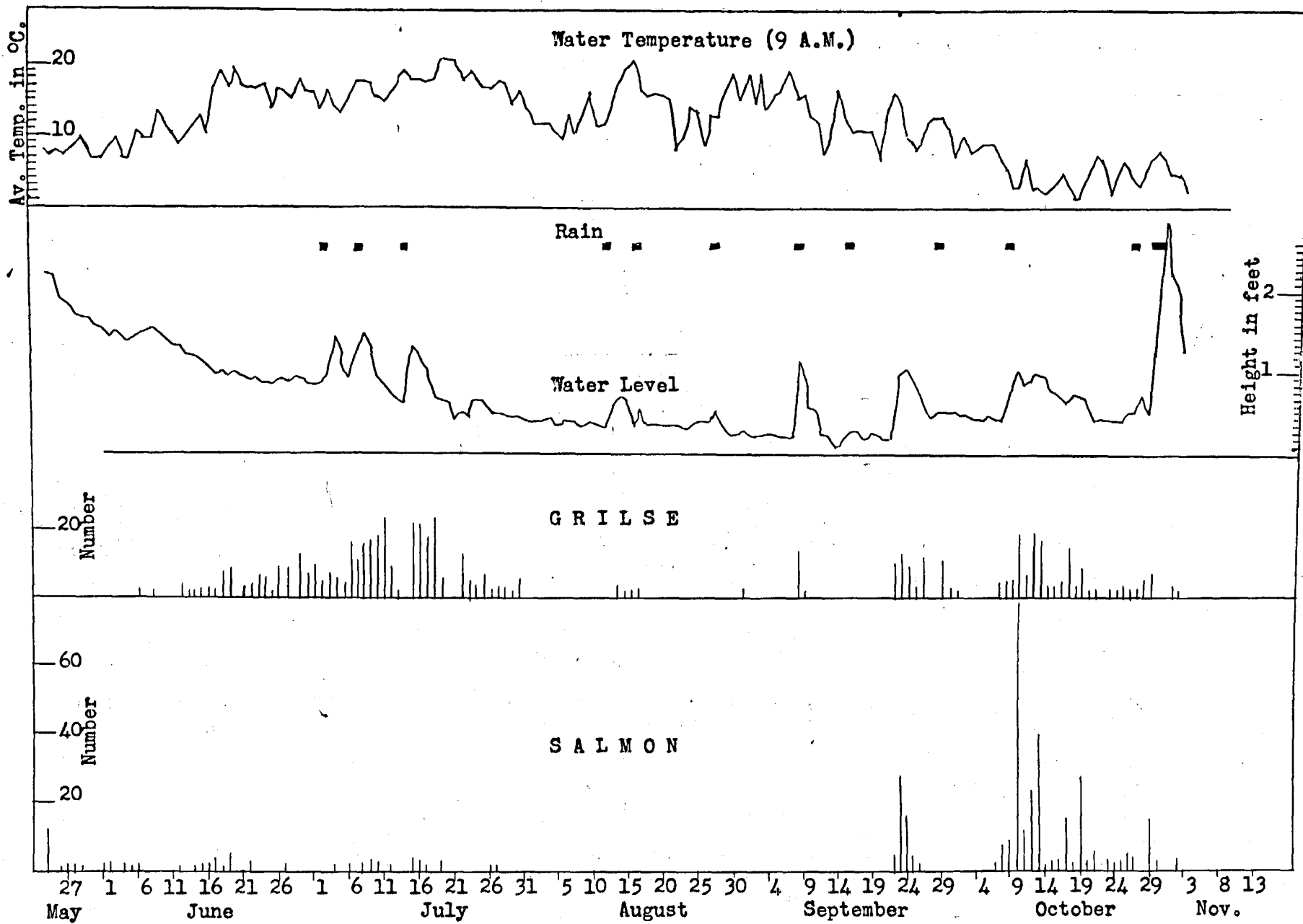


Figure 13. Daily records at Dungarvon River salmon counting fence, 1953.

ASCENDING FISH CHECKED AT EXPERIMENTAL TRAP IN MIRAMICHI ESTUARY, CHATHAM, N.B., 1953.

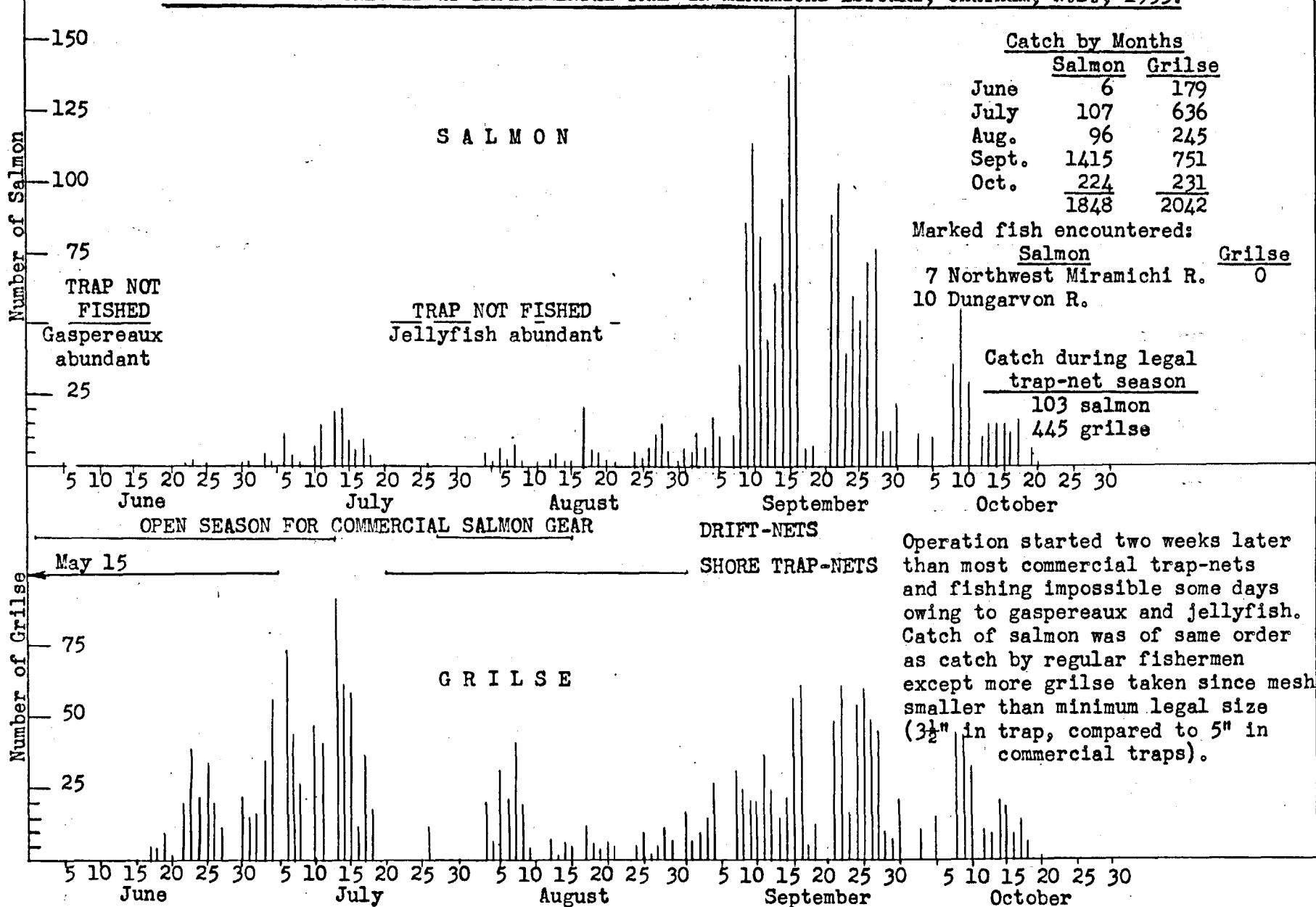


Figure 14. Ascending fish counted at experimental salmon trap in Miramichi estuary, 1953.

Figure 14 shows the grilse and larger salmon recorded in 1953. The total numbers of salmon and grilse are almost equal - 1848:2042. There was a marked seasonal difference in the runs of the two size groups as indicated also at our upriver traps. In the early summer many more grilse than salmon ascended, but in the late season the run of salmon was much stronger than the run of grilse.

It is popularly believed that following the lifting of the drift-nets in the outer bay for the annual 2-week mid-season close period many more salmon enter the upper estuary. This is not confirmed by the 1953 estuarial records where the small July run of salmon tapered off to almost nothing by the middle of the close period. At this time the trap had to be tied up periodically because of an enormous quantity of jellyfish which meshed in it, but when it was fishing properly very few salmon were taken. The drift-nets do not capture any significant number of grilse because the size of the mesh is too large.

3. At Miramichi drift-nets. For the past two years our technician, Mr. W. G. Irving, has checked the landings of salmon caught by the Miramichi drifters who operate outside a line from Neguac to Escuminac (see map preceding Appendix 1) for the main purpose of recording the number and kind of marked fish. Nearly all the catch is landed at Escuminac, N.B. The information obtained on the size of the daily catches through the drift-net season is useful for comparison with the runs of fish recorded elsewhere.

The landings as purchased at Escuminac by six buyers, and the total of these, are shown in Figure 15. The gaps in the record are the result of the weekly 2-day close period plus one storm on June 12. If the catches indicate the available stock of salmon, this reached a maximum abundance around June 23 then fell off to practically nothing by the end of the first period of the season. In the second period the salmon were so scarce that an average of only seven boats fished per night and all the fish were purchased by one buyer.

There is little information yet on the movements of these salmon after leaving the drifting area. Reporting on the recaptures of salmon tagged in 1937 in the Miramichi drift-net fishery, Belding and Préfontaine stated that recaptures in the Miramichi district were made either within three weeks after tagging or from eight to fifteen weeks after tagging. The numbers of tagged fish recaptured were too small to estimate the proportion of all the salmon caught by the Miramichi drift-nets which would have ascended the Miramichi River with the early run or with the late run. It is possible that the salmon which occur in the drifting area from early June to early July remain mostly in the outer part of the estuary and do not ascend the river until September and October in the large fall run. More tagging of salmon in this area would be desirable.

(b) Port Daniel River, P.Q.

This spring under our supervision the Quebec Department of Fisheries installed a new counting fence on the Port Daniel

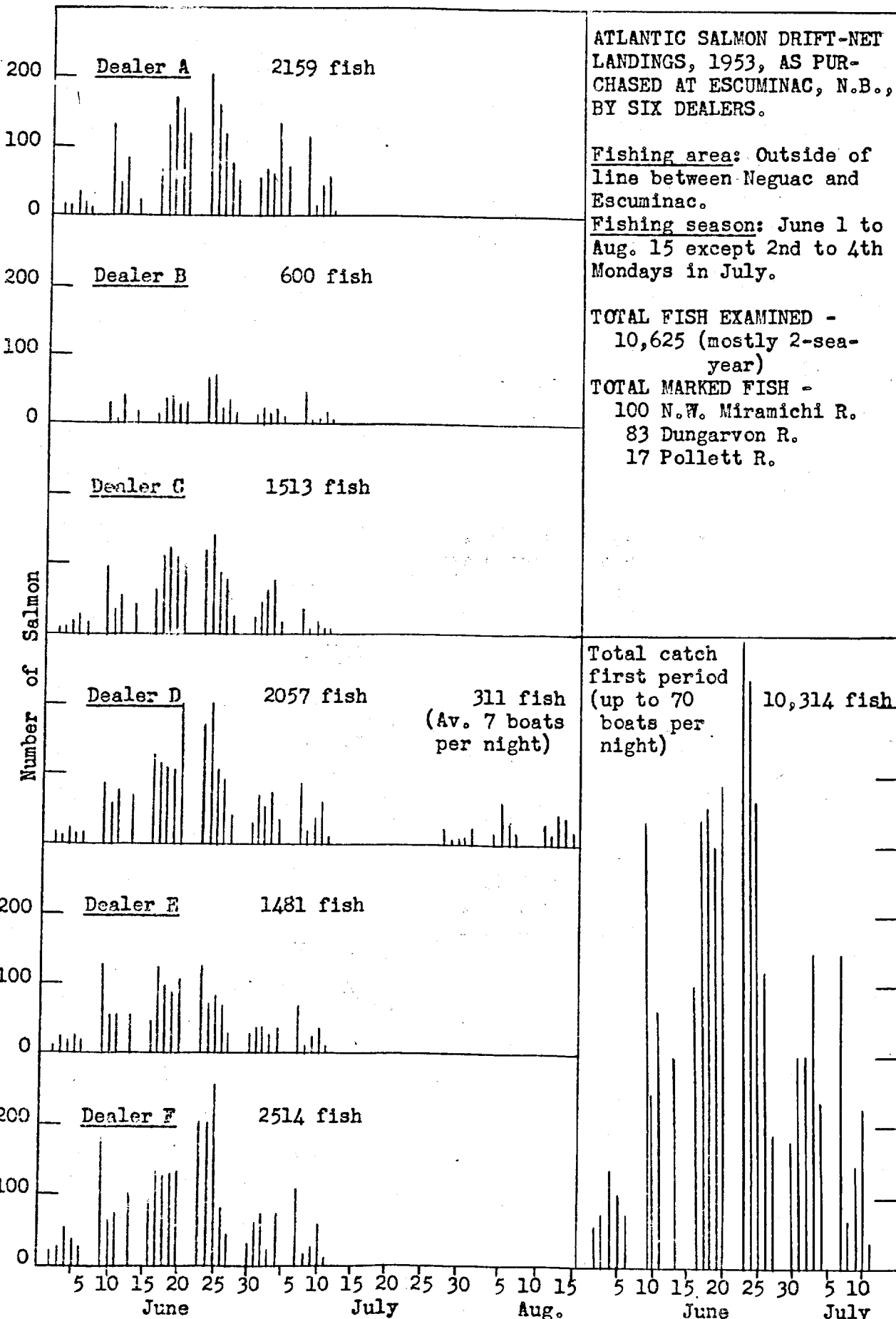


Figure 15. Salmon landings at Escuminac, N.B., from drift-nets, 1953.

River on the Gaspé peninsula (see map preceding Appendix 1 and Figure 1). The fence had a down-trap (for smolt counting and marking) and an up-trap (for ascending fish) to determine the time and extent of the runs, look for marked and tagged salmon and provide other information hitherto completely lacking in this area.

There was practically no early run of salmon, which was surprising since it was believed locally that the streams in this area had predominantly early runs. By August 31 only 14 fish had ascended but large numbers had been seen lying under bridges in the lower estuary. In September the run increased and by October 23, 105 fish (29 females, 76 males) had passed through the trap. The largest daily runs were 18 (9 males, 9 females) on September 16 and 14 (9 males, 5 females) on September 17. The stream is quite small and poorly populated by other fish species. Presumably the 1953 run will be quite adequate to stock the parr-rearing waters above the trap.

(c) Pollett River, N.B.

The Pollett River, which until quite recently has been used exclusively for planting experiments with hatchery-produced stock, is now provided with a fishway at the lower end of the middle experimental area. Records can be obtained of the ascending salmon which from now on will be allowed to spawn in the middle and upper sections of the river. The information on recent runs is given in Appendix 71 by P. F. Elson.

C. J. Kerswill

Appendix No. 69

SALMON ANGLING SUCCESS AND SOME FACTORS AFFECTING IT

Salmon anglers, and the camp owners who accommodate them, seldom admit that they have experienced a good season on the rivers. Sometimes this is justified because many anglers wish to holiday in July and August when water levels are lowest, water temperatures are high, and salmon are not eager to take a fly. Some anglers prefer to fish at the opening of the season when it is popularly believed that a run of large fish ascends from the sea. When unusually high and murky water interferes with fly fishing at this time or the run is delayed a few days there are complaints; and there may be some truth in the popular notion that the early run of salmon into certain rivers like the Miramichi is not as large in proportion to the total annual run as in earlier times. The salmon angling statistics now obtained by the Department are much better than those of a few years ago, and they show that in the whole Maritime region very large numbers of fish (around 60,000) are taken annually, and that the sport is now enjoyed by a great many people. Likely many more fish in all are caught by anglers now than 15 years ago.

