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1952

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FISHERIES RESEARCH BOARD OF CANADA

REPORT

of the

ATLANTIC BIOLOGICAL STATION

for

1952

by

A. W. H. NEEDLER, Director

With Investigators' Summaries as Appendices



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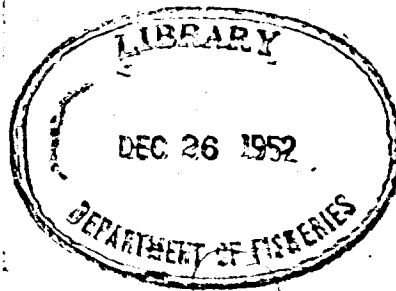
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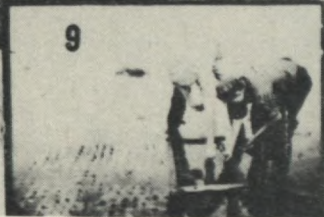
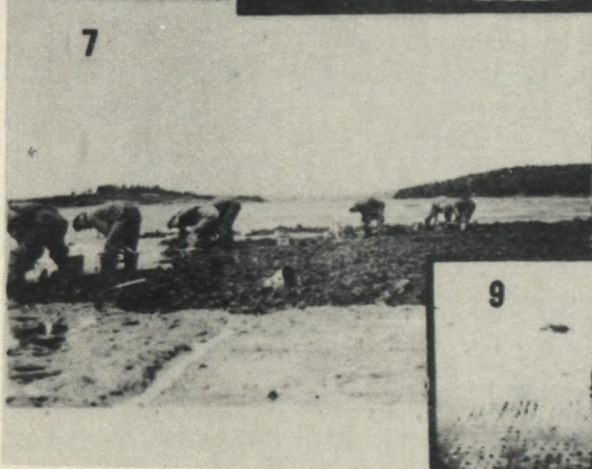
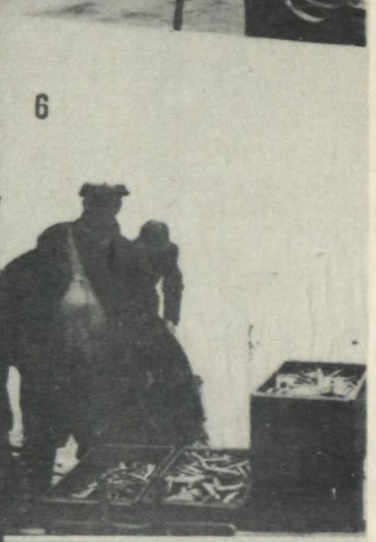
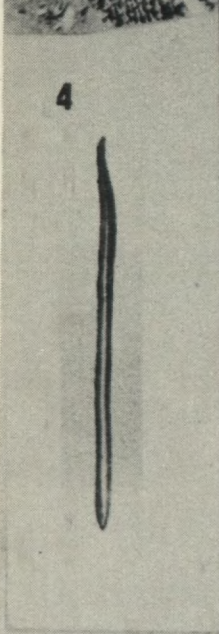
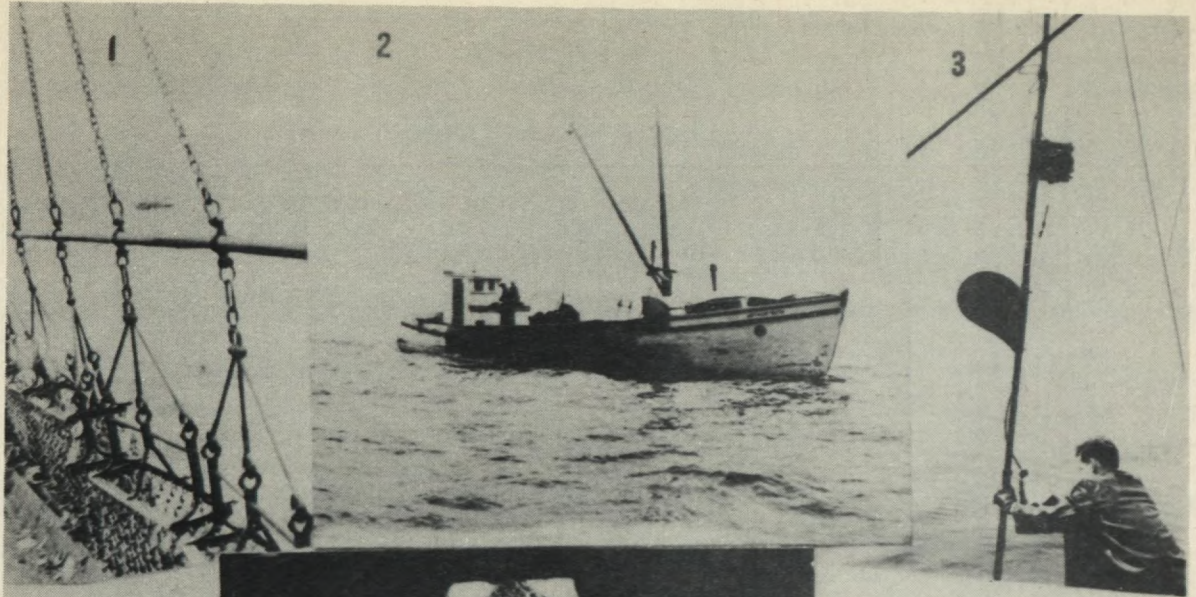


With Investigators' Summaries as Appendices

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## Features of Shellfish Investigations

1. Hauling scallop "savings gear" in experiments off Digby, N. S. These drags have large mesh that permits the escape of small scallops.
2. Exploring for new scallop beds in the Gulf of St. Lawrence with a chartered Digby scallop dragger.
3. Adjusting submarine camera for photographing a Digby scallop bed 50 fathoms down, to discover abundance of scallops.
4. A new industry. Blood worms dug in Yarmouth County, N. S., and shipped air freight to New England are used as bait in the salt-water sports fishery.
5. Four valuable Canadian east coast shellfish: scallop (a "tagged" specimen), razor clam, soft-shelled clam (bored by clam drill) and bar clam.
6. A tide's catch of razor clams on the beach at St. Mary Bay, N. S. - a new industry.
7. "Systematic" digging of experimental plots, Halifax County, N. S. All the ground is turned to measure yields of soft-shelled clams per unit area of beach.
8. "Random" digging of flats in Charlotte County, N. B. This is the industrial way of harvesting soft-shelled clams. Diggers work wherever and whenever they choose.
9. Planting "seed clams" 16 per square foot to measure growth rate and survival of soft-shelled clams, Musquodoboit Harbour, N. S.



## Features of Shellfish Investigations

1. Many productive areas are closed to clam fishing because the shellfish harbour paralytic poison or are contaminated by sewage. Means of using them without risk to public health are being devised.
2. Sampling sewage-contaminated clams that are cleansing themselves in an experimental floating car in clean water near St. Andrews, N. B. Industrial application is expected.
3. A one-celled plant, Gonyaulax (magnified 1,000 times), appears in late summer in some waters and is eaten by bivalves. It contains paralytic poison which the shellfish extract and store for a time. Investigation has shown that all affected stocks of soft-shelled clams can be used by fishing at appropriate seasons.
4. Towers of castings on the beach in Musquodoboit Harbour, N. S., mark the burrow-mouths of lug worms which are used as fish bait in Europe. A search has so far discovered no worthwhile concentrations on this coast.
5. Planting seed clams by broadcasting, during clam farming trials in Musquodoboit Harbour, N. S.
6. Bar-clam fishing with a Long Island, N. Y., type of hydraulic dredge from M/B "Mactra S." in Miramichi Bay, N. B. Catches in the Gulf of St. Lawrence are too small to justify the costly operation.
7. Commercial scallop fishing with a lobster boat on the Richibucto bed discovered in our Gulf of St. Lawrence explorations. The type of drag used is that which we recommended for small boats after fishing trials with several types of inexpensive light gear.
8. The boring sponge eats into shells of scallops, and shrinks and darkens their meats.
9. By washing and screening the beach soil which diggers have turned we recover the soft-shelled clams they miss and get estimates of the proportions of clams removed or killed by fishing.
10. Gull "puddles" on sandy beaches show where the birds have fed on seed clams which they wash from the soil by churning it with their webbed feet.
11. Starfish are serious enemies of scallops and outnumber them in some catches.
12. Clam drills (a kind of snail) bore holes in shellfish and clean out the meat with their long snouts (see soft-shelled clam shell in frontispiece).