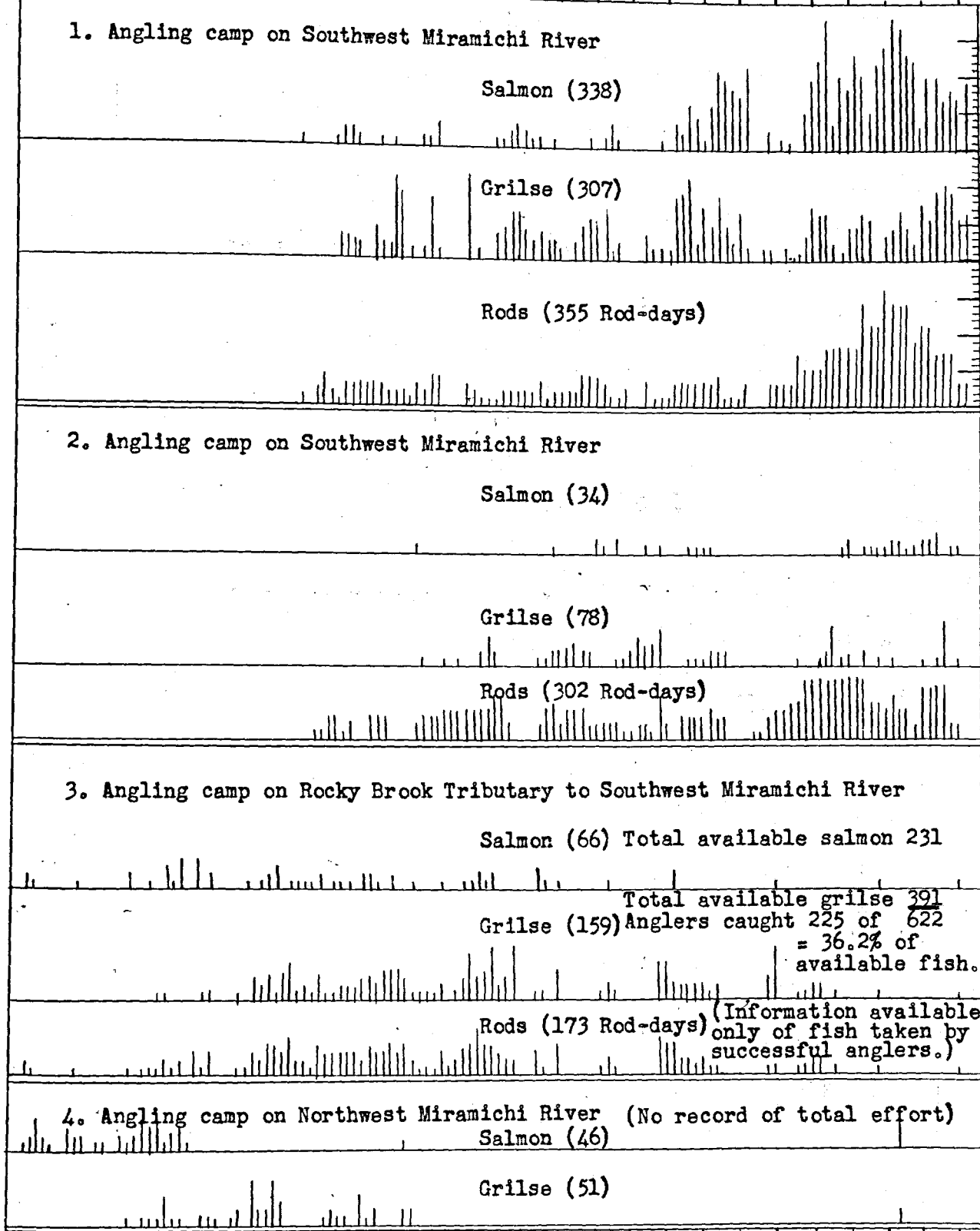
Rarely in complaints about angling success is mention made of the experience and skill of the angler in fly fishing. More is needed to hook a salmon during low-water conditions than possession of an expensive fly-fishing outfit. Few anglers are adept with dry flies or even try to use them, but at certain times they may be much more effective than wet flies. This August the writer watched an expert dry-fly fisherman from New York catch 3 fish in 45 minutes on the Southwest Miramichi River while local anglers using wet flies were getting no strikes and very few people were even trying to fish because they thought that it was hopeless.

The number of fish that should be caught per week to satisfy the average angler is obscure. In eastern Canada angling for salmon is limited to the use of an artificial fly - no worms or nymphs, no accessory spinners, no lures like wobblers or Devon minnows which are legal overseas can be used. Since salmon angling seems to be made as difficult as possible, it might be expected that the angler would be pleased with the slightest trophy - perhaps one or two fish per week in recognition of his skill. This is seldom the case.

Regardless of the perplexity of the salmon angling problem it must be given serious attention. It is largely responsible for so much attention being directed now to research on Atlantic salmon and to a recent expansion in fish culture development work on salmon by the Department. The commercial value of the species is only about 2 1/2 million dollars per year including Newfoundland catches. Anglers argue that salmon are worth a minimum of \$100 per fish to the tourist industry, while to the commercial fisherman the average salmon is worth about \$3. This often leads to strong feelings that the capture of Atlantic salmon should be restricted to the sportsmen.

Figure 16 shows the 1953 catches of salmon (exclusive of "black" spring salmon, legal here) by anglers at four representative camps on the Miramichi River where accurate records of daily catches and effort were kept for us. Camp No. 1 had an excellent season overall, partly because the owner is interested in popularizing September angling when fish are plentiful in his pools and readily take the fly. He did not try to angle in May and June this year. Possibly considerably smaller catches would have satisfied his guests during September. The owner of camp No. 2 was not pleased with the season; although a fair number of grilse were taken the catch of larger salmon was too low. For camp No. 3 we have an accurate record of the number of salmon and grilse available to the anglers because a new trap of the Department was installed and operated near the mouth of the brook on which only this camp operates; the catch throughout the season should be judged as excellent and the proportion of available fish taken (36.2%) was somewhat higher than the ratio commonly imagined. Camp No. 4 specializes in early spring and summer angling and this was considered to be an average season by the owner. Such information collected over the years will be useful in assessing the validity of complaints. It is also possible to compare such data with the records of ascending fish at our traps (Figures 10

May 22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20 25 30 4 9 14 19 24 29
 June July Aug. Sept.



22 27 1 6 11 16 21 26 1 6 11 16 21 26 31 5 10 15 20 25 30 4 9 14 19 24 29
 May June July Aug. Sept.

Figure 16. Salmon catches at four Miramichi River angling camps, 1953.

to 14) and the records of commercial catches (Figure 15) in assessing the effects of present fishery regulations and commercial catches on the anglers' take.

The use of spin-fishing tackle is becoming popular in eastern Canada for trout angling and it is suspected that salmon may be taken on it now although the practice is illegal unless artificial flies supplemented with floats are used. In September the writer tried experimental angling with a spinning outfit using various 1/4-oz. lures on 5-lb. test monofilament nylon line. The 4 1/2-lb. grilse shown in Figure 7 was taken in the Digdeguash River, N.B., where fish are plentiful but there is no sport fishery because to our knowledge salmon will not take flies, possibly because the water is very deeply coloured. Five other fish were hooked on the Miramichi River in several hours of angling with metal wobblers and plastic lures. It is believed that careful consideration should be given to revising the fishery regulations to permit angling with lures other than artificial flies, at least on certain waters. This might lead to satisfaction of some anglers who cannot catch a fish with flies under existing water conditions when they are on an expensive angling trip. Other waters like the Digdeguash River, not now used by anglers, might become popular recreational areas. Reliable information was obtained this year that the present restriction of salmon angling to fly fishing is often not adhered to, anglers using worms and spinners, possibly under the guise of trout fishing, even on famous salmon streams like the Restigouche River.

C. J. Kerswill

Appendix No. 70

REVIEW OF DATA ON RECAPTURES OF SALMON TAGGED AS KELTS BY DEPARTMENT OF FISHERIES, 1913 TO 1944

In 1951 the Atlantic Salmon Association recommended that an extensive tagging programme be undertaken in the Gulf of St. Lawrence to supplement present information on the movements of salmon which has been based largely on tagging experiments. The Board had already undertaken smolt-marking experiments in the Gulf which were believed to offer better possibilities than tagging experiments because much larger numbers of fish could be handled for the money spent and because the rivers of origin of the fish would be known. It is believed that extensive tagging may be desirable at some future date, particularly if new tags recently developed for use on smolts in Sweden prove satisfactory here. Many data are available already, however, from Atlantic coast salmon tagging projects and not all have been published. They have been obtained by various organizations including the Department of Fisheries, the Fisheries Research Board, the Quebec Salmon Commission and the Nova Scotia Department of Trade and Industry. As the first stage of the review, the large body of data obtained by the Fish Culture Branch of the Department of Fisheries on recaptures of salmon tagged as kelts in the Canadian Atlantic area from 1913 to 1944 was analysed this summer. Or-

ganization of the data and preparation of charts were possible only through the availability of Mr. L. R. Day for part-time assistance over several months.

The table below indicates the scope and nature of the data in showing where the 18,498 kelts were tagged, the number from each source which were recaptured, and the percentage of the recaptures made in Newfoundland waters. The latter is given because most of the recaptures which occurred outside the area of tagging were made in the waters around Newfoundland. These recaptures were not made in the fresh waters of rivers but in the sea in commercial gear, indicating that the salmon were taken while enroute to other areas, probably their "home" streams. Most of the recaptures in Newfoundland waters occurred in the eastern region, particularly around the Avalon Peninsula and in Bonavista Bay. A few occurred in Labrador and some were taken on either side of the Strait of Belle Isle. Recaptures in the western region of Newfoundland occurred only for fish which had been tagged off the Margaree River on Cape Breton Island, N.S., the closest point of tagging to Newfoundland.

Results of kelt tagging - Canadian Atlantic coast - 1913-1944

Location	Number tagged	Recaptures		Recaptures in Newfoundland waters	
		Number	% of no. tagged in each place	Number	% of total recaptures
Saguenay R., P.Q.	641	16	2.5	1	6.25
York R., P.Q.	325	2	0.6	-	-
Antigonish R., N.S.	2,362	46	1.9	2	8.7
Nipisiquit R., N.B.	582	8	1.4	-	-
Miramichi R., N.B.	2,723	153	5.6	4	2.6
Miramichi R., N.B. (Blair's '30)	484	12	2.5	2	16.7
R. Philip and Wallace R., N.S.	2,472	75	3.0	7	9.3
Morell R., P.E.I.	780	23	2.9	8	34.8
Margaree R., N.S.	3,897	244	6.3	22	9.0
Sackville R., N.S.	637	31	4.9	1	3.2
Nictaux R., N.S.	895	41	4.6	14	34.1
Saint John R., N.B.	<u>2,700</u>	<u>71</u>	2.6	<u>1</u>	1.4
Totals	18,498	722		62	

These data are given added meaning by the 1953 recaptures around Newfoundland of salmon marked as descending smolts in the Miramichi and Pollett Rivers, N.B. Fish tagged as kelts and marked as smolts apparently had the same pattern of movement. Tagged kelts from the Nictaux River, N.S., in Bay of Fundy waters were retaken mostly from Bonavista to St. John's, Newfoundland, as were marked fish from the Pollett River (also from the Bay of Fundy watershed), and some of both were taken in Labrador. The recaptures of kelts tagged at the Miramichi, although few in Newfoundland, were made in the areas covered by Miramichi marked fish, but the latter were taken over a wider area likely because more fish were marked than were tagged.

It appears that the pattern of movement of at least a good proportion of salmon originating in various rivers of the Maritime Provinces is eastward to waters beyond Newfoundland. Before returning towards their rivers of origin (which tendency seems to be highly developed) many of these fish move along the east coast of Newfoundland and are vulnerable to capture by commercial nets.

L. R. Day
C. J. Kerswill

Appendix No. 71

GROWTH AND MIGRATION OF POLLETT RIVER SALMON

But scanty information has been assembled from either side of the Atlantic on the behaviour of Salmo salar between the time it leaves its natal river as a smolt and its subsequent return towards fresh water as a maturing adult grilse or large salmon. Except for the unique Baltic fishery for growing salmon, records of their capture at sea are few and far between. Out of a total of 82 British records of salmon taken in the open sea, as opposed to those taken in salmon fisheries where the fish are presumably migrating towards spawning grounds, only two specimens were such immature fish, variously termed "pre-grilse" and "post-smolts".

In Canada there are opportunities for studies of this stage. Comeau recorded in 1909 that thousands of such young salmon, from 1/2 to 1 1/2 lb. in weight, were captured by herring fishermen along the north shore of the Gulf of St. Lawrence and were at one time sold in the markets of Quebec City. Some post-smolts are taken in herring fisheries in the Bay of Fundy, particularly in weirs at Grand Manan and Passamaquoddy Bay and in the general vicinity of Halls Harbour on the Nova Scotia shore below Minas Channel. The Halls Harbour fishery is of particular interest because marked post-smolts which originated from the Board's salmon planting experiments in the Petitcodiac River, and from experiments of the Maine Sea Run Salmon Commission, were recorded there as early as 1945. As a result this fishery offers an opportunity of studying the growth made by such salmon during their first few months at sea, for analysis of their food at this stage and, if a satisfactory procedure for tagging these delicate fish can be developed, for studying their subsequent use by man.

Since 1951 an effort has been made to improve the recording of such marked post-smolts captured in the weirs of the vicinity, which are built for taking both salmon and herring. In 1952 several of the weir operators were contacted personally and arrangements made for recording the general size of the catches of post-smolts and the numbers of marked fish taken. Almost the entire catch of the two weirs taking the most post-smolts was shipped to the Atlantic Biological Station for verification of marks.

Table I Origin of salmon post-smolts taken near Halls Harbour, N.S.

<u>Year</u>	<u>Pollett River*</u>	<u>Maine rivers</u>	<u>Undetermined rivers</u>
1951	23 (25,187)	26	no record
1952	204 (26,297)	23	536+
1953	9 (3,639)	6	400+

* In brackets, the number of marked smolts liberated 2 1/2 months earlier.

Table II Sizes of Pollett River salmon at different ages (1952 data)

<u>Stage</u>	<u>Smolts</u>	<u>Post-smolts</u>	<u>Adults</u>	<u>Weight</u>
		Two years in river plus 2 1/2 months in sea	Two years in river plus 1 1/2 years in sea	
<u>Approx. age</u>	<u>Two years in river</u>			
<u>Total length (cm.)</u>	15.9	29.7	62.9	4.7 lb.
<u>(Stan. dev.)</u>	(±1.1)	(±1.4)	(±3.7)	(±.7) lb.

The growth made by the Pollett fish in the 2 1/2 months following descent as smolts is shown in Table II. The scales of these fish show the first sea-winter band just beginning to form.

Only seven of the more than 80,000 smolts marked and liberated from the Pollett since 1949 have been retaken in the experimental section of the Pollett as mature fish (Table III). These few, however, have been similar in size and growth characteristics, as shown by scale examination, to the unmarked fish entering the river. Both these groups have the first part of their scale patterns similar to those of the Pollett post-smolts taken at Halls Harbour, frequently including a brief slowing of growth about 6 to 10 circuli out from the last winter band of parr life. Such unmarked adults could well have originated, at least in part, from the lower Pollett or other parts of the Petitcodiac system. The fish from the Maine rivers show a less obvious check, and that not quite so far beyond their last parr winter band. Not enough fish have been examined to know whether these differences will give reliable clues to the origin of the salmon.

Table III Adult salmon entering the experimental area of the Pollett.

<u>Year</u>	<u>Marked as Pollett smolts</u>	<u>Unmarked</u>	<u>Total</u>
1950	1	14	15
1951	0	5	5
1952	3	137	140
1953 (to Nov. 4)	3	41	44
<u>Totals</u>	<u>7</u>	<u>197</u>	<u>204</u>

Season of salmon run. In common with other streams of the region, the Petitcodiac and the Pollett have the bulk of their salmon run concentrated in the late autumn. A few fish enter each year as early as July and even late June, depending on height of

water in the river among other factors, but by far the largest part of the run enters after mid-October or even mid-November, and these runs appear to be related partly to spring tides.

Table IV Numbers of salmon entering the experimental Pollett

<u>Year</u>	<u>July and August</u>	<u>September and October</u>	<u>November</u>
1952	11	6	123
1953	9	30	7 (to November 4)

P. F. Elson

Appendix No. 72

HOMING OF SALMON TO PETITCODIAC RIVER

There is evidence indicating that the homing of salmon may be largely inherent behaviour. Large numbers of smolt from non-indigenous fry plantings have been marked and liberated from the experimental area of the Pollett River, a branch of the Petitcodiac, but only a few of the spawning run of mature salmon have been marked fish. This condition is in contrast with the good returns of marked salmon to Holmes Brook of the Petitcodiac River where only indigenous smolts had been marked.