DEPARTMENT OF FISHERIES

# WARNING

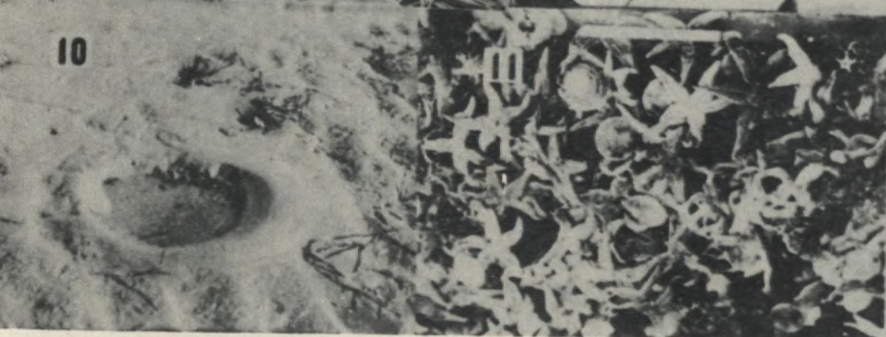
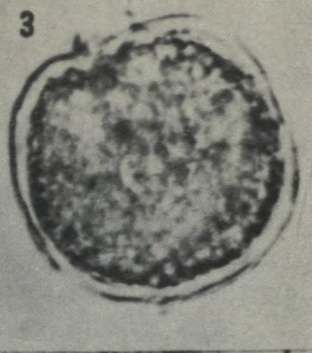
SHELLFISH AREA CLOSED

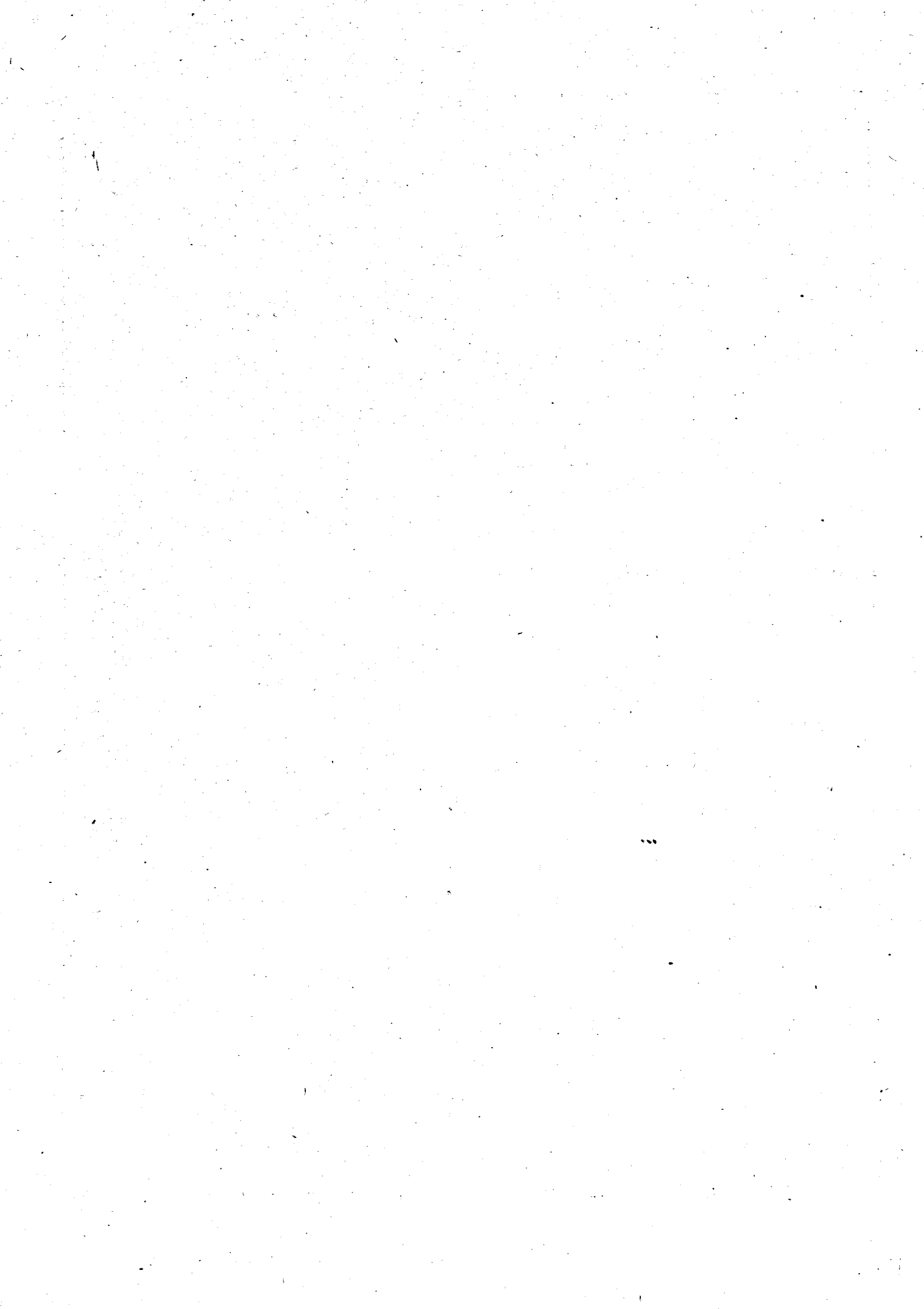
As the Department of National Health and Welfare has determined that clams taken from this area are affected with paralytic poison, this area is closed for the taking of clams except for use as bait or for treatment by the canning process; and is closed for the taking of mussels for human consumption.

Notice Posted

STEWART BATES  
District Inspector

ANYONE FOUND GUILTY OF VIOLATING THIS POSTER WILL BE PROSECUTED





REPORT FOR 1952 OF THE  
ATLANTIC BIOLOGICAL STATION, ST. ANDREWS, N. B.

By A. W. H. Needler, Director

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The ultimate aim of the fisheries biologist is to discover how to exploit the fisheries resource to the fullest possible advantage of our society, being closely allied in this endeavour with the economist, the administrator and the industry. With human populations increasing more rapidly than their supplies of animal protein, there can be little doubt of the long-term need for increased production. The problem itself, however, is complex and has not only scientific but also administrative and economic aspects, all three being inseparable. The Station in its work is therefore closely associated with various branches of the fisheries administration and of the industry. Its work should be judged only as part of a joint attack on the fisheries problem as a whole.

The need is to learn how to get more or better fish economically. As most branches of our fisheries are underdeveloped, emphasis is needed on improvement of production and capture rather than on restriction of fishing to protect the long-term yield. In a very few cases we can so alter the conditions under which fish grow as to increase their abundance in a manner akin to farming. More often we must learn how to find fish better by exploring for new species or stocks and discovering more about the occurrence and movements of all valuable kinds. We must also learn how to catch fish more efficiently by studying the operation of kinds of gear new or familiar, and by learning how successful catching is influenced by the activities of the fish. In a very few cases there is evidence that restriction might improve long-term yield and intensive critical work is needed to lay the basis for restricting only those fisheries of which this is true. We must also learn how to improve quality, protect public health and help the holding and transport of species marketed alive. Work on all these biological aspects of the problem of fisheries development is included in the Station's program.

Positive cultural measures. The cases in which the production of fish or shellfish can be increased by positive cultural or "farming" measures speak for themselves. They are limited to fresh waters and inshore areas where some control of the environment is possible. Successes have been achieved in oyster farming, an industry having been established on the basis of our findings. Successes are emerging in the cases of trout, salmon and smelt. Investigations of soft-shelled clam farming have failed to confirm prospects for success based on supposed profitable operations elsewhere. Investigations are proceeding actively on positive measures to produce oysters, salmon and trout, but are coming to an end in the case of clams and smelt.

Exploration. To explore the fisheries resources of our waters is a slow and difficult task with our limited boats and personnel. It has been shown, however, that efforts in this direction can pay well. The Station's explorations led to the establishment of new flounder and scallop fisheries. They have played an important part in the establishment of the Irish moss industry and the expansion of the clam industry, starting small bait-worm and razor-clam fisheries to supplement the latter. It has been shown that fat herring can be caught in good quantities in the Gulf of St. Lawrence over a four-month season. On the other hand, explorations failed to reveal good commercial quantities of shrimps or bar-clams. Explorations are continuing actively for herring (off the outer coast of Nova Scotia), groundfish (for small draggers) and other species.

Search for commercially valuable fish stocks can be successful only if it is supported by knowledge of the physical environment and of the habits of the fish. It depends on the current and accumulated results of investigations on hydrography and on the lives and activities of the valuable species.

Fishing methods. The fishing industry of the Canadian Atlantic coast has much to learn of fishing methods, old and new, and improvement in catching efficiency is important to its successful competition with other fisheries and, indeed, food industries. The Station has helped to meet this need by testing and demonstrating fishing gears developed elsewhere and by attempting to develop still further improvements in techniques.

The introduction of outside methods has met with varied success as should be expected in view of the diversity of conditions for fishing. The Station played an important part in the introduction of long-lining with powered haulers in Nova Scotia and in initiating its later extension to Newfoundland -- a development of the greatest importance to small-vessel fishing. Danish seining was found to have limited applicability, because it needs such smooth bottom, but has proved its commercial worth on a small scale in Chedabucto Bay. The widespread flounder dragging by the Station's small boats stimulated the adoption of this method by inshore fishermen. Demonstration of the value of sonic sounders led to their general adoption in sardine seining in the Bay of Fundy. The effectiveness of the deep drift-nets used in the North Sea has been demonstrated in herring fishing in the Gulf of St. Lawrence but costs appear too high for present price structure. Experiments on the use of special trawls for herring are still proceeding but have already led to the catching of sardines on the bottom in day-time with modified groundfish drags. Gill-netting for groundfish, using powered haulers and modified Great Lakes techniques, was tried but found unpromising.

Improvement of fishing techniques depends ultimately on knowledge of how the gear works and how the fish act. The influence of light on the vertical movement of herring and other pelagic fishes is an important factor and is being studied. Pelagic trawls are in an early stage of development as commercial fishing gear and the Station is co-operating in testing

some new designs. The development of a cheap and easily-operated tool for measuring the actual pull on towing warps opens the way for a study now being undertaken of the pulls required to operate various gears under various conditions and of the abilities of boats of various sizes, designs and powers to deliver these pulls. Such information would be very valuable both to fishermen and to those who formulate development policies.

Regulation of intensive fisheries. The public, influenced perhaps by the facts of stock raising, has exaggerated the benefits to be expected from the protection of small fish. Farm stock have very small numbers of young, which survive well; fish have very large numbers, which suffer severe mortalities. With the former there is good assurance that saved young will survive and can be found and used at a larger size; with the latter neither survival of saved young nor our ability to find and catch them at a larger size is at all well assured. Failure to catch and keep small fish may simply mean that we lose them. Each case in which it seems that restrictions on fishing designed to let fish grow larger in order to increase the long-term yield must, therefore, be examined very carefully.

Obviously the better the young survive, the faster they grow, and the better our chance of catching them again, the more likelihood is there that it will pay to protect them. To get information on these points needs intensive work over a long period and, consequently, a high cost whether reckoned in time, money or personnel. We should, therefore, attack only those cases where the chances of restrictions paying are good or where the stakes are very high. Even in these cases a great deal of work may produce what may be the very valuable, but is nevertheless the rather intangible, result of avoiding damaging restrictions.

Work of this kind is proceeding in the cases of the lobster where there is evidence that size limits can be valuable, the clam and the scallop, which appear now to be somewhat more doubtful cases, and groundfish, where more fishing seems desirable but where either undesirable restrictions or over-fishing might possibly occur and the stakes are very high. Harp seals which, being mammals, have a low reproductive rate which sets them apart from the other cases by making maintenance of the parent stock more important, are also being studied to assess the need for restrictive measures.

Protection of public health. Oysters and clams grow in sheltered inshore waters and pollution makes serious difficulties for these industries. The Station has played a major part in the co-operation between the Departments of Fisheries and National Health and Welfare in investigating the problems posed by pollution and in developing policies which permit the maximum use of the resource without danger to public health. A co-operative investigation is now in progress which promises to develop practical techniques for purifying clams by re-laying in waters free from pollution, and many other aspects of the problem are constantly under review and investigation. Paralytic shellfish poisoning has received the same co-operative

study and the Station, having completed the most urgent research in this field, is now withdrawing to an advisory position and leaving implementation of the policies which have been developed to the Conservation and Development Service and the Fish Inspection Laboratory.

Improvement of quality. The frequent presence of round-worms in cod fillets constitutes one of the most important hindrances to marketing them, and cod are the largest source of raw material for our fresh and frozen fish trade. Investigations have revealed the main points in the life history of this worm and shown that it matures in seals. Efforts are being continued to assess the possibility of reducing the numbers of worms by killing seals. The picture is not promising but the importance of the problem justifies the exhaustion of all reasonable possibilities.

Handling of live lobsters. An increasing proportion of the lobster catch is marketed alive and this branch of the trade suffers from losses in holding lobsters alive at the coast and from the difficulty of keeping them alive right to the consumer. The physical and chemical factors influencing the survival of lobsters are being studied intensively to provide the basis for improving holding conditions and reducing losses. Progress is being made in the development of cheap equipment for holding lobsters alive in aerated artificial sea water -- a development which, it is hoped, will greatly assist retail marketing.

### PROGRESS OF INVESTIGATIONS

Summaries of progress in some of the more important aspects of the Station's work are given below. The arrangement of these summaries according to types of investigation, as outlined above, was considered but it was concluded that it would be better to arrange them according to divisions of the fishery as in the past.

#### LOBSTERS

The lobster fishery, with an annual value of more than \$10,000,000, is by far the most important to the inshore fishermen and, in fact, contributes about half of their income. Stimulated by the development of canning, the fishery was in its early stages of rapid growth at the time of Confederation, the catch reaching a peak of over 80,000,000 pounds in the eighties and declining to less than 30,000,000 pounds in 1918, since when it has fluctuated between 25,000,000 and 50,000,000. The peak was to be expected in an increasingly intensive fishery for a relatively long-lived species and probably depended on fishing an accumulation of old individuals rather than on an annual crop, but the decline from the peak stimulated both investigations and attempts at conservation. The general life history of the lobster was determined; hatcheries founded in the nineties were shown by investigations to be useless and were discontinued in 1917; protection of egg-bearing females was

recommended and instituted. Since about 1918 the fishery has remained intensive and has shown fluctuations but no over-all downward trend.

Regulation of the fishery. Investigations to answer the question "What restrictions of the fishery, if any, can be confidently expected to improve the yield?" were commenced in 1936 and have been intensive since 1942. The population and the fishery have been studied in eighteen ports and regularly in five. The high proportions caught by the fishery (40% to 80%) have been determined by tagging which also, when combined with special catch statistics, permitted estimations of the populations of legal-sized lobsters. Consistent relationships have been found between population density and catch per effort, and between proportion caught, intensity of effort and size distribution. The tagging or marking of over 100,000 lobsters has shown that, although some gradual spread or individual movement occurs, there is no concerted migration either from area to area or on and off shore and that lobster populations are essentially local in character. Exploratory fishing has failed to reveal any considerable stocks seaward from the areas now fished in the Gulf of St. Lawrence. We thus have a local highly intensive fishery in which one might expect restrictive measures to be more than usually promising. What use then can be made of the great body of information resulting from these investigations?

The Station has been in close touch with the Department on the problems of the lobster industry. Results of its investigations have been used by the Department in considering changes in regulations and the Station played an important part in the Department's serious review of the regulations with the industry in 1952. The investigations have indicated that closed seasons have no value in maintaining the stocks, the highest proportions (up to 80%) being caught in areas with a two-month season, and that the seasons must be decided and their value assessed principally on economic grounds. The immediate effects of size-limit changes have been predicted in a number of instances (e.g. Appendix 3). Information on moulting has influenced the definition of seasons. In these and other ways the results of investigations are used by the Department.