To determine whether or not smolts from artificially-reared fry (fingerlings) from mature Pollett River salmon would return to the experimental area, some 10,000 eggs were collected from native stock at the trap below the experimental area. These eggs were placed in a hatching box in a large spring at Portagevale in the upper waters of the Kennebecasis River and were tended throughout the winter. Hatching began in late February and yolk sac absorption was complete late in April. There was only a moderate loss up to this stage. On May 2 most of the fry were taken to the Collingwood hatchery to be reared to fingerlings. On May 5 the remaining fry (about 2,500) were transferred to the Northwest Miramichi counting fence where they were retained in a floating trough. The fry were fed on a variety of foods including gaspereau eggs, egg custard, cooked fish and living organisms, mostly mayfly nymphs. They made good growth but first a disease and later excessive water temperatures took a heavy toll. Five hundred and fifteen were transported to Petitcodiac, marked by removing the adipose fin and were planted above the experimental area in the Pollett River August 21. Of 2,869 fingerlings brought from the Collingwood, N.S., hatchery on October 2 about two thousand appeared to be from the Petitcodiac River stock. However, all were marked October 5 and planted in the upper Pollett River. When smolts from these two plantings are taken they will be given a distinctive mark which will identify them if they return as grilse or salmon.

If, in contrast to the non-indigenous plantings, salmon from these smolts show a normal return to the Pollett it will be evident of inherent behaviour.

H. C. White

Appendix No. 73

THE BOUNTY KILL OF HARBOUR SEALS

Bounty kill records for years previous to 1949 suggest that the kill was almost exclusively of pups of the year, possibly keeping the population from increasing but not striking at maturing and adult stock. It is chiefly the adults which create the nuisance to fishermen and lead to complaints of damage to gear and predation on fish caught in nets. It is individuals older than one year which are major hosts to the reproductive stage of the cod-worm. The proportion of these in the total kill has been observed since 1950 when the bounty on them was raised from \$5 to \$10, while the bounty on pups was left at \$5. From 1950 to 1952 this proportion rose from 16% to 30%. This year, to the end of October, it is 26%.

There is no indication that the hunting effort has decreased on harbour seals, and it is expected that the increase in the kill of the maturing and breeding stock will produce eventually a noticeable decrease in the population, which will be reflected in a decrease in the bounty kill. While it may be too early yet to draw definite conclusions, the expected reduction appears to be taking place. The seasonal pattern of the kill to date in 1953 is very similar to that of past years (Appendix 80 of the 1952 Annual Report) but the total annual kill is gradually becoming less. The following table summarizes the kill for the past four years (to the end of October each year for comparison with 1953):

	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>
No. killed:	1340	1240	1200	980
Proportion immatures and adults:	16%	24%	30%	26%

During the coming year the detailed distribution of these kills will be studied and an attempt will be made through field trips to determine whether a reduction in harbour seal population actually has taken place, and, if so, in which specific areas.

The question of further intensification of harbour seal control by the bounty method will require careful consideration from four main viewpoints: (1) the role of several hundred thousand harp seals present in the Gulf of St. Lawrence from January until May or June as vectors of cod-worm; (2) the invulnerability of much of the grey seal population which also carries cod-worm but to a lesser extent than harbour seals; (3) the location of areas affected by the bounty-induced reduction, if any, in the harbour seal population; (4) the fact that one of the disadvantageous and uncontrollable factors of the bounty method, the smuggling of jaws from areas outside Canadian jurisdiction, has begun to take place and would in-

crease with an increased bounty, although to date this has been from areas in Maine from which seals could be expected to repopulate adjacent Canadian waters.

H. D. Fisher

Appendix No. 74

THE BREEDING SEASON OF THE HARBOUR SEAL

Published reports dealing with the life history of the harbour seal indicate that for all parts of the range of the species the whelping season occurs mainly during May and June, with the exception of parts of Puget Sound where whelping apparently takes place one or two months later. The mating season has always been stated or assumed to occur during September and October, this belief being based on observations of gatherings of adult seals at that time displaying a great deal of quarrelsome and noisy activity assumed to indicate sexual activity. In one or two instances apparent acts of mating have actually been reported.

The study of sectioned ovaries from adult harbour seals taken from June to August during the past few seasons in the Bay of Fundy has revealed that the corpus luteum of pregnancy persists during lactation, as in the harp seal, but that by the end of June and early July regression has begun. By mid-July new corpora lutea have been found, which until this summer had been taken for the corpora lutea of the recently terminated pregnancy, still largely unregressed. Not only is the initial regression of the corpus luteum of pregnancy apparently very rapid upon the termination of lactation, but, as in the harp seal (Appendix 78), development of the new corpus luteum also is apparently very rapid, luteal cells having completely filled the follicle to form a solid and nearly full-sized corpus by mid-July. Implantation of the blastocyst has been observed on September 21 and several very early embryonic stages have been recovered during the first week of October.

It therefore appears that harbour seals mate not in the autumn as has been believed but immediately upon the termination of lactation in late June or early July, and that implantation of the blastocyst is delayed for a period of about two months. The reproductive pattern of the harbour seal thus appears to be closely similar to that of the harp seal, which is of the same genus. The period of delay in implantation in the harbour seal may provide a clue as to the period of delay in the harp seal. It might be expected that with fertilization occurring at the end of March the blastocyst in the latter species implants at about the end of May, resulting in a period of embryonic development of about nine months as in the harbour seal.

A series of harbour seal testes will be examined histologically to determine the onset and decline of spermatogenesis for final confirmation of the mating season.

H. D. Fisher

Appendix No. 75

WHELPING CONCENTRATIONS OF GREY SEALS

During January and February whelping groups of grey seals were sought in order to attempt tagging of the newly-born animals before they entered the water. Two pupping localities were visited, Amet Sound, N.S., and Deadman Island, M.I.

On January 22 and 23 between Amet Island and Malagash Point 7 adult grey females with pups in various stages of moulting were seen on loose ice. From Malagash Point to Malagash Salt Mines a band of slushy ice extended 3 miles from shore. In this on scattered pans of firmer ice were 43 adult grey seals. Most of these were females with pups. Three females appeared to have two pups each. Many male adults could be seen in the water. On the same day one adult was lying on the ice near the Department of Fisheries oyster sub-station at Malagash Basin and 3 more with pups were found just inside Cape John. On the previous day one adult female had been seen from the M.V. "Abegweit" on very loose drifting ice in the middle of Northumberland Strait between Cape Tormentine and Borden. Unseasonably warm weather prevented the ice from becoming firm enough to permit tagging.

Some local residents formerly hunted this whelping group before the freeze-up. These men estimate the total population at 500 and say that the seals build up to that number gradually during November and December and remain in the area until February or March.

The first two weeks of February were spent on the Magdalen Islands. While much of interest was learned about the grey seals at Deadman Island, no attempt at tagging could be made, partly because of the warm and stormy weather and partly because of legal conflict between the two groups of hunters who go out to Deadman Island.

The herd apparently arrives at the Island in December and stays until March. Over much of this period pups are being born. One reported phenomenon on which there was general agreement was twinning, two foetuses having been in several females. It seems quite definite that an unknown but considerable number of grey seal females produce more than one pup here.

Perhaps once in seven years a winter such as the past one protects the herd from extensive hunting. In other years all seals possible are killed, amounting to about 200 animals. Probably two thirds of these are newly-born or foetal seals; most of the other third are breeding females. Strangely, about the same number return each year in spite of the fact that control in this area is about as intensive as it could be. Part of the reason for the extensive killing is that the hunters collect a bounty on these seals from the provincial fisheries department.

Another locality frequented regularly by grey seals was discovered at Enmore Bay, P.E.I. No whelping occurs here

but a herd of about 100 arrives in mid-August and remains until the freeze-up. They are hunted very little.

Bounty claims show that several grey seal pups were taken at Panmure Island off Prince Edward Island. It is hoped that this place as well as Amet Sound can be visited in the winter of 1953-54.

B. A. Mackenzie

Appendix No. 76

DENTAL ANNULI AS AGE INDICATORS IN THE HARP SEAL

The interpretation of seasonal dental annuli in certain animals has been shown to be an accurate means of aging. V. B. Scheffer found that in the Alaska fur seal the annuli are visible macroscopically as ridges on the root of the canine tooth. The only preparation necessary is the extraction and cleaning of the tooth. R. M. Laws found that in the elephant seal it is possible to read the annuli microscopically by reflected light from the bisected and polished surface of the canine tooth and showed that similar annuli are present in several other phocids, including the harp seal. We have found in the case of the harp seal that for accurate reading it is necessary, after extracting and cleaning the canine tooth, to prepare thin sections of from 40μ to 200μ , and to examine these microscopically by transmitted light (Figures 1 to 8). The effectiveness of this method as a tool in wildlife management when large numbers of samples are to be read depends upon the amount of time involved in handling the material. Previous reports on age-compositions of harp seal tooth samples have required much painstaking and slow labour by hand in grinding the sections. We have now evolved a fast method of preparation whereby a 100μ section of a tooth can be cut and prepared within a minute.

Harp seals, like most and possibly all phocids, are born with their permanent dentition in the process of eruption, the milk dentition having been absorbed in utero. Cross sections of the canine tooth show, on the whole, clearly defined annuli in the dentine which we deduce, for reasons given below, to be annual, and which record fluctuations in the rate and manner of dentine deposition from birth. The annuli represent zones of dense dentine resulting from periods of interrupted or slowed deposition by the pulp, due to factors such as reduced feeding and moulting.

The canine tooth at birth early in March consists of a thin and quite fragile shell (less than 0.1 mm. thick below the level of alveolar bone of the jaw), well open at the root and with a large pulp cavity. Throughout most of the life of the seal the pulp deposits dentine and gradually closes over.

It is not possible to read ridges on the surface of the root because the root, instead of remaining open as in fur seals and elephant seals, lengthens rapidly and closes over, except for a minute canal, by the time three annuli have formed, although the pulp cavity remains quite large at that stage. The following

table gives the dimensions of the root opening and diameter of the pulp cavity in the canine teeth of harp seals at the stages of one month, three months, the beginning of the first annulus, second annulus and third annulus. These teeth because of their fragility are difficult to extract entire, and only a small number have been measured:

Age group	Date collected	Root opening (mm.)	Greatest width of pulp (mm.)
Ca. 1 month (1)*	Late March, 1953	6.0 x 3.0	6.5
Ca. 3 months (1)	Early June, 1953	5.7 x 2.8	6.4
Beginning of first annulus (21)	Mid-April, 1953	2.8 x 1.4	5.9
Beginning of second annulus (12)	Mid-April, 1953	1.5 x 0.7	5.0
Beginning of third annulus (6)	Mid-April, 1953	1.6 x 0.3	4.6

* Number of teeth measured

Tooth sections of all seals taken during April show a relatively large amount of clear dentine on the pulp side of the innermost annulus (Figure 6), i.e. the last previous annulus to be formed, when compared with sections of teeth collected during the southward movement in January (Figure 5). During April the seals are undergoing a period of reduced feeding and a metabolic change connected with the moult, and in many tooth sections the air spaces of interglobular dentine which lie on the outer borders of most annuli of dense dentine (e.g. Figure 7) can be seen to be starting to form. It thus appears that the areas of clear dentine between the annuli are laid down from the time of the southward movement in early winter until the time of the moult in the spring, when the seals are very fat and apparently feed well. The annuli of dense dentine apparently are laid down between the time of the moult and the end of the summer sojourn in the Arctic, when the seals are reported to become thin and apparently do not feed well.

We have been unable to find annuli in harbour seals which can be interpreted, and the pulp cavity in this species closes over completely by about the fifth or sixth year of life. They are present in the hooded seal, however, which has a phenomenally large cement layer in which annuli usually can be more easily read than in the dentine. This applies also to the single-rooted molars of the walrus, sections of which we have studied from walrus killed some 100 years or more ago on the Magdalen Islands.

H. D. Fisher

Appendix No. 77

ON THE NORTHWARD MOVEMENT, MOULTING AND AGE-COMPOSITION OF THE KILL OF IMMATURE AND ADULT HARP SEALS BY VESSELS IN 1953

Shortly after the mating season during late March and early April, immature and adult harp seals haul out to moult in

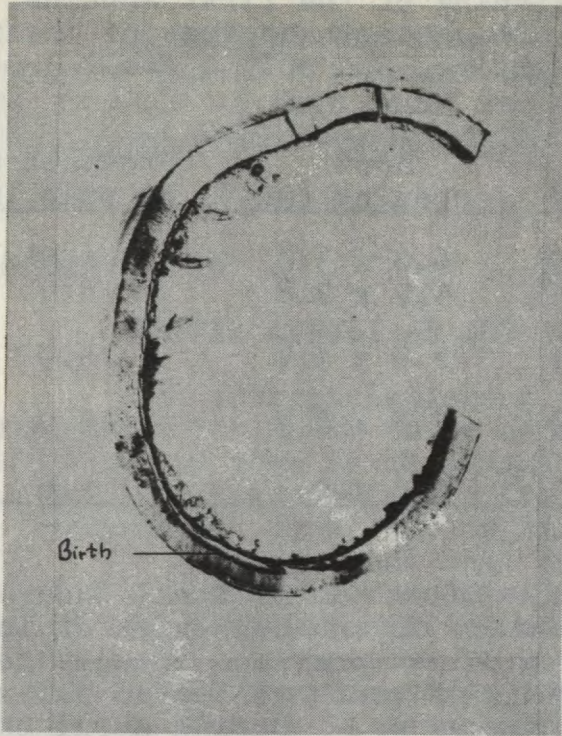


Fig. 1. From pup about one month old. Late March, 1953.

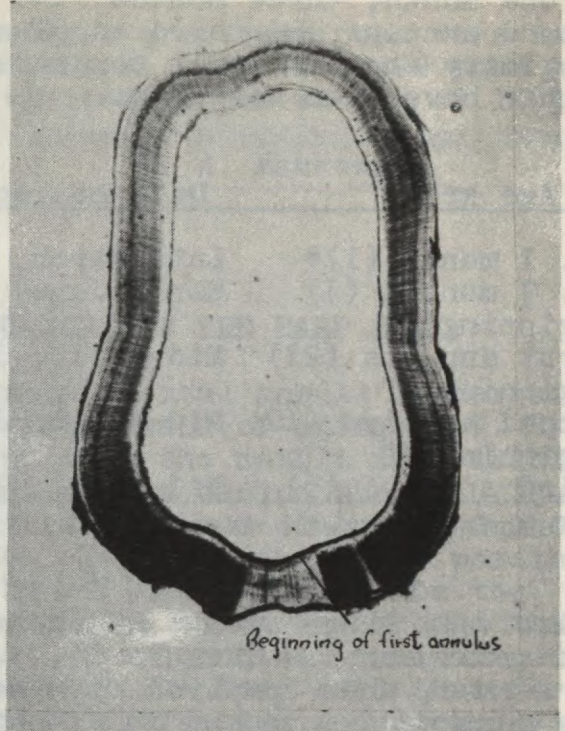


Fig. 2. Beginning of first annulus. Deduced age one year, plus one month. April, 1953.

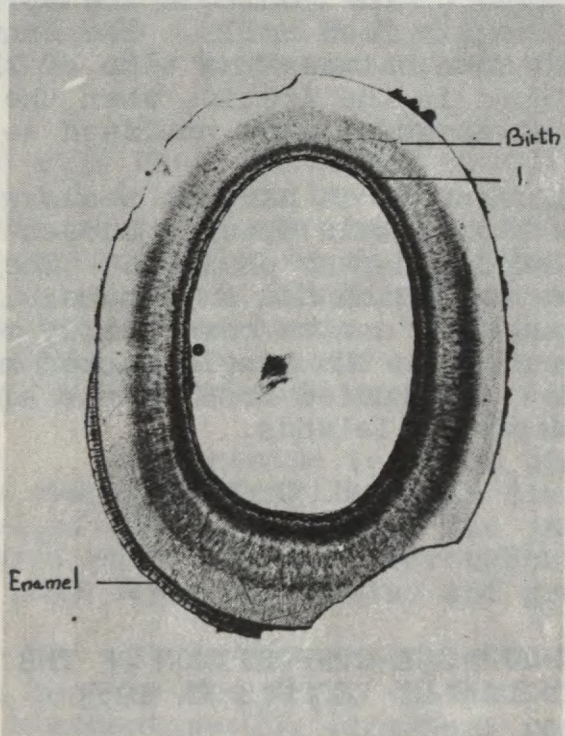


Fig. 3. One annulus plus some additional growth. Deduced age, one year plus 10 months. January, 1952.