The principal restrictive measure now in force in order to maintain the yield is the size limit. Economic considerations are important in assessing its merits, lobsters above a pound in weight being more valuable than the smaller lobsters which predominate in the catches in some areas. Evidence in favour of enforcement and possible increase of the present minimum size of 2 3/8" carapace measure (about 7") is of two kinds: (a) With an annual weight increase of about 50% (Appendix 2), proportions up to 80% and generally over 50% caught each year and an apparently low natural mortality under present conditions, it may be calculated that a greater total weight would be caught if the lobsters were allowed to grow larger. Since, however, this would increase the numbers of lobsters on the grounds, it might change survival, growth and proportion caught, and neither the effects of any given increase nor the optimum size limit can be predicted for any given place. Any change must, therefore, be

regarded as experimental and its effects closely followed.  
(b) Since the size limit was raised at Fourchu, N. S., from 7" to about 9" (total length) the total weight taken has increased very slightly but the value has increased appreciably even when allowance is made for changes in lobster prices generally.

The intensive study of the lobster fishery and populations is being continued in five typical areas in order to assess the results of changes proposed now and in the future. The time appears to be ripe for a carefully planned experimental increase of the size limit if support of a suitable fishing community can be obtained.

Commercial holding of live lobsters. An increasing proportion of the lobster catch is being marketed alive and the Station has assisted this branch of the trade by studying the factors governing the survival of lobsters. Some years ago special attention was paid to the transport of live lobsters out of water and the emphasis which these investigations placed on low temperatures and on protection of lobsters from direct contact with melting ice has been valuable to the industry. More recently the factors governing the survival of lobsters in water have been studied intensively. These investigations are still in progress but application of results is already commencing in the holding of live lobsters both on the coast and at the markets.

Experiments on the effects of temperature, salinity and oxygen on the survival of lobsters in the summers of 1949, 1950 and 1951 culminated in 1952 in a large experiment, or series of experiments, in which these three factors are being varied simultaneously. In this experiment (Appendix 4) which will be completed in 1953, lobsters are being acclimated to three levels each of temperature, salinity and oxygen -- making 27 combinations. On lobsters from each of these lots determinations are being made of the levels of high temperature, low salinity and low oxygen which will kill them -- 81 determinations, each using 40 lobsters. The results are not yet complete but the experiment has shown that the conditions to which lobsters are acclimated influence their survival under extremes of temperature, salinity or oxygen, and that the effects of the three factors are not independent. Thus, the higher the salinity in which lobsters have been held the higher the temperature they will survive, the lower the temperature the lower the salinity they will survive, the poorer the oxygen supply the lower the temperature needed to kill them. The effects of one factor on another are quite considerable, a difference of .5% in the salinity, for example, making a difference of 2°C. (3.6°F.) in the lethal temperature.

These experiments, when completed, will lay the basis for sound advice on the conditions under which lobsters should be held on the coast for shipment. They have already explained some losses and suggested remedies. It is planned to make a survey of the conditions under which lobsters are held so that improvements can be recommended where needed.

Another development which may prove of great value to the retailing of lobsters is the successful holding of commercial quantities in tanks with aerated, but not circulated, artificial sea water. Continuing experiments started in 1951, it was found in 1952 (Appendix 5) that water could be filtered cheaply and safely by using air pressure to force it up through a tube a few inches above the surface and allowing it to drain back into the tank through a filter. Glass wool was found to be unsatisfactory as a filter material as short fibres spread throughout the water and poor survival of lobsters resulted; cotton gauze was satisfactory. Lobsters survived more than three weeks at about 50°F. and the weak survivors of one experiment revived well when transferred to fresh artificial sea water after 26 days. Experiments indicate that in these confined conditions a small rise in temperature above 50°F. may seriously reduce survival time. The industry has already shown much interest and details are available for distribution on request. It is hoped that the results of these experiments will be used to reduce losses of live lobsters in retail marketing.

Variations in abundance of lobster larvae. In order to learn more about the factors governing the abundance of lobsters, systematic towing for lobster larvae has been carried out each summer since 1948 in the northern part of Northumberland Strait. Lobsters remain close to the surface until after they have moulted three times and the four "stages", differing both in size and shape, are caught in a special 12' x 3' rectangular plankton net. Since towing technique was standardized in 1949 there has been only a 2:1 variation in the numbers of first-stage larvae caught per tow, but survival has varied greatly, and in 1952, the best year, there were more than twenty times as many fourth-stage larvae per tow as in 1949. An attempt is being made to relate these differences to hydrographic or other causes and to abundance of lobsters when the larvae grow to commercial size five or six years later.

Capture of early bottom stages. Although the four free-swimming larval stages have been caught readily for a number of years, persistent and varied attempts both here and elsewhere have failed to find the earliest bottom stages. It has, therefore, been impossible to study the distribution, abundance or growth of young lobsters for a considerable period. In 1952, using a specially designed heavy-toothed 4-foot drag with small-meshed bag, a total of 432 lobsters were caught in 1 to 5 fathoms off Richibucto, N. B. Most of these were smaller than any taken by commercial gear and, indeed, of sizes very few of which have been reported; 19 were less than 1½ inches in total length. Study of the size distribution of these small lobsters has confirmed earlier estimates of growth made from study of larvae and from marking lobsters of commercial size.

## OYSTERS

The oyster of the eastern coast of North America, Ostrea (Crassostrea) virginica, supports one of the largest fishery industries of the world, production of high-quality oysters depending to a large degree on positive cultural methods. The Maritime Provinces of Canada, at the northern limit of this species' range, have a very small production (less than 1% of the whole) and Canada does not supply its own demand. The history of the oyster fishery is exemplified by that of Malpeque Bay, one of our most important oyster producing areas. Starting about 1865 the commercial catches grew rapidly to a maximum of over 30,000 barrels in the eighties and nineties and then declined rapidly to less than 5,000 barrels before 1910. The peak, as in the case of the lobster fishery, was due to the expanding fishery taking accumulated old individuals and the public fishery found an equilibrium based on an annual crop at a very much lower level. A contagious disease introduced in 1914 so decimated the remaining Malpeque oyster stocks that the fishery disappeared. It offered a challenge to re-establishment of the industry by oyster farming, known to be successful elsewhere.

Some early investigations had been conducted in Canada (including the first identification at the turn of the century of the oyster's free-swimming larval stage) but intensive investigations date from 1929 and were centred at first in the Malpeque Bay area where the oyster stocks had not yet recovered enough to support a fishery. There was from the first an unusual degree of co-operation between research, administration and private endeavour, a Fisheries Research Board employee being for twenty years in charge not only of scientific investigations but also of the Department of Fisheries' larger-scale experimental farming and of its field administration of a development policy built around the leasing of ground for oyster farming. Cultural methods from other areas were adapted to our conditions and some new ones developed. In the ten years following the offering of ground for lease in 1932 an oyster-farming industry was established in Malpeque Bay based on the methods and policies developed by research and having a production more than equalling the catch just before the disease. Oyster farming has only a seasonal labour requirement and its returns are slow in coming and fraught with some risk. The labour scarcity, high costs of materials, and assured good incomes in other fields have retarded its development for the past ten years. There is, however, enough good oyster ground for a much larger industry and, consequently, a challenge to research to find cheaper and surer methods of farming. Since its development in the Malpeque area, oyster farming fostered by the Federal Government has spread to other areas in all three Maritime Provinces and, in addition to the research headquarters at Eglarville, P. E. I., there are now smaller centres at Shippegan, N. B., and Malagash and Orangedale, N. S.

Oyster farming. Research to meet the developing needs of the industry is continuing, with special attention to reduction of costs. Oysters being immobile, except for a brief larval period, and occurring in shallow, sheltered waters,

can be "farmed" by a variety of measures analogous to those of agriculture -- seeding, thinning, protection from pests, etc. Some attention is being given to many aspects of the work; some recent highlights are given below.

The Station has continued, in close co-operation with the oyster culture services of the Department of Fisheries, to assist the industry by predicting the settlement of oyster spat, so that clean material to which the small oysters can attach themselves can be put in the water at the right time. In 1952 the hot, dry summer produced very favourable conditions; spawning was good and growth of the free-swimming larvae rapid. Good "sets" were obtained by the industry and were specially welcome because of failures in the two preceding years. The sets were, however, so good as to obscure the differences in the effectiveness of various materials being tested for spat collection (Appendix 8). Experiments in 1952 at Shippegan, N. B., showed that dipping spat collectors in DDT in oil did not repel barnacle larvae which sometimes settle in such large numbers as to prevent proper growth and survival of oyster spat. (Appendix 12).

While the improvement of techniques of spat collection still occupies a prominent place in our investigations, that step is now neither as expensive or as difficult as the rearing of spat for their first fifteen months safe from enemies, smothering, etc. In a small experiment in 1952 at Malagash, N. S., separated spat placed directly on the bottom in a dyke had a very high survival and a fair growth. The experiment will be repeated on a larger scale as it offers prospects for cheaper production of oysters large enough to plant out on maturing beds. (Appendix 10).

Preliminary trials of an echo sounder for finding suitable bottom for oyster farming gave promising results. One bed was found in Malpeque Bay and a preliminary exploration of Egmont Bay, P. E. I., carried out. (Appendix 9).

At Richibucto, N. B., where prospects for oyster farming have been under investigation for two years, trial spat collection was successful in 1952. (Appendix 11).

Oyster diseases. The disease, which decimated the oyster stocks of Malpeque Bay in 1914, spread throughout the Malpeque-Cascumpeque area in the next few years and was carried, apparently by oyster fishermen, to the Enmore-Percival area on the south coast of the province in 1933, and to the Charlottetown inlets in 1935. The re-establishment of the Malpeque industry since 1929 was based on stock bred from survivors of the original epidemic, and experiments have shown that this stock is resistant to the disease which still kills a high proportion of oysters introduced from areas where it has not yet occurred. Experiments in Johnston River, P. E. I., now indicate that the surviving native stock there is developing a resistance to the disease about sixteen years after the epidemic -- a period similar to that in the Malpeque area. (Appendix 13).

Oysters from West River, Charlottetown, P. E. I., have for the past three years suffered serious mortalities in storage, making them valueless commercially. Again in the winter of 1951-52 samples were placed in cold air storage in Charlottetown and observed during storage. The results confirmed that symptoms rose to a peak at the same time regardless of the spread of some seven weeks in the times of fishing. About 10% of the oysters died; another 30 to 40% developed symptoms but recovered during storage. It follows that the mortalities are due to infection of the oysters before they are taken from the water, although the symptoms do not develop if they are left there. The basic cause has not yet been discovered. (Appendix 13).

Sponges which riddle oyster shells. Boring sponges of the genus Cliona excavate large cavities in the shells of oysters and scallops. One species (C. celata) makes oysters unsuitable for sale in the shell; another species (C. vastifica) has been associated with the undesirable "dark meat" condition of scallops. The damaging effects are so serious that investigations were commenced in 1952, centred for the time being on the problem as it affects oysters in Malpeque Bay, P. E. I.

Little has been published on the biology of these sponges or on techniques for their culture, preservation or microscopic examination, and the investigation had to start from scratch. Attention was given to their identification (Appendix 17) and general mode of life (Appendix 15). Investigations have as yet failed to reveal any sexual reproduction or free-swimming stage, and there is evidence that oyster shells usually become infected through contact with other infected shells.

As well as having very fragile shells, spongy oysters often show pustules in various parts of the body, or weakening of the muscle attachment and possibly damage to the hinge ligament. The sponge seems to remain active at temperatures below those at which the oyster can repair its shell so that heavy damage may occur in winter. Single oysters are rarely attacked until they are almost of marketable size, but spat attached to spongy shell may be attacked at almost any size. (Appendix 14).

Experiments have shown that control measures requiring the raising of the oysters from the bottom, such as exposure to fresh water, may be possible but there seems little hope of methods applicable on the bottom. General studies of the biology of the sponge may show other points of attack, but any but empirical attempts at control must await further information on the reproduction and dispersal of the sponge. (Appendix 16).

Control of eel-grass on oyster grounds. In the early thirties a disease killed most of the eel-grass (Zostera) in Maritime Province waters and some grounds which were densely covered became so free of it as to be suitable for oyster farming. The eel-grass is now recovering and since 1949 the effects of eel-grass on oysters and means of controlling

eel-grass have been studied. In 1952 these investigations were restricted to observation, mainly in the Malpeque Bay area, P. E. I., of the results of experimental control measures, and to studies of the growth and morphology of the plants under various conditions.

Careful studies of the growth of individual plants showed that growth continued all summer. Seedlings, which were very numerous in 1952, are more susceptible to death by exposure and drying at low tide than are older plants. (Appendix 86).

An experiment started in 1949 has shown that in 1949, 1951 and 1952 oysters on the bottom grew faster free of eel-grass than among it, and that oysters raised slightly above the bottom grew faster than oysters on it, in 1950, a poor year for oyster growth, no differences were found. It is clear that decreased circulation in dense eel-grass decreases oyster growth. (Appendix 87).

Areas covered with hard materials such as clam shells, oyster shells, gravel and concrete slabs to control eel-grass still show resistance to reappearance of eel-grass seedlings, probably because of the difficulty of establishing a stable root system. Covering with tar paper over-laid with sand and treatment with Benoclor (in concentrations of 1 gallon or more per 1,000 square feet) were effective in removing the eel-grass initially but left a sand surface in which seeds can germinate, so that such areas can become covered again by new seedlings as well as by encroachment of older plants on the margin. It seems that these treatments may remain reasonably effective for five or six years only. (Appendix 88).

#### SOFT-SHELLED CLAMS (MYA)

The development of the trade in shelled clam meats ("shucked clams") and the resulting greatly increased demand caused an increase in the Canadian production starting in 1940. The take reached a peak in 1950, the marketed value in that year being well over the million dollar mark and exceeding that of scallops or oysters. The peak was reached by fishing accumulated stocks and expanding to new areas. The decline of the production towards an equilibrium at a lower level was predicted by the Station and is now taking place. The Station's investigations have been designed to lay the basis for maintaining production by bringing new areas into production, by clam farming and by regulation of the public fishery.

Exploration. The Station's explorations have helped the industry to maintain production by developing new areas. Even in 1952 some small producing areas were explored in the Bay of Chaleur area (Appendix 19) but this phase of the work is coming to a close as all existing stocks are coming into use. Some attention is being given to the development of new methods of taking clams which may permit the use of clams from areas now out of reach because they remain covered at all

or most low tides.

Clam farming not profitable. Clam farming, consisting of removing small clams from areas where their growth and survival is poor and planting them in more favourable areas, had long been practised in the United States. Starting in 1944 extensive experiments in clam farming have been carried out by the Station, principally at Sissiboo River and Petpeswick Harbour, N. S., and at St. Andrews. The effects, under various soil conditions, of various densities and methods of planting, of various tidal levels, of digging at various seasons and of many other phases of clam farming have been determined in carefully conducted plot experiments. The results have shown that slow growth and poor survival leave little prospect for profitable clam farming even in our most promising areas and have, in fact, stimulated a similar assessment of the supposedly profitable clam farming in New England, with much the same results. The Station's work in 1952 was limited to examination of the results in an experiment in Pocologan Harbour, N. B., where six bushels of 1 $\frac{3}{4}$ " clams planted in May, 1950, yielded in June, 1952, twelve bushels of clams showing an average growth in length of 60% and a 64% survival. This is the most promising result yet obtained but still barely profitable. (Appendix 18).

Regulation of the fishery. The knowledge gained in clam-farming experiments is of great value in attempting to lay the basis for regulations which will maintain the yield of the fishery at its optimum. Discovery that digging destroys about half of the small clams which are left suggested experiments, commenced in 1945, on the effects of the frequency of digging. In plot experiments in three areas with differing types of soil, the yields resulting from semi-annual, annual, biennial and triennial digging are being compared. Results to date indicate that a greater yield results when flats are dug once a year than when they are dug twice a year; results from still less frequent digging are not yet conclusive. The Station is co-operating with the Department in arranging application of these results through experimental regulation of the digging on larger areas. (Appendix 21).