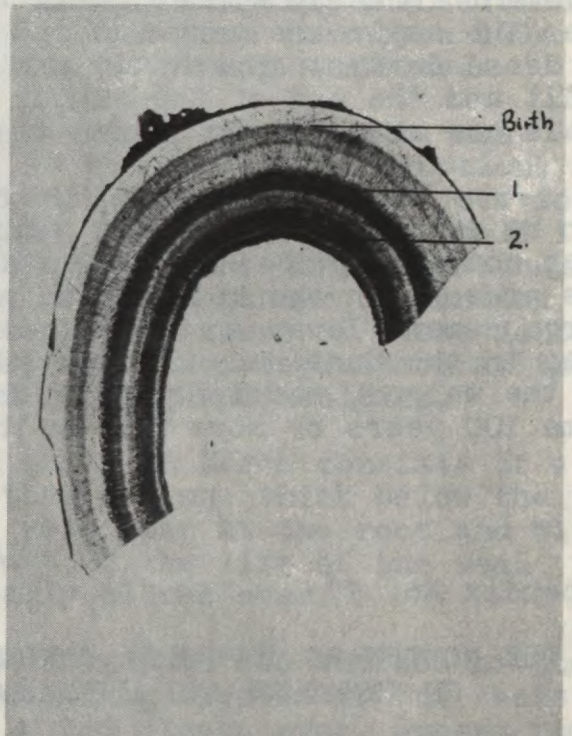


Fig. 4. Two annuli plus some additional growth. Deduced age, two years plus 10 months. January, 1952.

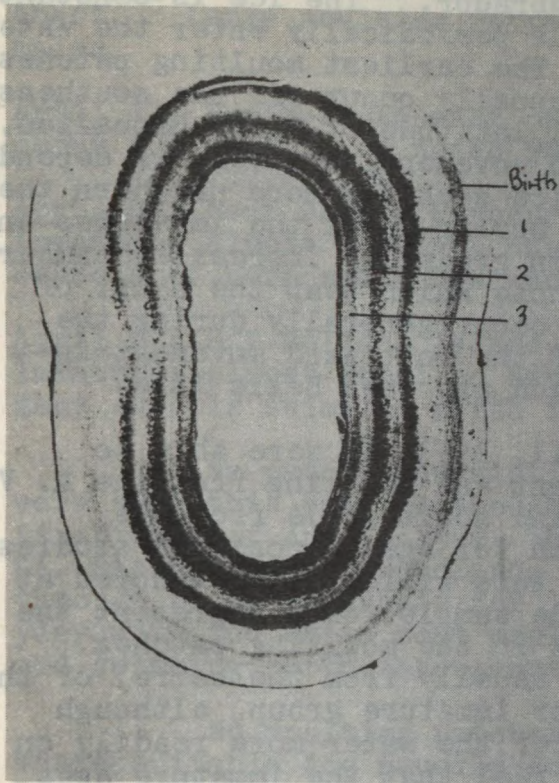


Fig. 5. Three annuli plus some additional growth. Deduced age three years plus 10 months. January, 1952.

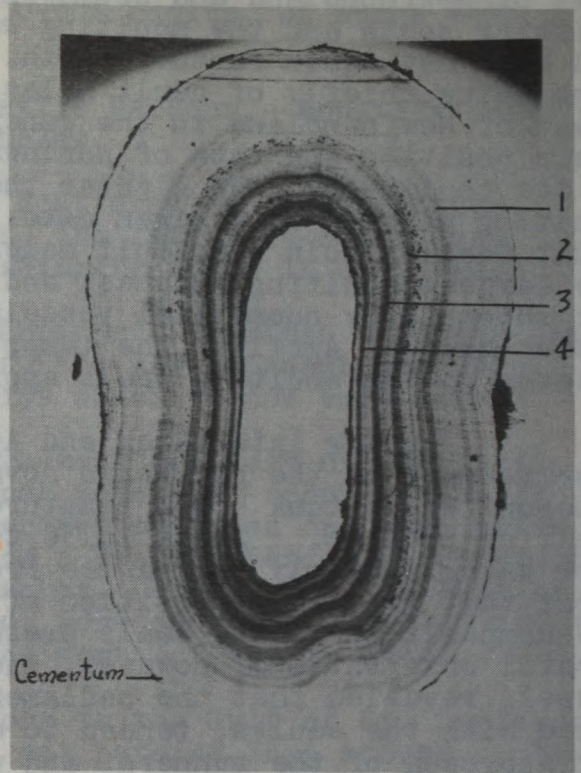


Fig. 6. Four annuli plus additional growth. Deduced age, five years plus one month. April, 1953.

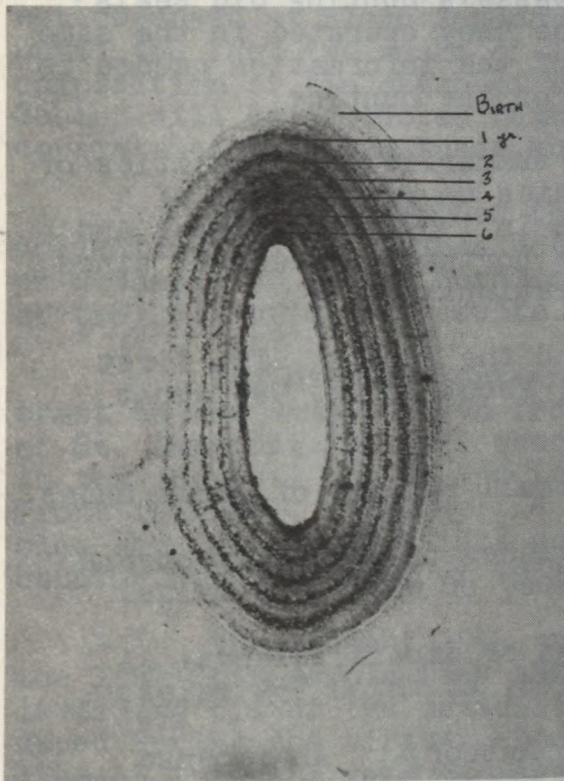


Fig. 7. Six annuli plus practically no additional growth. Deduced age six years plus 10 months. January, 1952.

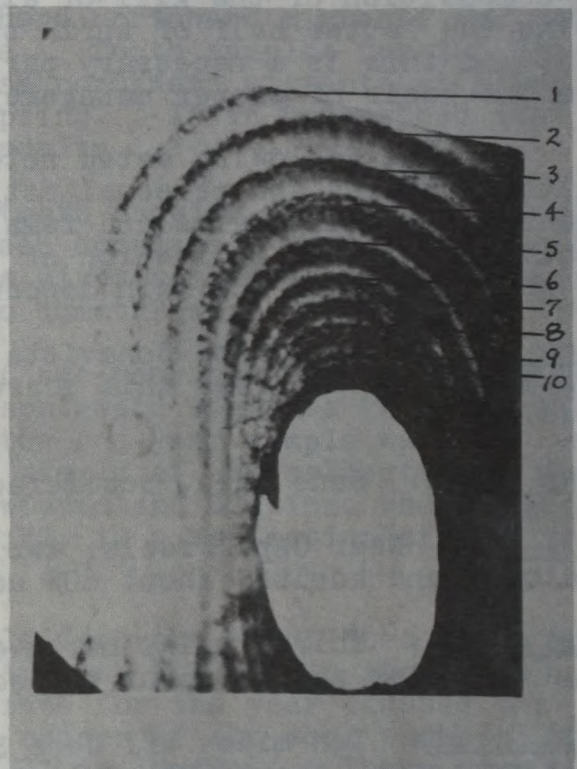


Fig. 8. Ten annuli plus some additional growth. Deduced age ten years plus 10 months. January, 1952.

scattered "patches", sometimes of immense numbers, on the pack ice east of Newfoundland and southern Labrador. The ice is constantly drifting south and the moulting seals periodically enter the water and haul out again further north. The earliest moulting patches, consisting chiefly of adult males, usually occur off the southeast coast of Newfoundland in the general latitude of Point Baccalieu. Their position and rate of northward movement, however, is dependent on ice conditions, the lighter the ice pack the more northern the moulting patches on a given date. During April the immatures and adult females join the adult males in gradually increasing numbers. The largest moulting patches, and those which bear the brunt of the shooting by commercial vessels, occur generally during the latter half of April. The tempo of the northward movement increases as the moulting seals approach and pass Belle Isle.

During late March and April, 1953, we were able to observe much of the northward movement and moulting from the M. V. "Theron" which took 4,900 immature and adult seals from the moulting patches. About 1,150 teeth for age composition studies were taken randomly on the ice from this kill. It was hoped at first that the age-composition of the sample would represent the age-composition of the seals present in the moulting patches. Careful observations, however, made usually from the barrel of the vessel, revealed that the bedlamer or immature group, although mixed with the adults, tended to enter the water more readily on the approach of the gunners, and we feel that the immature ages (1 to 4) will be more poorly represented than a true sample of the population would indicate. The relationships of the year classes within the immatures as a group, and within the adults as a group, are, however, probably indicative of the actual condition of the stock. We believe, too, that the sample is indicative of the age-composition of the kill of all vessels hunting old seals during the latter half of April since they operated in the same area, and this is a necessary part of the information needed to form the basis of proper management of the hunting.

The following dated notes summarize the localities of moulting patches and personal estimates on proportions of immatures to adult males and females in 1953. The dates and localities give an indication of the northward movement, since the ships followed the main concentrations:

March 28: Between Cape Bonavista and the Funks. The first moulting patch observed this season, about 5,000, 99% adult males.

March 30-31: Same area, scattered small patches of adult males.

April 6-7: Near Cape Freels, two patches of several thousand immatures and adults, about 60% adults, of which 95% males.

April 13-14: Thirty miles north-east of Groais Islands. A large moulting patch, about 60% adults, of which 95% males.

April 17-18: Ten miles off Cape St. Anthony. An immense moulting patch, about 60% adults, of which 95% males.

April 22: Between the north end of Belle Isle and the Labrador coast. Large moulting patch, 50-60% adults, of which 85% males.

April 23: South-south-east of Battle Harbour. Moulting patch about 60% adults, of which 90% males.

April 26: Near Battle Harbour. Scattered moulting patches, immatures almost equal to adults, the latter 75-80% males. Schools of harp seals now seen swimming north in open leads.

April 27: Off Bulldog Island, Labrador. Immense moulting patch, immatures almost equal to adults, the latter about 60% males. Many schools swimming north in ice which is now very loose.

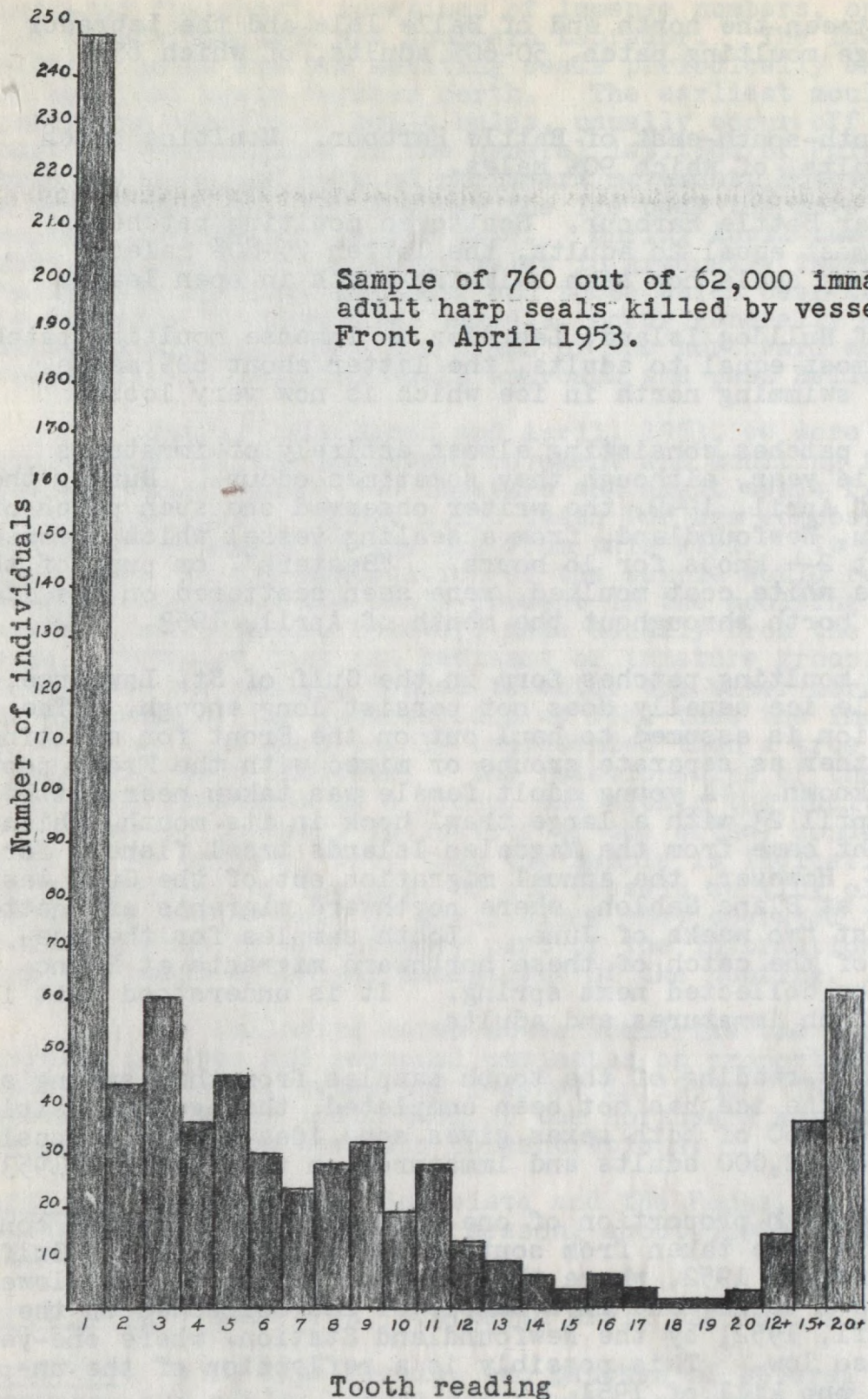
No patches consisting almost entirely of immatures were seen this year, although they sometimes occur. During the first week of April, 1949, the writer observed one such patch off Pt. Baccalieu, Newfoundland, from a sealing vessel which steamed through it at 2-4 knots for 18 hours. "Beaters", or pups of the year with the white coat moulted, were seen scattered on the ice and swimming north throughout the month of April, 1953.

No moulting patches form in the Gulf of St. Lawrence, where suitable ice usually does not persist long enough. The Gulf population is assumed to haul out on the Front for moulting, although whether as separate groups or mixed with the Front population is unknown. A young adult female was taken near Battle Harbour on April 23 with a large trawl hook in its mouth, which it was thought came from the Magdalen Islands trawl fishery for harp seals. However, the annual migration out of the Gulf was not observed at Blanc Sablon, where northward migrants are netted, until the last two weeks of June. Tooth samples for the age-composition of the catch of these northward migrants at Blanc Sablon will be collected next spring. It is understood that it consists of both immatures and adults.

While reading of the tooth samples from this spring's collecting in the ice has not been completed, the age-composition of a sample of 760 of both sexes gives some idea of the composition of the kill of 62,000 adults and immatures on the Front in 1953.

The high proportion of one-year-olds is in marked contrast to the sample taken from southward migrants into the Gulf of St. Lawrence in 1952, where the one-year sample was the lowest in the groups 1 to 12, and in a sample of 266 collected on the Front in April, 1952, by the Newfoundland Station, where one-year-olds were also low. This possibly is a reflection of the unusually high pup kill of 1951.

The present 1953 sample from the Front does agree with the 1952 Gulf sample (see ABS Circular No. 20) in showing a levelling off of the mortality rate for the year classes produced during the virtual closed season of the war, especially 1942-45 (present year classes 8-11 inclusive). These year classes may be regarded as forming the cream of the present breeding stock. The present hunting, however, is removing not



only this stock but a large proportion of the maturing stock (56% of the 62,000 for 1953). The proportion of immatures and adults in the total kill, moreover, has risen from 8% in 1895-1911, to 16% in 1912-1940, to 35% in 1946-1953, while the kill of pups has maintained a high level. The 1953 kill on the Front was

157,000 pups and 62,000 immatures and old. This is a very undesirable tendency.

The heavy kill of the larger seals since the war (averaging about 58,000 from 1947 to 1953 as contrasted with a pre-war average of about 25,000) is a cause for concern, as they are not as valuable individually as are the pups and it takes a number of pups (perhaps four or more) to produce one adult. The kill of 62,000 older seals in 1953 was probably more damaging to the stock than the kill of 157,000 pups and is dangerously high. It seems desirable to consider action to protect the older seals by some such measure as prohibition of hunting after April 15.