Consideration of the 2" minimum size limit in the light of information on growth, natural mortality, destruction by digging and proportions taken throw doubt on its value by itself but indicate its possible value if associated with controlled frequency of digging. Investigations are continuing. (Appendix 22).

The Station continued to assist the Department in the solution of local administrative problems such as the need for bait reserves and the inadvisability of applying the size limit in areas where growth is unusually poor.

Cleansing of sewage-contaminated clams. Dense stocks of clams in extensive polluted areas constitute a risk to public health through illegal sale and a potential source of valuable supplies if they can be made fit for human

consumption. Experiments in the cleansing of such clams by transfer to clean water were carried out in 1951 and 1952 in co-operation with the Department of National Health and Welfare and the Fish Inspection Laboratory, which provided bacteriological mobile laboratories and personnel. Heavily contaminated clams cleansed themselves rapidly when placed in water as cold as 41°F., with salinities between 30‰ and 33‰ and most probable numbers of coliform bacteria less than 20 per cubic centimetre.

Cleansing takes place in three phases: a 24-hour period of rapid cleansing, a 24-hour period with no cleansing and a final phase of 24 or more hours when the numbers of bacteria drop to very low levels. Crowding to a considerable degree has no effect, nor does regular intertidal exposure for 3- to 4-hour intervals. Removal of mud hastens cleansing and broken clams will not cleanse themselves. After cleansing clams have a higher meat yield and are handled more easily. A floating car was designed for quick loading and unloading under industrial conditions and proved satisfactory. A trial supervised industrial operation is planned for 1953. (Appendix 20).

#### PARALYTIC SHELLFISH POISON

The Station's major investigations in this field led a few years ago to the adoption of policies which protect the public from paralytic shellfish poisoning with a minimum of interference with the industry, and in recent years the Station has co-operated closely with the Departments of Fisheries and National Health and Welfare in the application of these policies and their extension to new areas. With the establishment of a new branch laboratory of the Fish Inspection Laboratory at St. Andrews late in 1952, the Station is being relieved of all routine aspects of this work. The work is being turned over with clear, complete, up-to-date records of work in this field.

The absence of any rise in toxicity in the summers of 1951 and 1952 was very welcome to the industry but remains unexplained and inconsistent with the past several years. (Appendix 31).

#### RAZOR CLAMS

In 1951 the Station encouraged trial canning of razor clams from the head of St. Mary Bay, N. S., leading to their first commercial use in the Maritime Provinces. In 1952 this led to a larger production (over 200,000 lb.) which more than offset the decline in the production of soft-shelled clams in Digby County. The razor clam stocks of this area differ from those elsewhere in the Maritimes by having unusually good and consistent reproduction and in living in soil below which there is hard pan which prevents them from escaping from the diggers. (Appendix 23).

## BAIT WORMS

In 1951 the Station carried out brief explorations for "sand worms" (Nereis) and "blood worms" (Glycera) which are in high demand in the United States for use as bait in sports fishing. Promising quantities of "blood worms" were found in Yarmouth County, N. S., trial shipments to the New York market were arranged and prospective buyers put in touch with prospective producers. In 1952 shipments valued at about \$30,000 were made from Goose Bay, Little River and Yarmouth Harbour, all in Yarmouth County. A digger can take daily in about five hours 600 to 1,000 worms worth one to one and a quarter cents apiece. (Appendix 24).

## SCALLOPS

The problems of the scallop fishery of the Maritime Provinces are of two kinds. In the Bay of Fundy there is an intensive fishery now subject to regulation. Here the need is for a consideration of the value of restrictive measures for maintaining the yield. Elsewhere there are unused scallop stocks to be found and developed. The Station has worked on both these aspects of the fishery.

Regulation of the intensive fishery. Broadly speaking the intensive Digby fishery dates from about 1920, production rising to a peak of over 1,500,000 lb. of scallop meat in 1937 and falling to less than 200,000 in 1950. Efforts to maintain the fishery by regulation have relied mainly on closed seasons and on a minimum size limit. Actually this appears to be another case (like the lobster, oyster and clam fisheries) of a fishery growing and spreading over new grounds, producing a peak yield dependent on accumulated stocks, and finding an equilibrium at a lower level of yield based on annual crops. On this have been superimposed fluctuations caused by known variations of great magnitude in the abundance of year classes. Our task is to sort out these factors and assess the value of regulations.

Investigations since 1934 of the general life history, and more intensive investigations since 1946 of the populations of scallops, have given reasonably good information on growth rates, age composition of the stock, catches and fishing effort. Of recent years, with stocks at a relatively low level, the proportion caught annually is about 25%. Abundance estimated by tagging and experimental fishing in 1949 and confirmed in 1952 by under-water photography (Appendix 30) was of the order of 0.6 scallops per square yard on one important fishing area. Scallop drags catch about 5% of the scallops in their path. Analysis of this information indicates that protection of small scallops would maintain the yield at a higher long-term level than would unrestricted fishing. This conclusion needs to be re-examined when the scallops are again more abundant and the fishing, consequently, more intensive, as is expected in the near future. An attempt is now being made to obtain information on the natural mortality by observing the numbers of shells

of recently dead scallops. (Appendix 29).

Development of a "savings gear". Scallops are shelled at sea and the shells discarded. A size limit based on the diameter of the shell is therefore not enforceable. Furthermore, small scallops are damaged by being landed on the boats and returned to the sea. Protection of small scallops therefore requires a "savings gear" which will not catch them. By experiments started in 1949 it has been shown that if the bags of scallop drags are made of rings with an inside diameter of  $3\frac{1}{4}$ " instead of the usual  $2\frac{5}{8}$ ", they catch only about half of the scallops below 4" in diameter but more of those above that size. In 1952 tests under commercial fishing conditions showed that this gear lasts as long as the standard gear and continues throughout its life to take fewer small and more large scallops. Estimates indicate that the gear is more expensive, perhaps raising fishing costs by about 2%, but this is offset by its greater efficiency in catching large scallops and the increase of 10 to 15% in the long-term yield which is expected to result if this gear is used. (Appendix 26).

Forecasting trends in Digby scallop production. In 1948 an increase in the catch of scallops in the Digby area was predicted on the basis of an observed correlation between abundance of year classes and the warmth of the water in the year they are spawned. This prediction was confirmed more recently as scallops too small to use appeared in greater abundance. In the autumn of 1952 this prediction came true; the fleet obtained high catches consisting mainly of scallops averaging about 3". (Appendix 25).

Exploration. Only in the Bay of Fundy is there an intensive scallop fishery which might benefit from restrictive measures. Incidental capture of scallops in fishing for groundfish indicates the presence of unused scallop stocks both off the outer coast of Nova Scotia and in the Gulf of St. Lawrence. Very high catches by limited commercial scallop fishing on Middle Ground indicates the possibility of developing a large fishery there and explorations are planned in that area when a suitable vessel becomes available. In the meanwhile explorations have been carried out in the southern Gulf of St. Lawrence where fishing has been sporadic and frequent mass mortalities of scallops have occurred.

Explorations in 1949 and 1950 discovered commercially promising concentrations of scallops in the vicinity of Pictou Island, N. S., and off Richibucto, N. B., but in the former area mass mortalities occurred before good use could be made of the stocks. In order to make possible economic use of the fluctuating stocks of the region the size limit was rescinded there on the Station's recommendation and gear suitable for operation from small boats, long in use in Lunenburg County, was tested and demonstrated.

In 1950 about two square miles of scallops in abundance were found off Richibucto, N. B., all belonging to the 1946 year class and only  $2\frac{1}{2}$  to 3" in diameter. This stock was

observed again in 1951 and a 10-day fishing trial was carried out at the end of May in 1952 which showed that fishing could be profitable. The information was released by press and radio and several boats based on Richibucto, N. B., and Miminegash, P. E. I., had profitable fishing in the summer and autumn. As there is only one year class present this fishery is not expected to last long; the total yield is not yet known. (Appendix 27).