Mr. B. A. Mackenzie assisted in the collection and preparation of material for this report.

H. D. Fisher

Appendix No. 78

REPRODUCTION AND SEXUAL MATURITY IN THE HARP SEAL

1. Ages at sexual maturity

Reproductive studies by this Station in the past have been based on specimens collected during the southward migration in January, and during the whelping season in the Gulf of St. Lawrence and on the Front. Ages at sexual maturity in the female have been estimated by comparing the age of the animal, determined from tooth sections, with the number of corpora lutea (i.e. the functional one, if present, plus old ones or corpora albicantia). Of 32 animals collected at La Tabatière in January, 1951 and 1952, 72% had first matured at 3 or 4 years of age and 28% at 5 or 6. Histological study of old scars in the ovaries has led to a careful re-examination of some ovaries from the above-mentioned sample and it is suspected that atresia of large follicles can at times produce a scar similar in gross appearance to that of an old corpus luteum, so that care must be exercised in counting old scars in the ovary. Much more reliable data would be obtained from animals between the ages of say 3 and 10, preferably in the spring, if fully mature follicles, recent ovulations and new corpora lutea could be readily detected.

During 1953 about 150 reproductive tracts of female harp seals were collected from the southward migration in January, and from the spring sealing in the ice in March and April. Table I shows some details on age and reproductive condition in 86 specimens between the ages of 1 and 10 years, in which the tooth reading is in no doubt. The term "rising 2" means that by March the seal would have been two years old. The term "new", used for corpora lutea, means a freshly formed post-ovulatory corpus, as against a functional corpus ("fcnl."), referring to the corpus luteum of advanced pregnancy.

Table I

Age	Number	Date	Corpora lutea	Follicular development
	1	4	Apr. 0	None to barely visible.
Rising	2	1	Jan. 0	None.
	2	1	Apr. 0	Small, immature follicles visible.
	3	12	Apr. 0	None to small immature follicles.
Rising	4	1	Jan. 0	None.
	4	13	Apr. 0	Medium-sized immature follicles in 7 seals. Large and nearly mature in 6 seals.
Rising	5	1	Jan. 0	Large maturing follicles.
	5	17	Apr. 1 new in 6 0 in 11	Large mature follicles in 3 of seals with no corpora. Small to medium immature follicles in others with no corpora.
Rising	6	2	Jan. 0	Medium-sized immature follicles in one; large ripening follicles in the other.
	6	9	Apr. 0 in 2	Large mature follicle in one; medium immature follicles in other.
			1 new in 2 2(1 new) in 2 3(1 new) in 3	Large follicles.
Rising	7	10	Jan. 1 fcnl. in 7	Maturing follicles in opposite ovary.
			2(1 fcnl.) in 2	Maturing follicles in opposite ovary.
			4(1 fcnl.) in 1	Maturing follicles in opposite ovary.
	7	4	Apr. 0 in 1	Mature follicle present.
			2(1 new) in 3	Large follicles.
	8	2	Apr. 1 new in 1	Large follicles.
			2(1 new) in 1	Large follicles.
Rising	9	5	Jan. 2(1 fcnl.) in 1 3(1 fcnl.) in 2 4(1 fcnl.) in 1 6(1 fcnl.) in 1	Large maturing follicles in all 5.
	9	3	Apr. 2(1 new) in 1 3(1 new) in 2	Large follicles. Large follicles.
Rising	10	2	Jan. 3(1 fcnl.) in 1	Maturing follicles.
	10	2	Apr. 3(1 new) in 1 5(1 new) in 1	Large follicles. Large follicles.

Note: In those animals with no corpus luteum development in April it is most unlikely that subsequent ovulation would occur in that year, since the breeding season was over as shown by histological examination of testes and by observations in the moulting patches from which the specimens were collected.

Of a total of 10 females in the above sample ovulating for the first time 6 were 5 year old, 2 were 6 years, one was 7 and one 8. None of the eighteen 5-year-old females collected had previously ovulated.

Of a total of 23 females between the ages of 6 and 10 which had ovulated in previous years, 1 had matured at 3 years, 3 at 4 years, 5 at 5 years, 7 at 6 years, 5 at 7 years, and 2 at 8 years, if we assume the interpretations of old corpora in the ovaries, made with due regard to the difficulties raised by the nature of atretic follicles, are correct. These data on age at sexual maturity are in line with those outlined by D. E. Sergeant in the Annual Report for 1952 of the Newfoundland Station.

2. Time of mating and formation of the corpus luteum

The collections of reproductive tracts made during April this year give some information on the time of formation and development of the corpus luteum. The data are summarized in Table II. Unlike that of most mammals, the corpus luteum of the harp seal does not show gross indications of regression upon the birth of the pup, and disintegrative processes apparently do not begin until the time of weaning, shortly after the middle of March.

Table II

	<u>Number of specimens on:</u>									
	Mar. 5-14	Mar. 19	Mar. 28	Apr. 8	Apr. 13	Apr. 14	Apr. 18	Apr. 22	Apr. 27	Apr. 28
Corpus luteum	5-14	19	28	8	13	14	18	22	27	28
No grossly visible change from pre-natal appearance in corpus luteum of pregnancy.	25									
Definite regression of corpus luteum of pregnancy to corpus albicans in progress.		2	1	1	1	3	12	11	5	1
Early luteal development in ruptured follicle, luteinizing cells migrating into follicular cavity.			1	1			1			
Ruptured follicle about half filled with luteal cells.						2	1			
New corpus luteum with very small core of follicular fluid, near maximum size ever attained.					1		1	7		
New corpus luteum fully filled in and at practically full size.						1	9	4	5	1

Our journal notes indicate that by March 16 the mothers were leaving the pups, in which the first indications of the moult were present. The material on which Table II is based points to a mating season beginning about the end of the second week after parturition, if we take March 10-12 as representing the peak of pupping in 1953, which it seemed to be from our observations in the whelping patches. This is in accord with the conclusions of Sivertsen on the White Sea harp seal, although pupping and mating are one to two weeks earlier in that area.

The corpus luteum develops quickly and attains a surprising size, almost a maximum, during the last half of April. In harp, as in other, seals there is delayed implantation, so that it is impossible to tell from the ovarian appearance before implantation whether the female has been impregnated or not. Corpora lutea will develop regardless of whether or not mating occurs, resulting in a condition known as "pseudo-pregnancy" if it has not. At implantation time, regression of the corpora lutea in unfertilized females will occur. Attempts to locate the blastocysts in the reproductive tract were unsuccessful, but it is felt that this can be done in future using fresh instead of preserved material. This would enable figures on reproductive success to be gathered for comparison with those obtained from animals in late pregnancy in January during the southward movement.

The size gained by the corpus luteum in April places further doubt on the value of old corpora lutea as indicators of previous pregnancies. While corpora of pseudo-pregnancy probably would regress more quickly than those of pregnancy because of the comparatively small amount of connective tissue and vascular elements they contain, it would be difficult to distinguish them by gross appearance. Histological studies now in progress may throw some light on this.

Preliminary histological examination of testes shows active spermatogenesis in material collected on March 25 but progressive regression for April 6 onwards. The mating season, therefore, would appear to last no longer than three weeks.

Miss Mona Blair made histological preparations of reproductive material and Mr. B. A. Mackenzie assisted in its collection.

H. D. Fisher

Appendix No. 79

WHELPING DATES, WEIGHT INCREASE AND PELAGE IN HARP SEAL PUPS ON THE "FRONT", 1953

While weights and pelage conditions have been reported upon previously for the Front (Annual Report of this Station for 1951, Annual Report of Newfoundland Fisheries Research Station for 1952), the following data are given since rates of weight increase appear to vary from year to year, and measurements from a series of years may contribute interesting information.

The March 5 weights given in Table I were from the earliest whelping group encountered by us. It consisted of a very small patch in the lower part of the Strait of Belle Isle, first seen on March 4 when whelping was in progress and none of the pups seemed older than one day.

A large whelping patch was found by the industry's spotting 'plane on March 8 about 50 miles N.E. of Belle Isle. Mr. Karl Karlsen reported from the aircraft that the patch was nine to ten miles by six to seven miles, and that whelping was in an early phase. This patch was found on the same date and almost at the same locality as that found by our survey aircraft in 1951, when whelping also was considered to be barely under way.

Radio reports from ships on the Front to the south of Belle Isle on March 8 indicated that scattered pups being seen there weighed about 30 pounds, which is about the stage that the Strait of Belle Isle pups taken on March 5 would have reached. It thus appears that scattered whelping took place as early as March 4.

Table I Weights in lb. and pelage conditions in pups on the Front, 1953. Sculp weights for the most part are from the same animals weighed entire.

Date	Number weighed	Entire weight	Sculp weight	Sculp wt./ entire wt.	Carcass weight	Condition of pelage
Mar. 5	5	22(15-25)	-	-	-	All white, fast
Mar. 9	13	27(19-39)	11 (8-13)	41%	16	All white, fast
Mar. 10	25	-	13 (5-19)	-	-	All white, fast
Mar. 11	41	-	14 (4-24)	-	-	All white, fast
Mar. 12	24	-	15(10-23)	-	-	All white, fast
Mar. 15	26	-	20(11-27)	-	-	Hair beginning to loosen on some.
Mar. 25	16 entire 4 sculp	73(53-100)	50(43-60)	68%	23	12% white, not fast; 75% ragged; 13% complete moult.
Mar. 26	28	71(40-99)	43(23-63)	61%	28	7% white, not fast; 63% ragged; 30% complete moult.
Apr. 1	12	64(49-80)	39(25-53)	62%	25	100% complete moult.
Apr. 2	22	64(49-88)	39(27-56)	62%	25	100% complete moult.
Apr. 5	44	62(32-91)	37(17-54)	59%	25	100% complete moult.
Apr. 12	16 entire 26 sculp	60(47-67)	35(26-42)	58%	25	100% complete moult.

The whelping patch discovered by the aircraft was entered on March 9, when the pups at the periphery of the patch were judged, from the condition of the umbilical stub and general size, to be two or three days old. Newly-born pups were encountered from time to time, however, up to March 14. These were not confined to any one general area, nor were they scattered randomly. They seemed always to be in definite little groups within the patch in no apparent pattern. We are at a loss at present to explain this phenomenon, although it is quite conceivable that the season of birth as a whole should last at least two weeks. The variation in birth time of groups within the patch accounts for the great range in weights indicated in Table I and for the apparent slow rate of weight increase shown from March 5 to 15, although the presence of ships in the patch apparently hinders normal weight increase (Appendix 77 of the Annual Report for 1951).

The weights recorded from March 25 to April 12 are from a different group of seals, to the southward, from those recorded earlier, so that the two groups may not be strictly comparable. (A large whelping patch was discovered by the industry's spotting aircraft S.E. of the Funks on March 14.) The data on the whole suggest a peak in weight around March 20 when the seals had probably been weaned, and a beginning of the moult (loosening of hair) on March 15, with the moult completed by the end of March. The decrease in weight shown is due, as has been previously pointed out, to initial starvation prior to active feeding by the pup in the water. The weights given are considerably less for all dates than those recorded for similar dates in 1952, although birth dates for 1952 and 1953 apparently were similar.

H. D. Fisher

Appendix No. 80

FOOD HABITS OF HARP SEALS

During March and April, 1953, a total of 242 harp seal stomachs were examined from the M. V. "Theron". The majority of these were empty, but since this fact is of some significance more detailed information is presented in the accompanying table.

On March 14, when Pandalus (carrying eggs) and small bottom fish were found in adult harps, the water temperature from 50 metres to the surface was -1.8°C . The top layers as far as could be ascertained were crystal clear and devoid of much plankton. The seals must have gone to a considerable depth to find food, as the depth in the general area was over 90 fathoms. A few days after this date a phyto-planktonic bloom began to appear in the ice-pack, being very evident by March 28.

The small quantities of amphipods found in beaters on April 1 coincided with the appearance, for two days, of a layer of water at 50 metres with a temperature of -1.45° compared with -1.7° down to 25 metres.

Date	Locality	No. of stomachs	Age group	Remarks
March 10	E. of Belle Isle	3	Adult ♀	No food, a few <u>Contracaecum</u> nematodes.
March 11	E. of Belle Isle	3	Adult ♀	No food, a few <u>Contracaecum</u> nematodes.
March 12	E. of Belle Isle	2	Adult ♀	No food, a few <u>Contracaecum</u> nematodes.
March 14	E. of Cape Bauld	3	Adult ♀	All contained fair quantities shrimp (<u>Pandalus</u> sp.) and a few small bottom fish. Empty.
March 29	E. of Bonavista	6	Pups (beaters)	Empty.
April 1	E. of Bonavista	6	Pups (beaters)	Small quantities of amphipods.
April 2	E. of Bonavista	2	Pups (beaters)	Strips of green seaweed.
April 5	S.E. of Cape Freels	100	Pups (beaters)	Empty except for 1 bird feather.
April 6	S.E. of Cape Freels	20	Pups (beaters)	Empty.
April 8	S.E. of Cape Freels	8	Pups (beaters)	Empty.
April 12	S.E. of Groais Is.	25	Pups (beaters)	Empty.
April 13	N.E. of Groais Is.	1	Adult ♀	Empty.
April 18	Off Cape St. Anthony	6	Beaters	Empty.
		30	Adults	Empty except for fair numbers of <u>Contracaecum</u> nematodes.
		20	Immatures	Empty except for fair numbers of <u>Contracaecum</u> nematodes.
April 20	N.E. of Groais Is.	1	Beater	Filled with small decapods.
April 22	Between Belle Isle and Labrador	6	Immatures	Filled with small decapods.

By the last ten days of April zooplankton was quite evident under the ice in water with a surface temperature of -1.05° and a 50-metre temperature of -1.65° . No zooplankton was collected but it consisted as far as could be seen of scattered ctenophores and many small crustaceans looking like euphausiids ranging from minute to over two inches. The latter constituted available seal food.

During the latter half of June, through arrangements with the provincial fishery officer at Blanc Sablon, 105 stomachs were collected from northward migrants in the Strait of Belle Isle. These were collected chiefly to compare the incidence of Porrocaecum worms with stomachs collected a month and a half earlier last year at the Magdalen Islands. Worm identifications

have not been completed, but it is of interest to note that only 14 stomachs contained food. Of these, two contained small quantities of shrimp (*Pandalus*), and 12 contained small quantities of herring or herring remains, one of these stomachs containing also squid remains.

H. D. Fisher

Appendix No. 81

PELAGE PATTERNS IN THE HARP SEAL

The following table on pelage patterns for samples of the various age groups of harp seals is comprised of data taken chiefly from La Tabatière, 1950 to 1953, but also from the Front in 1953. The data are drawn up bearing in mind that, for example, a 5-year-old seal taken in April, 1953, even though it is in the process of moulting, still bears the pelage pattern it attained in 1952, or upon reaching the age of 4, since the old hair is still present. Explanations of the pelage pattern categories are as follows:

- B = the varied spotted patterns of the bedlamers, chiefly immature.
- BF = bedlamer spotting with a face mask beginning.
- FSB = a very faint beginning of a saddle mark, with spots in the area normally covered by a fully developed saddle.
- FS = a very faint saddle, incompleated posteriorly, with no other marks.
- MS = a "medium" saddle, i.e., light brown and with borders clearly defined over all its shape, and a light brown face mask.
- MSB = a "medium" saddle with darker spots in it, and a light brown face mask.
- S = a dark brown - sometimes almost black - fully developed saddle with a full dark face mask.

New pelage after attaining age of:	No. of specimens	<u>Pelage pattern</u> (no. in each category)							
		B	BF	FSB	FS	MSB	MS	S	
Females:	2	100	100						
	3	50	50						
	4	28	28						
	5	10	6			1		3	
	6	11	4		3	2			2
	7	5	1			1			3
	8	8			1	4		1	2
	9	8				2	1	1	4
	10	7				2	1	1	3
	11	9			1	1			7
	12	2							2
Over 12	7	7							7

New pelage after attaining age of:	No. of specimens	Pelage pattern (no. in each category)						
		B	BF	FSB	FS	MSB	MS	S
Males:								
2	25	25						
3	27	27						
4	2		1					1
5	7							7
6	7	1						6
7	7							7
8	4							4
Over 8	17							17

It thus appears that on the whole the change in the male from the spotted bedlamer marking to a black saddle and face mask takes place quite abruptly at the end of the fourth year, with perhaps some intermediate forms at this stage. Sexual maturity, however, apparently takes place on the whole towards the sixth year, as is suggested by studies of baculum lengths and weights. Histological studies of testes to clarify this picture are not completed.

In the female the change to the saddle and mask is more gradual and may not be attained at all in some individuals. The change moreover apparently does not begin until the end of the fifth year. Full saddle and mask development has not been found by us in females under 6+ years of age, and apparently is not uniformly attained until 12+ years of age. Bedlamer markings, moreover, persist in some females until the eighth year, with several intermediate categories as late as the twelfth year. Sexual maturity takes place chiefly in the fifth and sixth years, so that many females with bedlamer markings are sexually mature and bear young. Since the division of the figures for the catch by vessels into the age categories of "young" (pups), "bedlamers" (immatures) and "old" (adults) is made on the basis of pelage patterns, it would seem that a proportion of the catch listed as "bedlamer" is composed of sexually mature females.

H. D. Fisher

Appendix No. 82

THE EFFECTIVENESS OF METHODS USED TO CONTROL EEL-GRASS ON OYSTER GROUND

Covering with shell, gravel and concrete. All areas treated by these methods remained effectively clear of eel-grass. One series of experiments was set out in 1948 on dense eel-grass-covered bottom at Shippegan, N.B., and consisted of three areas, 10' x 20', covered by: (a) 3" of gravel, (b) 3" of clam shells, (c) concrete slabs 1" thick. The control is still complete and all three plots have produced excellent oysters, many of these having been harvested in the autumn of 1952 after growing there for five summers and four winters.

A larger area located near the P.E.I. Biological Station was covered by oyster shells in 1949 and then enlarged considerably

in 1950. This area also is effectively clear of eel-grass, although there is a heavy growth of mussels on the shells and very few young oysters have been caught naturally.

Covering with tarpaper and sand. This treatment was begun at the P.E.I. Biological Station in 1949 and enlarged in 1950. It consisted of covering the eel-grass with strips of lapped tarpaper which in turn were held down by a heavy coating of sand. This method was effective in eradicating the eel-grass but created a new bottom in which seeds could germinate and thus recolonize the area. The extent of recolonization has been followed both this past summer and in 1952. A selected area, 6 x 23 metres, was searched at low tide and all the plants removed by hand in August of 1952. There were 234 1952 seedlings with an average of one branch each, and 112 older plants with a total of 163 branches. The total density was the low value of five upright shoots per square metre. Half of this same area was covered in August of this year and 116 upright shoots of 1953 seedlings together with 45 shoots of older plants missed the year before were uprooted. This gave an average of 2.3 plants per sq. metre. A detailed study of the encroachment of the older plants from the margin was followed in one corner of the area. The spread is considerable, but irregular.

Benoclor-treated areas. This treatment consisted of spreading evenly over the area sand saturated with Benoclor-3 at a concentration of 1 to 1.1 gal. of Benoclor in 10 pails of sand per 1,000 sq. feet. The treated sand sank to the bottom where the Benoclor came in contact with the eel-grass, killed the growing point and eventually the whole plant. This control is only temporary, since the chemical is gradually dispersed and seeds of later years reach the area from elsewhere, germinate and re-establish plants in the area. All of the areas treated in this way on private and departmental areas during 1950 and 1951 were re-examined to assess the recolonization.

Area	Location	Year	Remarks
A.	Near P.E.I. Biol. Stn.	1950	Cleared an area 30' x 50'.
		1951	Clear except for a few seedlings.
		1952	20 plants/sq.m. (untreated: 214/sq.m.)
		1953	57 plants/sq.m. (untreated: 304/sq.m.)
B.	Near P.E.I. Biol. Stn.	1951	Cleared area 30' x 50'
		1952	9 plants/sq.m. (untreated: 181/sq.m.)
		1953	51 plants/sq.m. (untreated: 158/sq.m.)
C.	Shippegan, N.B.	1950	Completely cleared.
		1951	Apparently still clear.
		1952	Not relocated.
		1953	General covering of about 30 plants/sq.m. whereas untreated: 60 plants/sq.m.
D.	Shippegan Reserve.		In 1951 this large area was treated and showed a continuing partial freedom from eel-grass plants; the areas which were cleared originally have only a relatively small growth of plants recolonizing them. The effectiveness of the original treatment was low because of water currents over the area.

It appears that the duration of effect of the Benoclor treatment is sufficient to warrant its being used for treatment of selected small areas where conditions of current and depth are favourable.

A circular has been prepared on the control of eel-grass in oyster culture areas.

A. R. A. Taylor

Appendix No. 83

THE BIOLOGY AND MORPHOLOGY OF EEL-GRASS

Determinations of density of growth of plants in relation to depth and distance from shore have been made at intervals during the summers since 1948. In "Bideford River", near the P.E.I. Biological Station, the greatest density of growth is 3 to 7 metres short of the shoreward limit, an abrupt decrease in numbers occurs shoreward and a more gradual decrease occurs towards deeper water. It has been found that an extension of occupation of the bottom of about 1 to 1.5 metres has occurred shoreward and a slight, but less regular and more indefinite, extension has occurred into deeper water over the period of study. Vegetative recolonization of bottom cleared of eel-grass in water of very favourable depth and bottom has been seen along the edges of the tarpaper- and sand-covered plot where maximum extension from the margin onto the plot was about 2.3 metres in three years.

Studies of growth of plants as expressed in change in leaf length and width, and in numbers and lengths of internodes of the rhizome were carried out by tagging and measuring plants: (1) in position in the bottom; (2) transplanted into pots sunk in the sea bottom; (3) grown in sea water in constant temperature tanks under artificial light. Some of the results can be summarized briefly. Growth occurs at all seasons of the year and at temperatures ranging from less than 5°C. to temperatures greater than 23°C. (greater than 30°C. for short periods). These results are contrary to those published by Setchell who described a cold rigor at temperatures below 10°C., a heat rigor at temperatures above 20°C., and a recrudescence rigor during periods when the temperature was falling below 20°C.

Seedlings which germinated in May or early June had produced about fifteen leaves by mid-September and ten more leaves were produced from then until late June of the next year. This keeps pace with a similar production of leaves by the mature rhizomes of larger plants.

Detailed anatomical studies have been made showing the development of the seedling structure from the embryo and the development of the mature axis, leaves, branches and roots of the vegetative plant. Studies of the development of the flowering branches are still under way. The time of initiation of flowering-branch primordia seems to be October and November. Dissections of large numbers of stem apices revealed no reproductive primordia

before October.

The complete rubber suit and Aqua-Lung apparatus acquired in September, 1952, proved very useful in these studies. The former helped particularly in that it enabled the investigator to enter the water and examine the plants when the temperature was low, and to remain longer in the water under most circumstances than otherwise could be done. The latter was advantageous in that it made it possible to complete observations and records under water without having to ascend to the surface for air and then to return to the work as had to be done in the past. In this way some work was done which otherwise could not possibly have been done without extreme discomfort, if at all.

A. R. A. Taylor

Appendix No. 84

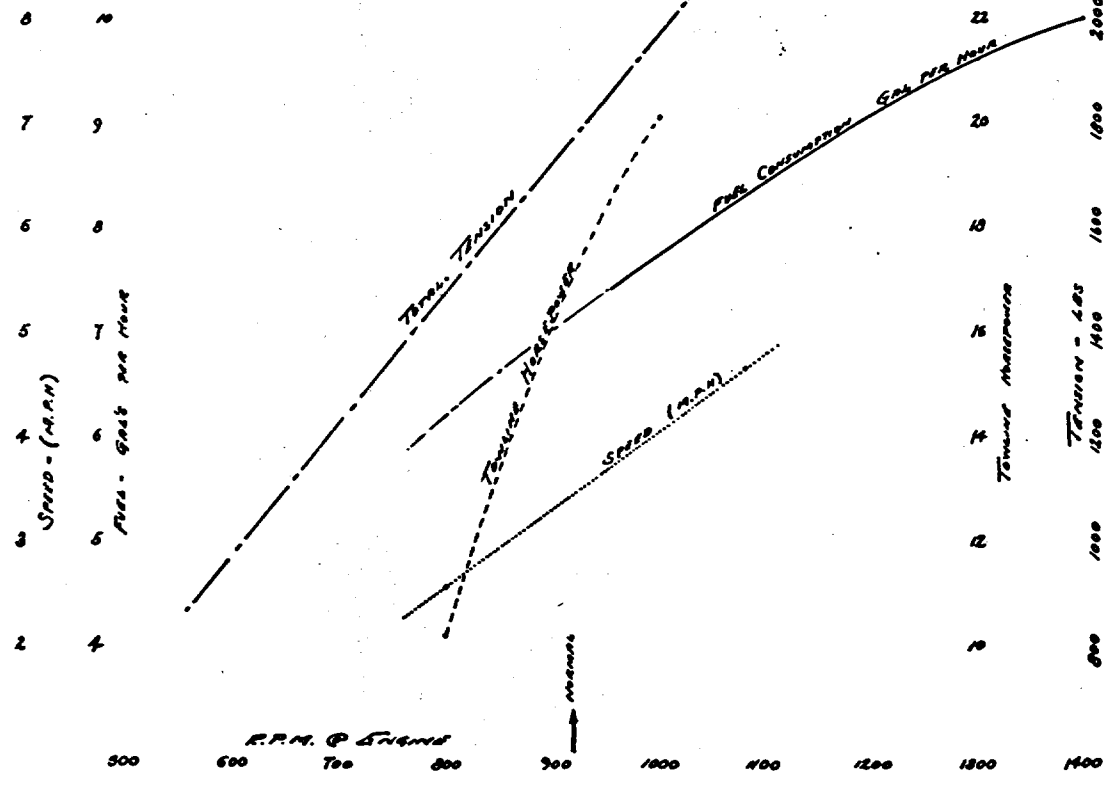
TENSIONS IN TOWING CABLES AND PERFORMANCE OF VESSELS IN DRAGGING

In the last decade there has been a great expansion in the small-dragger fleet of the Atlantic coast. Many small fishing craft have been converted from other methods to dragging; many have been built especially for dragging. Because of lack of knowledge of the pulls required to operate various sizes and types of drags and of the pulls delivered by the many combinations of engine, propeller and hull form, there has been much waste effort and expenditure. To lay the basis for sounder development a study was started in 1953 of two phases: (A) the tensions developed in towing warps when gears of various types are operated at various speeds and under various conditions and (B) the performance of the small vessels, variously designed, powered and equipped, in meeting the requirements of dragging. Both phases involved examination of the operation of a variety of fishing vessels with observations when possible on warp tensions, boat speed, engine R.P.M. and fuel consumption together with records of characteristics of the gear used, boat size and general form, engine and propeller specifications and equipment generally. The sort of information obtained is exemplified in the accompanying figures.

(A) Warp tensions with various towed fishing gears. The objective of this phase is to determine what pulls are required to operate various sizes and types of towed gear so as to indicate what gear can be handled satisfactorily by boats capable of delivering various pulls. Data are being obtained on the relationship of the tensions in towing cables to the characteristics of the gear (size and type of net or drag, area and weight of otter-boards, etc.), to the towing speed and to various other conditions (type of ground, weather conditions, etc.). Tensions were measured by a traction dynamometer and towing speeds by timing the passage of a floating object from bow to stern.

The problems are too complex for generalization on the basis of the preliminary work in 1953 which has, however, given a general picture on which to base further work. Table I and the accompanying graph summarize some of the data obtained on the

7 IRISH PATRIOT - Schoof Dredger
 L-75 B-19.5 D-13
 MURPHY DIESEL - 205 HP @ 1400 RPM
 2-DEEP SEA Schoof Dredge



① SOUIS No. 2
 L-57 B-41 D-49 37-9 Tons
 DISCOO CAT 120 HP @ 1000 RPM
 PROP. 42x36, 25:1 RED & REV GEAR
 DREDGE 75x86 @ 2300 LB.
 NET - 35 YARDS (COTTON)
 30' BRIGLES

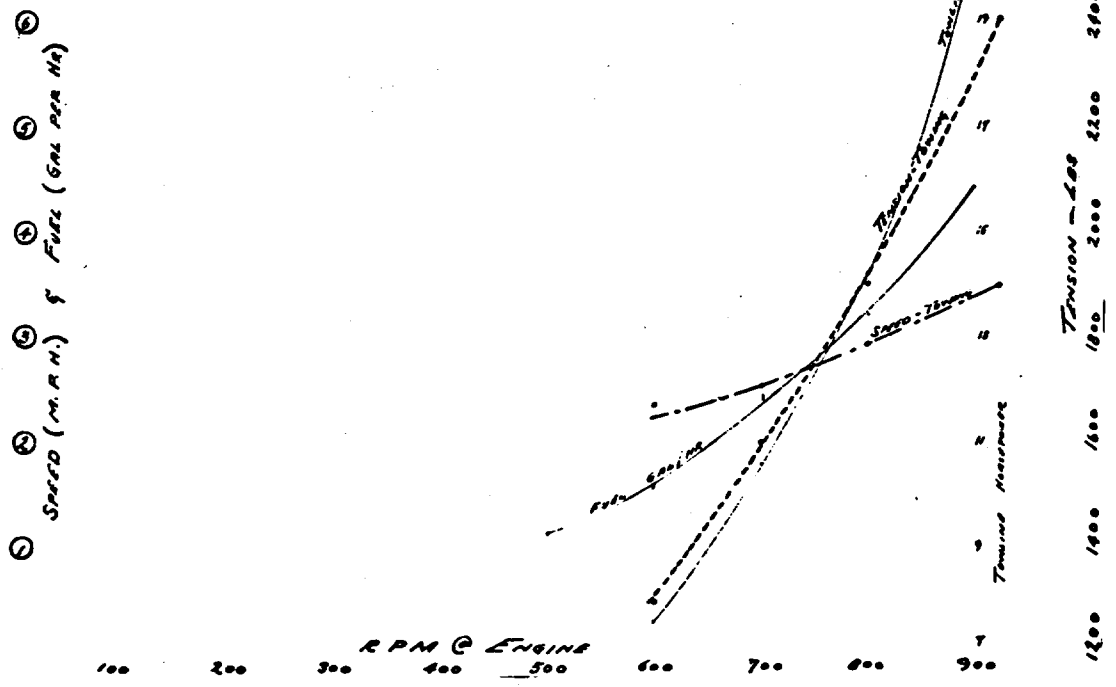
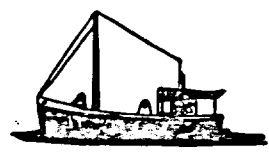


Table I Tension required to pull various gears at the "normal" towing speeds of various boats

Net	Doors	Door area	Weight	Tension	Towing speed
No. 50 flounder drag	54 x 28	1510	100	500	3.4
"	54 x 28	1510	100	400	2.4
"	54 x 28	1510	100	700	
"	60 x 27	1620	100	700	2.4
"	55 x 26	1430	150	500	
No. 60 flounder drag	60 x 30	1800	250	500	2.7
"	66.5 x 31.5	2095	190	1100	5.45
"	60 x 24	1440	150	550	1.7
3/4 - 35	72 x 36	2592	300	2200	4.6
"	65 x 28	1820	200	2100	2.7
7/8 - 35	72 x 38	2736	370	3200	2.9
"	72 x 38	2736	370	2800	2.7
"	55 x 29	1595	200	1600	2.3
No. 35	72 x 36	2592	300	2400	3.5
"	72 x 36	2592	300	2300	2.8
41 - A	9'6" x 4'9"	6498	900	7500	4.1
Iceland	9'6" x 4'9"	6498	1000	8750	3.9
Digby scallop gear (7	31" drags on single bar)			1300	1.8
Deep sea scallop gear (2	separate 11-foot drags)			1780	3.4

tensions in towing warps in relation to towing speed and type of gear. Without attempting a complete analysis, the following points may be mentioned:

(1) The tensions which were measured varied from less than 500 lb. for small flounder drags to almost 9,000 lbs. for an "Iceland" trawl (commonly used by the larger Nova Scotian trawlers).

(2) The data suggest that the area and weight of the otter-boards of "doors" have a marked effect on the tension and emphasize the importance of using doors which, while capable of spreading the net satisfactorily, are not unnecessarily large.

(3) The data already give same basis for selecting the appropriate gear for boats of known towing ability.

(B) Boat performance. Table II summarizes the descriptions of 19 vessels studied and gives some indication of the wide variation and the complexity of the problems of boat performance. The basis is, however, being laid for assessing the ability of boats to handle various types and sizes of gear.

The table makes no mention of fuel consumption which was measured when possible. It was found to differ greatly even between vessels of the same size and towing the same gear. The data indicate that fuel consumptions of engines of different make can differ so greatly as to constitute a major factor in determining the profits of the operation.