Factors influencing survival of scallops. The scallop (*Pecten grandis*) on which our fishery depends is a cold-water form. The waters of the southern Gulf of St. Lawrence are very warm in the summer at the surface with much colder water only a few fathoms down. The water movements associated with storms can cause sudden temperature changes on the bottom in the moderate depths where scallops are found, sometimes perhaps raising the temperature too rapidly and too far for the scallops to stand. It has been thought that these unfavourable temperature conditions cause the very severe mortalities which have frequently been observed in various parts of this area.

In 1952 experiments were carried out at St. Andrews in which scallops held at about 50°F. and 59°F. were found to be killed by about 71°F. and 74°F. respectively. Further experiments are planned using scallops held at lower temperatures. On the basis of these results temperatures may be responsible for the scallop mortalities in the region. Other experiments showed that scallops survive salinities far lower than any that occur on the scallop grounds. (Appendix 28).

### GROUND FISH

The fishery for "groundfish", the species such as cod, haddock and flatfish which are usually caught close to the bottom, is the most important branch of the Canadian Atlantic fisheries. Even in the Maritime Provinces, although less important than the lobster fishery to the inshore fisherman, its total importance is greater and in Newfoundland it dominates the whole fishing industry even more. Groundfish represent the principal present and potential source of supply for the growing trade in fresh and frozen fish and in Canada the most abundant species is the cod.

The Canadian fishery for groundfish is still capable of expansion and, in order to maintain its competitive position, needs to make the most efficient use of available stocks and methods. This need for positive development is for the time being the most important aspect of the problem but the increasing fishing effort by many nations is already affecting the stocks and making it apparent that the possible need for regulation cannot be entirely disregarded. We must have the basis for guarding against either over-fishing or unnecessary restrictions.

Effects of the fishery on the stocks. In 1945 an intensive effort was started to obtain reliable and thorough information on when and where groundfish are caught and with what effort, and on the sizes and ages of the fish. Earlier information on growth, migrations and general life history is also being supplemented. In general we are getting reasonably good "vital

statistics" on growth, age composition of the stocks, and total mortality rates but still lack the basis for distinguishing between natural mortality and the mortality caused by fishing -- a distinction very important to any assessment of the possible value of various measures to restrict fishing.

With the establishment of the International Commission for the Northwest Atlantic Fisheries as an active body, the Station's long-term program in this field assumes an additional importance. The Commission (now in its second year) provides a mechanism for the co-ordination of investigations by the member countries on the groundfish fishery of the region and for international agreement on such restrictive measures as are found desirable. The need for evidence for or against such measures becomes more urgent. Canada, with the greatest interest in the northwest Atlantic fisheries, must play an active part in the Commission's work and the Station's responsibility for investigations, especially in the Commission's Sub-area 4 (the Scotian Shelf and the Gulf of St. Lawrence), is increased. The Station has played an active part in the early development of the Commission's program and in consideration of a proposed experimental minimum-mesh regulation in the Commission's Sub-area 5 (off New England).

The Station's work in this field in 1952 was a continuation of the long-term program of investigation of the fishery and of the stocks, but a few developments may deserve special mention.

The effects of the increasing fishing effort, by United States and other countries as well as by ourselves, are already becoming evident in changing age composition of the stocks we fish. Landings of cod on the Canadian mainland reached a peak in 1946-47 and have since declined to pre-war level. The peak catches depended on accumulated stocks of cod which were fished more intensively than formerly because of increased demand. Recent decrease in the catch per effort indicates decreased abundance of cod on the banks off Nova Scotia and in the Gulf of St. Lawrence. That this is due to increased fishing rather than to smaller production of young fish is indicated by the lower proportion of old fish in the catch. The accumulated stock of the large, old, "steak" cod appears to have been greatly reduced. While this is a symptom of a more intensive fishery and makes it harder to catch paying quantities of fish, it does not mean that restrictive measures are yet necessary. (Appendix 40).

Information is being obtained on the quantities of small haddock and cod caught by our fishery and discarded at sea. This has a bearing on the possible value of extending the Commission's experiment in the requirement of a minimum mesh in trawls to the grounds off Nova Scotia. Observations made to date on trawlers at sea indicate that only small quantities of cod are discarded but that considerable quantities of haddock are caught and killed but not used. (Appendix 41).

Cod can be tagged reasonably satisfactorily and more cod tagging is planned as a means of estimating the proportion caught by the fishery. Haddock, on the other hand, suffer such

severe mortalities when raised to the surface for tagging that this technique is useless. Preliminary attempts to tag groundfish on the bottom with marked hooks snapped off the line and left in the fishes' mouths met with little success. (Appendix 42).

The increased abundance of haddock, predicted five years ago on the basis of data on the age composition of the stock and on catch per fishing effort, has continued. In our waters the abundance of haddock year classes varies more greatly from year to year than in the case of cod, making predictions of this sort more significant.

Development of inshore dragging. The Station's explorations, begun in 1947, have stimulated the development of inshore small-boat dragging, first in St. Mary Bay and the Bay of Fundy and later in eastern Nova Scotia and the Gulf of St. Lawrence. The number of small fishing boats converted to dragging increased from about 50 in 1951 to about 90 in 1952, the most marked increase being in eastern Nova Scotia. Dragging has been concentrated in and about Chedabucto and George Bays, flatfish being important in the former and both flatfish and haddock in the latter. The industry's trend towards accepting smaller flounders has continued in 1952, the minimum size dropping to 10 inches, and this is permitting use of stocks of small, slow-growing flounders in a number of new areas from southwestern Nova Scotia to the Miramichi. Flatfish still constitute over 60% of the catch of this small-boat dragging but there is a trend towards fishing other species, including haddock, catfish, hake and cod. (Appendix 36). Late in 1951 the Station explored areas in the southeastern Gulf of St. Lawrence and in Northumberland Strait (Appendix 37); no actual exploration was done in 1952 but advice to fishermen on areas and methods continued.

Tagging and sampling the winter flounder population in St. Mary Bay, together with statistics of catch and effort, indicate a natural mortality of about 30% and growth in weight of about 33% annually. Data suggest that a higher long-term yield would be obtained by less intensive fishing than in the last three years (Appendix 43). It is planned to follow the development of this fishery with further tagging experiments.

Experiments to select the mesh in flounder drags which would leave in the water the flounders too small to be used by the industry indicate that substitution of a 5½" mesh (between knot centres) for the present standard 3" mesh would release most of the flounders shorter than 10" now discarded without seriously affecting the catch of marketable flounders (Appendix 44). The larger-meshed nets would be cheaper and more efficient.

The Station's experimental Danish seining in 1949 showed that this method was promising for flatfish fishing in Chedabucto Bay, N. S., and gear and hauling equipment were lent to a commercial fisherman for successful trials there in 1951. In 1952 he has continued to use the method with his own equipment and it appears to be more efficient for catching flatfish than dragging with small boats. Its use is limited to places

where there are large areas of smooth bottom. (Appendix 39).

Redfish dragging for small vessels. Small redfish draggers have continued to operate successfully in the Gulf of Maine even after fishing there was no longer considered profitable for larger trawlers. The latter now fish redfish profitably close to the Canadian coast, suggesting that small draggers based in our ports could do well in this fishery. The "J. J. Cowie" (over-all length about 65 feet) was used by the Station in 1952 on preliminary trials which will be continued in an attempt to develop this fishery. (Appendix 38).

Parasites. An immature stage of a trematode (Stephanostomum histrix) occurs in very small cysts in the winter flounder and has caused some marketing difficulty. Investigations completed in 1952 have shown that the trematode matures in the alimentary tract of the sea raven (Hemitripterus), the wrymouth (Cryptacanthodes), the eelpout (Zoarces), the halibut, and the short-horn sculpin (Myoxocephalus). The youngest immature stages occur in two snails (Buccinum and Neptunea) where they multiply asexually before passing into flatfish, all six species of which may have cysts. All stages of the parasite are marine and widely spread so that no control can be suggested. Infection is seldom serious and the parasite is harmless to man. (Appendix 35).