SPEEDS & TENSIONS
OF
VARIOUS TOWED GEARS

- A. — ICELAND TRAWL
- B. — NO. 41-A TRAWL
- C. — NO. 35 TRAWL (TWO BOATS)
- D. — NO. 3/4-35 TRAWL (TWO BOATS)
- E. — NO. 1/8-35 TRAWL (TWO BOATS)
- F. — NO. 60 FLOUNDER DRAG (TWO BOATS)
- G. — NO. 50 FLOUNDER DRAG (THREE BOATS)
- H. — SCALLOP DRAGS (DEEP SEA)
- I. — SCALLOP DRAGS (DIGBY TYPE)
- ◆ — NORMAL TOWING CONDITIONS

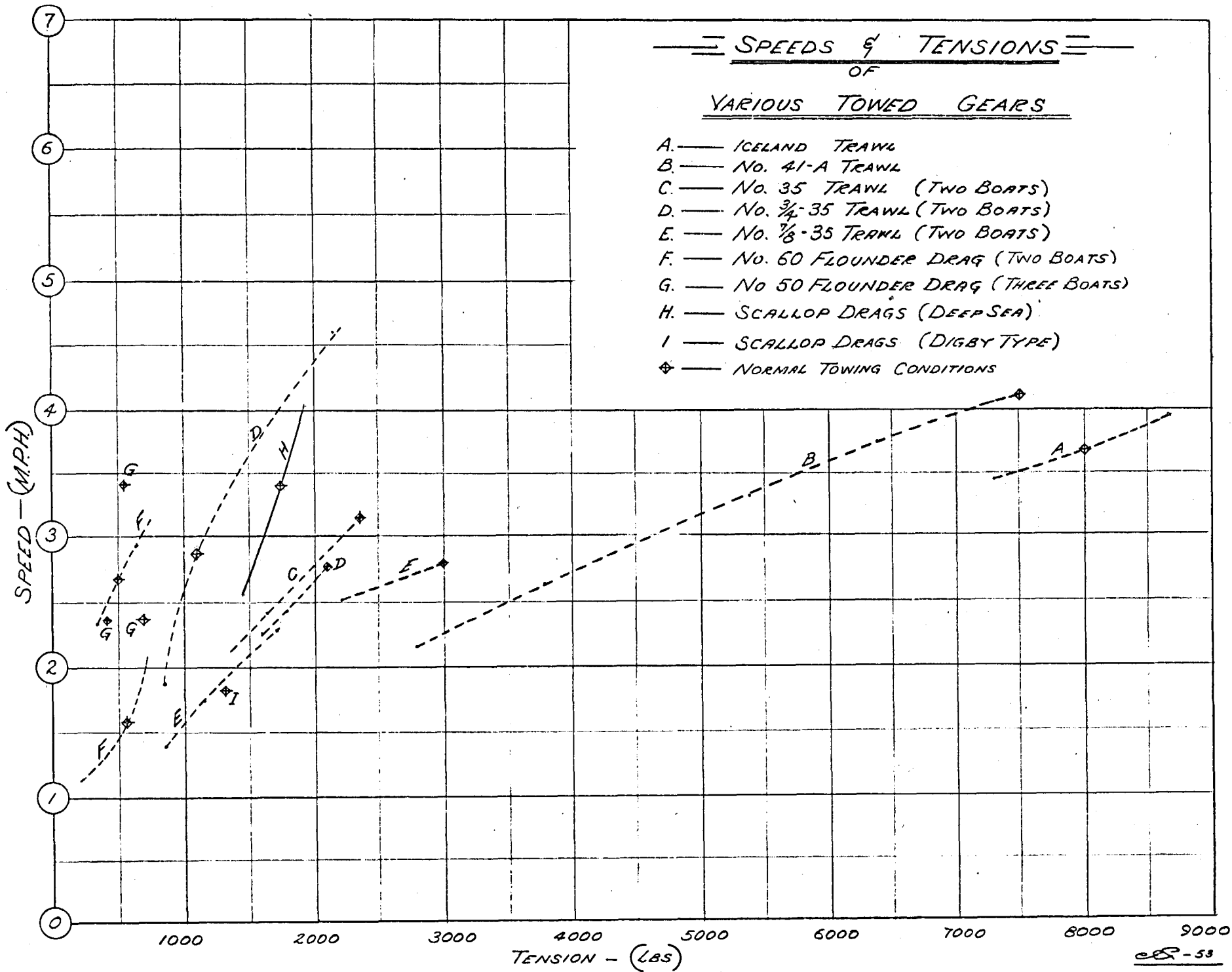


Table II Boat, engine and gear data

	Overall length (feet)	Gear*	Doors		Engine**	Propeller	Red. Gear	Total pull ⁺ both warps (lb.)	Speed ⁺ (m.p.h.)	Slip ⁺ (%)
			Size (inches)	Wt. (lb.)						
1.	132	Iceland	114 x 57	1,000	Bess. 440 D		None	8,750	3.9	
2.	103	No. 41A	114 x 57	850	Atlas 400 D		None	7,500	4.1	
3.	67	No. 3-35	72 x 36	300	Cat. 120 D	51 x 45	3:1	2,200	4.6	72
4.	60	No. 7/8-35	72 x 38	370	Gard. 114 D	48 x 44	3:1	3,200	2.9	75
5.	57	No. 35	72 x 36	300	Cat. 120 D	42 x 36	2.5:1	2,400	3.5	73
6.	60	No. 7/8-35	72 x 38	370	Gard. 114 D	48 x 44	3:1	2,800	2.7	76
7.	57	No. 35	72 x 36	300	GM 170 D	36 x 28	3:1	2,300	2.8	79
8.	50	No. 7/8-35	55 x 29	200	Gard. 76 D	37 x 32	3:1	1,600	2.3	69
9.	49	No. 60	60 x 30	250	Chrys. C. 115 G	28 x 20	3.17:1	500	2.7	76
10.	48.6	No. 3-35	65 x 28		GM 78 D	36 x 24	3:1	2,100	2.75	66
11.	45	No. 60	60 x 24	150	Gray 96 G	22 x 16	2:1	550	1.7	87
12.	42	No. 50	55 x 26	150	Mercury 110 G	24 x 16	3:1	500		
13.	40.8	No. 60	66½ x 31½	190	GMC 130 G	29 x 19	3:1	1,100	5.45	
14.	38'8"	No. 50	60 x 27	100	Ford 97 G	18 x 16		700	2.4	
15.	38	No. 50	54 x 28	100	Chev. 87 G	18 x 16	1.9:1	700		
16.	38	No. 50	54 x 28	100	Chev. 100 G	18 x 18	2:1	560	3.4	76
17.	38	No. 50	54 x 28	100	'46 Chev. truck 95 G	16 x 10	None	400	2.4	
18.	75	Deep sea scallop drag			Murphy 205 D			1,780	3.4	
19.	58	Digby scallop gear			Chrys. M. 140 G	29 x 24	3.17:1	1,300	1.8	83

*Trade names for otter trawls (except last two); #50 and #60 are "flounder drags".

**Bess = Bessemer; Cat. = Caterpillar; Gard. = Gardner; GM = General Motors Diesel; GMC = General Motors gasoline; Chrys. C. = Chrysler car; Chrys. M. = Chrysler marine (8 cyl.); D = diesel; G = gasoline; number shows maker's figures for brake horsepower.

+At "normal" towing speed.

Plans. This investigation can develop in several important directions:

(1) It is planned to discover to what degree the maximum pulls delivered by vessels tied to the wharf indicate their dragging abilities. This will be done by comparing such pulls with those delivered by the vessels when fishing. It is hoped that an easy test of dragging ability can be developed.

(2) The effects of various factors on the tensions required to operate various sorts of drags need to be studied. Such factors include the ratio of the length of the warp to depth, the separate effect of door size and weight, different rigging of nets (length of bridles, type and size of rollers and floats, shape). These are all important and can be studied experimentally.

(3) The performance of various types of boat, engine and equipment is a very complex subject on which information can be obtained only by gradual collection of data over a long period. Progress will depend on the interest and co-operation of the operators of fishing vessels rather than on experimental work of our own.

(4) There is an important field for investigation in the influence of various factors on the efficiency of drags in catching fish. Because of its relation to the capacity of vessels to handle drags properly speed is one of the most important of these factors to study and experimentation is being considered.

C. E. Petite

Appendix No. 85

RECORDS OF UNUSUAL SPECIES FROM THE ATLANTIC COAST, 1953

The following species of invertebrates and fishes have been reported in 1953 and are recorded below along with some belated 1952 records.

Invertebrates

Callinectes sapidus Rathbun. The blue crab.

A male specimen, approximately 18 cm. across the carapace was caught in a lobster trap by Mr. G. A. Snow, Port Maitland, N.S., while doing experimental fishing for the Station. It was brought to the Station alive by Messrs. R. C. Murray and L. G. Kervin. The specimen closely resembles C. sapidus acutidens, which has not been found north of Florida. Mr. R. E. S. Homans has reported two specimens taken early in the year, one of them in St. Margaret Bay, N.S. The blue crab is rarely found in Canadian waters although Piers (Proc. N.S. Inst. Sci. Vol. 15, 1923) recorded 17 specimens from Cow Bay, N.S., and one from Sandford, N.S., just a few miles from the place where the present specimen was taken.

Fishes

Prionace glauca (L.). Great blue shark.

One specimen approximately 5 feet long was taken near Miminegash, P.E.I., during the summer of 1952. Identified and reported by Dr. L. P. Chiasson.

Carcharodon carcharias (L.). Great white shark.

Several specimens seem to have occurred in Maritime waters in the summer of 1953.

- (1) A specimen estimated to be about 12 feet long was responsible for the drowning of two lobster fishermen in the Fourchu area of Cape Breton Island on July 9. The fish was identified from a tooth which had broken off and was found in the smashed dory.
- (2) A specimen was caught by a sport fisherman at Wedgeport, N.S., on July 9 or 10, 1953. A male, approximately 8 feet long. It was examined and teeth submitted by Mr. W. L. Klawe.
- (3) A 15- to 16-foot specimen was caught in the Lunenburg area during the late summer and was exhibited at the Lunenburg Exhibition.
- (4) On August 25 an adult male harbour seal (Phoca vitulina) was shot near Dochet Island in the St. Croix River, N.B. This animal had recently had its hind limb and tail severed, apparently by a shark. The size of the tooth slashes suggested that they were caused by a great white shark.

Cetorhinus maximus (Gunner). Basking shark.

One specimen, reported in newspapers as 12 feet long, taken off Devils Island, N.S., August 27, 1953. Identified by Dr. W. J. Dyer. On September 3, 1953, Mr. H. D. Fisher identified another basking shark, 28½ feet long, which was stranded at Mace's Bay, N.B.

A less definite record was published in a Bridgewater, N.S., newspaper describing a 12-foot shark which was caught off Apple Tree Cove, N.S., in late August, 1953. The description indicates a basking shark.

Dasybatis centroura (Mitchill). Sting ray.

There have been two newspaper reports of the occurrence of this species this year. The first was reported from St. Ann's Bay, Cape Breton, about August 3, 1953.

The second specimen was landed at Upper Cape, N.B., (Northumberland Strait) by a resident of Sackville, N.B., who has been able to provide drawings and a minute description of some

aspects of the animal. The specimen was about 3 feet long. A final opinion from Dr. H. B. Bigelow and Mr. W. C. Schroeder has not been received but the description corresponds closely to that of this species. It has not been recorded north of Cape Cod previously.

Gymnothorax funebris Ranzani. Moray eel.

This specimen, which was mentioned in the 1952 Annual Report, has since been available for examination. Caught at Eastern Passage, Halifax Harbour, N.S., August 30, 1952. Length 169 cm.

Tarpon atlanticus (Cuvier and Valenciennes). Tarpon.

Two specimens, 5 feet 6 inches and 4 feet long respectively, were caught near Sambro, N.S., on August 3 and 4, 1953. Identified by Dr. W. J. Dyer.

Etrumeus sadina (Mitchill). Round herring.

This species was again reported by some Charlotte County, N.B., weir fishermen. Specimens were examined by Fisheries Inspector Richard Ross at a cannery at Fairhaven, N.B., on October 22, 1953.

Notacanthus nasus Bloch. Spiny eel.

A small specimen, 72 cm. long, was forwarded to the Atlantic Biological Station. Along with three other specimens it was caught on Grand Banks (43° 16' N., 51° 20' W.). Caught by the trawler "Fort Louisburg".

Alepisaurus ferox Lowe. Lancet fish.

Three specimens were caught off La Have Bank in depths from 210 to 700 fathoms on August 22, 1953. Caught by Alexander Nickerson of Lockeport, N.S. One specimen, seen and identified by Mr. F. D. McCracken, was approximately 148 cm. long.

Paralepis rissoi bróyeri Lutken. Scaled lancet.

Two specimens, 23 and 25 cm. long, were caught by the "J. J. Cowie" off Fox River, Quebec, in 148 fathoms on June 19, 1953.

Ruvettus pretiosus Cocco. Escolar.

This specimen, 110 cm. long, was mentioned in the 1952 Annual Report and has since been received at the Atlantic Biological Station. Caught by the schooner "Dot and Hellie" near Western Bank (43° 22' N., 60° 32' W.) in 300 fathoms on September 26, 1952.

Monacanthus hispidus (L.). Filefish.

A specimen, 12 cm. long, was caught near Lockeport, N.S., in late August, 1953. Sent in by Mr. W. L. Klawe.

Leptagonus decagonus Bloch and Schneider. Northern alligatorfish.

Two specimens were taken in 1953 and a dried specimen collected in 1952 has been turned in. They were caught as follows:

- (1) Orphan Bank (?). Late August, 1952, by the dragger "Little Gaspé". Length approximately 20 cm. Specimen broken.
- (2) Off Fox River, Quebec, in 160 fathoms on October 20, 1953, by the "J. J. Cowie". Length 20 cm.
- (3) Off Margaree, N.S., summer of 1953, by the trawler "Marion Crouse". Length 13 cm.

Careproctus longipinnis Burke. Sea tadpole.

One specimen, 14 cm. long, was taken off English Point, near Rimouski, Quebec, in 110 fathoms, on June 25, 1953, by the "J. J. Cowie".

Lycodes vahli maculatus Vladykov. Vahl's eelpout.

A specimen, 29 cm. long, was caught by the "J. J. Cowie" in 107 fathoms off Fame Point, Quebec, on June 18, 1953. Another specimen was taken by the same vessel near the mouth of the Saguenay River on July 22, 1953.

Gymnelis viridis Fabricius. (?)

Two small, badly-mutilated specimens were caught by the "J. J. Cowie" off Rimouski, Quebec, on July 21, 1953. They were approximately 10 cm. in length.

Enchelyopus cimbrius L. Four-bearded rockling.

Two specimens were taken by the "J. J. Cowie":

- (1) In 100 fathoms off Fame Point, Quebec, June 18, 1953. Length 14 cm.
- (2) In 10⁴ fathoms near the mouth of the Saguenay River, July 22, 1953. Length 21 cm.

Macrourus bairdi Goode and Bean. Grenadier.

One specimen, 26 cm. in length, was caught by the "J. J. Cowie" in 100 fathoms off Fame Point, Quebec, on June 18, 1953.

Tautogolabrus adspersus Walbaum. Cunner.

A male specimen, 44 cm. in length and weighing 3 1/4 pounds, was caught on hook and line off Head Harbour Light, Campobello Island, N.B., on September 9, 1953. This is an exceptionally large specimen.

In addition the following species have been reported and will be available later for identification:

Balistes vetula L. - Queen triggerfish. Banks off Nova Scotia.
Lactophrys trigonus (L.). - Common trunkfish. Banks off Nova Scotia.
Lopholatilus chamaeleonticeps Goode and Bean. Tilefish

Caught on June 2, 1953, in 78 fathoms between La Have and Emerald Banks. The description and drawings submitted by Mr. Murray Fraser make this identification practically certain. The specimen was about 75 cm. long.

A. H. Leim
L. R. Day

Appendix No. 86

ANNUAL REPORT, ATLANTIC OCEANOGRAPHIC GROUP*

Introduction

1. The Atlantic Oceanographic Group, under the Canadian Joint Committee on Oceanography, has been responsible since its inception for the furthering of oceanographic activities on the Atlantic coast. During the coming year, as a result of discussions dealing with the requirements in Arctic oceanography, the Group will take on added responsibilities for a program in physical and chemical oceanography in the Eastern Arctic.

2. The program of physical and chemical oceanography now carried out by the Group is based on meeting the requirements of the Fisheries Research Board of Canada and the Royal Canadian Navy. Basically, both are interested in a broad knowledge of the physical and chemical nature of our waters, and both have specific problems related to contained areas. To fulfill these requirements, the program of oceanographic studies is designed to build up a reference library of information to meet any inquiries that develop, and to deal with the fundamentals of the problems that arise.

3. To fulfill the requirements, there is a pooling of ships, personnel, and equipment between the Fisheries Research Board of Canada and the Royal Canadian Navy, and also excellent co-operative ventures among the Atlantic Oceanographic Group, the Atlantic Biological Station, the Newfoundland Fisheries Research Station, the Hydrographic Service, the Naval Research Establishment, the Quebec Marine Biological Station, the Eastern Arctic Investigations of the Fisheries Research Board, and the Nova Scotia Centre for Geological Sciences. On an international basis, co-operation is maintained with the Woods Hole Oceanographic Institution and the U.S. Hydrographic Service, wherein there is an exchange of data collected in waters of common interest.

* Slightly abbreviated and re-arranged by the Director.

Personnel

4. During the past year the staff of the Atlantic Oceanographic Group consisted of the following:

Dr. H. B. Hachey	Oceanographer-in-Charge
*Dr. L. Lauzier	Oceanographer
Mr. H. J. McLellan	Associate Oceanographer
Mr. W. B. Bailey	Assistant Oceanographer
Mr. R. W. Trites	Junior Oceanographer (Seconded P.O.G.)
Mr. J. A. Sullivan	Assistant Technician III
Mr. G. B. Taylor	Assistant Technician II
Mr. J. H. Hull	Assistant Technician II
Mr. C. C. Cunningham	Assistant Technician II
Mrs. M. M. Irwin (M. M. Meating)	Stenographer 2B
Professor D. G. MacGregor	Associate Oceanographer (Seasonal)

5. Mr. R. W. Trites, shown as seconded to P.O.G., is continuing his graduate work at the Oceanographic Institute of U.B.C. It is expected that he will return to A.O.G. in October, 1954.

6. Professor D. G. MacGregor of Mount Allison University was again employed on a seasonal basis. His chief work was concerned with an analysis of water conditions in the Strait of Canso, an area that is of particular oceanographic interest due to the construction of the Canso Causeway.

General Program 1953

7. The program of the Atlantic Oceanographic Group was, as in former years, chiefly concerned with the seasonal cruises over waters contiguous to the Atlantic coast. This program was curtailed to some extent this year due to an extensive refit to the oceanographic ship, the C.N.A.V. "Sackville". As a result only the late summer and fall cruises were completed.

8. An extended cruise of the "slope water" regime was carried out, but was not as extensive as planned owing to an outbreak of "polio" on the ship.

9. Initiating a detailed study of the fundamentals of the Gaspé Current, the late summer cruise was extended into the estuary of the St. Lawrence River as far as the Saguenay.

10. Expanding our investigations of Bay of Fundy waters, under a program designed to complete seasonal cruises of the whole bay, with extensions to cover contiguous areas, a spring cruise consisting of five sections was completed in April when the land

* Member of Atlantic Biological Station staff working with the Group under instruction from the Director.

drainage was near maximum. To study the changes occurring during a tidal cycle, one section across the mouth of the bay was occupied five times in a sequence of tidal stages.

11. Continued observations of water conditions at selected coastal points permit a close check on changing water conditions. The continuity of these observations at representative points over a period of years (as many as thirty years in one case) has resulted in a body of data from which significant conclusions can be drawn in relation to the changing conditions from year to year. Normal conditions for representative areas have been assessed, and the departures from the normal have proven to be of considerable interest in relation to the problems of the fisheries. Our program consists of the taking of surface water temperatures twice daily at five selected stations, surface and bottom temperatures twice daily at one station, bathythermograph lowerings twice daily at one station, serial observations of temperature and salinity at one station twice per month and at another station monthly.

Associated Programs

12. During the past year the Atlantic Biological Station has carried out investigations relative to the herring, redfish, lobster larvae and scallop in which the water temperature conditions are of some concern. During the period of the investigations the water temperature conditions were assessed by means of bathythermograph observations, and the Atlantic Oceanographic Group will be involved in the analysis of these data.

13. The program of the Marine Biological Station of the Province of Quebec involving surveys of the waters around the Gaspé peninsula, from the Bay of Chaleur to the North Shore of the Gulf of St. Lawrence, is closely associated with our seasonal program in the Gulf of St. Lawrence. Contacts are maintained chiefly through an annual discussion of programs.

14. The Canadian Hydrographic Service carried out a program of oceanographic observations while proceeding to and from the survey areas. Six major ships took part in this program in 1953, operating in areas ranging from the Gulf of St. Lawrence to Hudson Strait. In addition, the launch "Henry Hudson" continued auxiliary oceanographic observations in the Strait of Canso and in the regions of Georges Bay and Chedabucto Bay, while carrying out projects of the Tide and Current Survey. The oceanographic data are turned over to the Atlantic Oceanographic Group for processing.

15. The Naval Research Establishment maintains bathythermographs on the Lurcher Lightship and processes the records received. Several oceanographic cruises of the waters of the Halifax Approaches were made. Close liaison is maintained between N.R.E. and A.O.G.

16. In the past years, in co-operation with the Nova Scotia Centre for Geological Sciences, we have been investigating some of the features of the sea floor in the Gulf of St. Lawrence in relation to the geology of the neighbouring land bodies. The data of 1952 have not been analysed due to the prolonged illness

of the geologist responsible for the work. Interest is developing in certain geophysical problems related to ocean areas through activities of the Nova Scotia Research Foundation and the Dominion Observatory. Tentative plans for 1954 have been discussed, in part involving a symposium on the subject "Geology and its Oceanographic Aspects", and in part a seismic survey of the Sable Island Area.

17. The Newfoundland Fisheries Research Station of the Fisheries Research Board carries out an oceanographic program in conjunction with experimental fishing. In 1953 two major cruises of the Grand Banks were made and the waters of the Labrador current were explored from Labrador to the Grand Banks. These data, in addition to those collected by the International Ice Patrol, the Canadian Hydrographic Service, and the Eastern Arctic Investigations of the Fisheries Research Board, are our main sources of information from such areas.

18. The lack of an oceanographic vessel, as a result of the extended refit to the C.N.A.V. "Sackville", presented an excellent opportunity of assessing a large body of data that has been accumulating from the various general programs. As a result several reports have been issued, and work has progressed on several others.

The accumulated temperature data for the waters of the Scotian Shelf have now been processed for years up to 1952 inclusive, and the diagrams have been completed to show the distributions for all seasons. The reports have been circulated to the various organizations co-operating under the Joint Committee. The present analyses of these data, as covered in these recent reports, are designed chiefly to give further detail to our general knowledge of these waters. The general trends from season to season and from year to year may be followed in some detail, and at times major changes are found to be of considerable significance.

19. Diagrams were also prepared illustrating the distribution of bottom temperatures over the Scotian Shelf for various seasons of the year. While these charts of bottom temperature have been prepared chiefly for their interest to groundfish investigations, they have been in demand, and have been of value in planning the position of new Atlantic cables. It has been shown that bottom temperatures range from less than 0.0° to greater than 15.0° C., and that the typical three-layer stratification of the waters of the Scotian Shelf, and the influence of the slope water and of cold waters to the east, make bottom temperature a complicated function of depth and location. Maximum bottom temperatures have been observed to be as much as two degrees higher than those recorded over the area in pre-war years. This is of significance in showing that in recent years slope water has exerted a much greater influence on the bottom-water temperatures of the Scotian Shelf. It is of interest to note that slope water incursions show their greatest influence around Emerald, La Have, and the western part of Sable Island Banks. This is related to the configuration of the bottom, wherein a submarine channel of 75 fathoms leads into the deeper area of the Shelf, now generally referred to as the Scotian Gulf.

20. The trend of water temperatures over the areas contiguous to the Atlantic coast are closely followed from regular observations at selected and representative areas. A general warming of the waters has taken place during the last thirteen years, the period 1949-1953 being recognized as the warmest quinquenniad on record with peak temperatures occurring, in general, in 1951. The peak temperatures were equalled or closely approximated in 1953, particularly in the early months of the year. The late fall observations show a considerable abatement towards lower temperatures.

21. The band of water lying between the Gulf Stream and the coastal waters off the Scotian Shelf is known as slope water. It has been shown that this slope water, through mixing with coastal waters, and through incursions in considerable mass, has a very far-reaching influence on the nature of the waters over the Scotian Shelf. Observations of the slope water are made regularly during seasonal cruises, and a number of special cruises have been made to clarify the nature and behaviour of this water mass. There is convincing evidence that the slope water is the region of origin of easterly flowing currents paralleling the Gulf Stream. From current determinations and considerations of continuity, it seems reasonable that such currents of the order of one knot should exist.

22. The Bay of Islands, on the west coast of Newfoundland, presents an area close at hand which approximates a fiord with a threshold separating the deep waters from those of the Gulf of St. Lawrence. The waters of this area have been studied in considerable detail, chiefly in relation to the distribution of herring. A report has been issued dealing with the general properties of the water mass, the seasonal and annual variations of temperature and salinity, and observations that were indicative of internal waves.

23. Analysis of data from the Bay of Fundy has been given considerable attention. One section across the mouth of the bay has been occupied on ten occasions during the period 1950 to 1952, and the variations that have been observed in temperature and salinity characteristics have been used to illustrate the influences of tidal mixing, vernal warming, continental drainage, autumnal cooling, and winter chilling as they combine from time to time to determine the hydrographic conditions. A comparison of 1952 observations with those for 1950 and 1951 for the winter, summer, and autumn months, shows that, in general, conditions were similar to those in the previous years except for November, 1952, when salinities indicated large-scale replacements of the waters in the bay. These observations in November, 1952, are of considerable significance. The occupation of the section in November followed one made about three weeks earlier, and the contrast in conditions indicated that the waters of the Bay of Fundy had seemingly been completely replaced in the three-week interval. The result is rather startling, as in previous thinking of the replacement of these waters it has been customary to think of a somewhat slower process. It must be remembered that this wholesale replacement was observed when the dynamic stability was quite low. Comparing the deeper water temperatures and salinities as observed at the mouth of the bay in recent years with those of

1916-18, it has been found that the temperatures of recent years are about three degrees warmer, and the corresponding salinities are approximately 0.5‰ higher. Observations of temperatures and salinities made in the outer Quoddy region of the Bay of Fundy on a monthly basis since 1924 have been subjected to a detailed analysis, and the characteristics of a surface, intermediate, and bottom layer have been outlined. Normal conditions have been determined to which the annual departures can be related.

24. Some interesting theoretical considerations have arisen relative to the effects of the closing of the Strait of Canso by a causeway and lock. The possible effects on water conditions, currents, tides, and marine life generally are being considered by the Group and the Canadian Hydrographic Service. Observations were made at a series of seven stations in the Strait during each of thirteen passages between May and November, 1953. In addition, the Hydrographic Service made extensive observations on the temperature structure at selected points. Paired passages at different stages of the tide show evidence of tidal displacement of the complete body of water of from 3 to 10 miles. Vigorous mixing and consequent homogeneity characterize the central portion of the Strait at all seasons. Densities are generally lower at the Gulf of St. Lawrence end than at the Atlantic end, and both isotherms and isohalines slope downward from south to north. This would indicate a southward flow of water from the Gulf of St. Lawrence in the surface layers, and a compensating flow of deeper waters towards the north. Such a surface flow is in agreement with the consistently longer periods of southward flow given in the tables for tidal currents in the Strait of Canso.

General Liaison

25. Liaison was maintained with all institutions having an interest in oceanographic problems of the Western North Atlantic.

26. The Oceanographer-in-Charge has been associated with fishery biologists in giving attention to hydrographic matters pertaining to the convention area of the International Commission for the Northwest Atlantic Fisheries. In this connection he attended sub-committee meetings at St. Andrews, N.B., and Woods Hole, Massachusetts, as well as Panel meetings at Copenhagen, Denmark. Also attended was the Copenhagen meeting of the International Council for the Exploration of the Sea.

27. Dr. Lauzier, whose prime responsibility is in liaison duties between the Atlantic Biological Station and the Group, is also associated with the Quebec Department of Fisheries in monitoring the oceanographic programs of the Marine Biological Station at Grand River, P.Q.

28. Mr. Bailey is responsible for field liaison with the working parties of the Canadian Hydrographic Service, visiting the ships before departures and arranging for the collection of oceanographic data.

29. Liaison with the Naval Research Establishment is chiefly the responsibility of the Oceanographer-in-Charge with the assistance of Mr. McLellan.

30. International liaison is maintained by the oceanographer-in-charge. Messrs. McLellan and Bailey have both paid visits to the Woods Hole Oceanographic Institution during the past year, as has the oceanographer-in-charge.

31. Copies of all BT records were supplied to the Woods Hole Oceanographic Institution and the U. S. Hydrographic Office. The Naval Research Establishment at Halifax, N.S., makes extensive use of our records, and the above-mentioned organizations continue to supply us with copies of their records made in areas of common interest.

32. Water temperatures from St. Andrews, N.B., and Entry Island, P.Q., were supplied daily to the Meteorological Service of Canada. Recently, too, they have been supplied with copies of our summarized monthly data on surface water temperatures.

33. In connection with the laying of new transatlantic cable, we have had inquiries from the Canadian Overseas Telecommunication Corporation relative to bottom-water temperatures on the Grand Banks and the Scotian Shelf. The temperature effects on the balanced circuits required for modern transmission methods in underwater cables cause some concern. The data furnished will allow the best assessment of the location of the new cables.

34. The mining developments in northern New Brunswick have brought about inquiries on harbour facilities and ice conditions in the northwestern area of the Gulf of St. Lawrence. Our ability to deal with inquiries on ice conditions is due to the excellent records supplied by the Ice Distribution Survey made under the Geographic Branch of the Department of Mines and Technical Surveys.

35. Assessments of specific areas have been made to meet the requirements of the Royal Canadian Navy.

36. Specific data on Canadian waters were supplied to the Boothbay Harbour Research Station and McGill University.

37. The following meetings were attended by the Oceanographer-in-Charge:

- (a) On Arctic Oceanography, called by the Defence Research Board (2 meetings), Ottawa, Ontario.
- (b) Associate Committee on Geodesy and Geophysics of the National Research Council (2 meetings), Ottawa, Ontario.
- (c) Committee on the Geophysical Year called by the National Research Council (2 meetings), Ottawa, Ontario.
- (d) Committee on Oceanography of the Royal Society of Canada, London, Ontario.

38. A series of papers on oceanography was presented before an Oceanographic Session of the Royal Society of Canada. Two papers originated from the Atlantic Oceanographic Group, in one case associated with the Canadian Hydrographic Service as follows:

- (a) Wind Currents and Dominant Surface Flow at Sambro Lightship. By H. B. Hachey and N. O. Fothergill.
- (b) The Easterly Flow of Slope Water south of the Grand Banks. By H. J. McLellan.

Publications

Papers and Manuscript Reports from the Group are included in the general list of publications earlier in this Report.

The following summary reports have been distributed by the Group:

- (a) Seasonal Cruises. H. J. McLellan and L. Lauzier
- (b) Studies of the Slope Water off the Scotian Shelf. H. J. McLellan
- (c) The Wind Currents and Dominant Surface Flow at Sambro Lightship. H. B. Hachey and N. O. Fothergill
- (d) Recent Surface Water Temperatures. L. Lauzier
- (e) Bottom Temperatures on the Scotian Shelf. H. J. McLellan
- (f) Annual Variations of Temperature and Salinity in the Bay of Fundy. W. B. Bailey, D. G. MacGregor and H. B. Hachey
- (g) Hydrographical Features of the Waters of the Bay of Islands, Newfoundland, in the Autumn. L. Lauzier
- (h) A Survey of Water Conditions in the Grand Manan Channel in April, 1952. H. J. McLellan
- (i) Water Conditions in the Strait of Canso. D. G. MacGregor and H. J. McLellan
- (j) Temperature Conditions around Prince Edward Island in 1952. L. Lauzier
- (k) BT Surveys related to Specific Biological and Fisheries Problems. L. Lauzier
- (l) A Spring Survey of the Bay of Fundy. W. B. Bailey
- (m) Seasonal Variations in the Hydrographic Conditions of the Bay of Fundy. W. B. Bailey
- (n) Oceanographic Observations by the Marine Biological Station (Quebec). L. Lauzier
- (o) Oceanographic Observations by Canadian Hydrographic Service Vessels. W. B. Bailey
- (p) Oceanographic Data Supplied by Other Agencies. W. B. Bailey

H. B. Hachey