## HERRING

Except for the small-herring or "sardine" fishery of Charlotte County, N. B., and the winter fishery for larger herring in certain Newfoundland areas, herring catches on the Canadian Atlantic coast are made during short seasons and consist mainly of thin spawning fish. The stocks, again with the possible exception of the "sardines", are lightly fished. If fully used they could support, as in European waters, a large meal and oil, or food industry. Although the development of our herring fishery has apparently been retarded by marketing difficulties, these difficulties might be overcome if we could catch high-quality herring cheaply. The Station's efforts have been directed toward learning how to find and catch herring.

Drift-net fishing for herring in the Gulf of St. Lawrence. From 1944 to 1949 the governments of Canada, the four Atlantic Provinces and Newfoundland co-operated, through the Atlantic Herring Investigation Committee, in exploration of the Gulf of St. Lawrence in the hope of establishing a large herring fishery. The Committee learned a great deal about the hydrography of the Gulf, showed that several more or less distinct herring populations were present but, in spite of extensive search with sonic sounders and some exploratory fishing, failed to find concentrations of herring for purse-seining or other large-scale fishing. The Station continued the explorations by drift-net fishing from 1950 to 1952.

In 1950 good catches of large fat herring were made throughout the summer; catches per night per net (37½ yards long and 150 meshes deep) averaged 136 pounds as compared with 50 to 100 pounds in the North Sea with nets twice as deep. In

1951 catches were poor until late in the season when deeper nets were used, and good catches were again made. In 1952, using North Sea nets 360 meshes deep, catches averaged over 300 lb. per net-night and over 400 lb. in some areas. Thus good drift-net catches of fat herring can be made from May to September. There is some commercial interest in these results and it is hoped that herring may be caught profitably for reduction by purse-seining or trawling, if not by drift-netting, in the best areas. (Appendix 45).

Surface water temperatures where drift-nets were set averaged 14.1°C. in 1950, 15.9°C. in 1951 and 14.4°C. in 1952, the warmer surface water in 1951 possibly explaining the low catches in that year by shallow nets. The average catch per net-night was 83 lb. with moonlight, 237 lb. when dark and overcast and 541 lb. with clear starlight. Herring were largely in the bottom half of the nets on moonlight nights. Good catches of herring showed some correlation with good catches of the small crustacean Calanus. When good catches were made fish could usually be recorded by the echo sounder, but not always. (Appendix 46). Weekly samples of herring were tested for fatness, showing that recovery from the thin spawning condition is very rapid (from 3.5% fat in mid-May to 11.5% in mid-June). (Appendix 47).

Examination of samples of herring for length, age and number of vertebrae shows that these characteristics have remained stable for several years for the various herring populations. The drift-net herring taken on American Bank off the Gaspé coast from May to September are very similar to those taken in the Bay of Chaleur in May. Drift-net herring from the southeastern part of the Gulf are different from the above but indistinguishable from the spring spawning herring of the Magdalen Islands and Prince Edward Island. (Appendix 50).

Explorations for herring off the outer coast of Nova Scotia. Explorations have been requested by the industry in this area because the inshore summer fishery has had disappointing catches in some recent years. Preliminary search in 1952 using bottom trawls from the M/V "Harengus" and drift-nets from the M/B "Mallotus" failed to discover commercial quantities in new places. (Appendix 48). Further explorations over a longer season are planned for 1953.

Methods of catching herring. Experiments with mid-water and bottom trawls carried out in February, 1952, in Charlotte County, N. B., waters, was followed by the successful commercial use of flounder drags with small-meshed cod-ends for catching sardines. Operated from small boats with a crew of two, the trawls apparently out-fished purse-seines requiring more men and more expensive equipment. The trawls caught the small herring on the bottom in daylight, the seines up in the water at night. The two-boat Larsen and mid-water trawl had only moderate success. Experiments are planned in the winter of 1953 with bottom trawls specially designed for herring fishing and with a new design of mid-water trawl. (Appendix 49).

## ATTRACTING PELAGIC FISH WITH LIGHTS

Attempts to catch billfish consistently in commercial quantities were continued in 1952. Gill-nets failed to catch them and the very few observed in nets damaged themselves badly. Experiments with lights and lift-nets in the Japanese manner were not successful in obtaining commercial quantities (Appendix 52) but yielded information on the reactions of billfish, herring, gaspereau and squid which may yet be of great practical value (Appendix 53). Colour had little influence on the effectiveness of lights in attracting these species. Fish tended to stay close to the light better when it was weak (5 watts), concentrating in the periphery of the area affected by bright lights (up to 1,000 watts). The results are sufficiently promising to encourage further attempts. It is interesting to note that viewed from above in these experiments herring always milled anticlockwise and gaspereau always clockwise and that neither could be reversed.

## SMELT

Sea smelt are highly prized and relatively easy to market. The annual marketed value of the catch sometimes exceeds \$1,500,000 and production seems to be limited mainly by availability of smelts in the sea. A moderate downward trend of the catch (averaging about 1% per year) for the preceding twenty-five years prompted the initiation of investigations in 1941, centred in the Miramichi area which produces about half of the New Brunswick catch and about a third of that on the Canadian Atlantic coast. Means of maintaining or increasing the smelt stocks were sought along two main lines: the improvement of conditions for reproduction and the regulation of the fishery.

Smelt are anadromous fish closely related to the salmon and trout family. They present some of the aspects of the salmon problem in miniature and the investigations have a general as well as a particular interest.

Keeping the spawning grounds accessible to the smelt. As summarized in earlier reports, it was soon found that smelt were often crowded below obstructions to such a degree as to reduce not only the proportion of the eggs hatching successfully on any area of bottom but sometimes even the total number. It was confirmed experimentally that relatively inexpensive removal of small obstructions leads immediately to occupation of a greater area of spawning ground and, consequently, to the hatching of greater numbers of larvae.

Spawning, larval production and the commercial catch. The value of such stream clearance depends, of course, not on its immediate effects in increasing the numbers of larvae but rather on its ultimate effects on the abundance of smelts of marketable size. A series of observations is being made to indicate the relationships between the size of the spawning run and the abundance of larvae and between the latter and the abundance of smelt of the same brood when they reach commercial size. As might be expected under conditions of crowding such that area of spawning ground rather than numbers of spawners is

the limiting factor, five years' observations show no correlation between the relative size of the spawning run, estimated from visual observation and from special fishing, and the relative abundance of larvae, indicated by the numbers taken in a regular series of tows (Appendix 55). Sampling of the commercial catch for age and size composition, coupled with detailed catch statistics, has given a reliable estimate of the total commercial yields from only two broods, those of 1947 and 1948, and more broods must pass through the fishery before the correlation between larval abundance and yield to the fishery can be tested (Appendix 56). The ultimate value of stream clearance cannot, therefore, be estimated yet even though we know that it can increase the numbers of larvae.

Regulation of the fishery. The crowding of smelts on the spawning grounds and the absence of a correlation between the size of the spawning run and the production of larvae shows that, under present conditions, no benefits can be expected from restricting the fishery to permit more spawners to escape. Tagging and marking showed that the fishery takes a very high proportion (sometimes over 75%) of the smelt entering the Miramichi estuary during the fishing season (i.e. before mid-February). It also indicated that a considerable part of the stock does not enter the estuary until later and is not used. The marking also suggests a high mortality rate and there is no evidence that small smelt are so likely to return to the catches at a greater size as to make it pay to leave them in the water. Although it has been shown that the smelt trap-nets are so selective as to make a minimum mesh an effective means of protecting small smelt, it is not clear that this would pay.

Divisions of the smelt stock in the Miramichi estuary. The marking has shown that the smelt which enter the fishing area in the Miramichi estuary before the fishing season ends at mid-February spawn early in the main branches of the river. Those which spawn later and in the brooks enter the estuary after the fishing season is closed and are not used. Examination of the scales of early and late spawners has shown that the former had grown more in their first year than the latter, indicating that the early spawners were in the main produced by early spawning. Furthermore, the numbers of vertebrae in early and late spawners differ (Appendix 58). Thus the Miramichi smelt stock is not a homogeneous unit and it may be that the present closed season is preventing optimum use of the stock by protecting a part of it which does not contribute importantly to the fishery in any way. As in the case of salmon, we do not know enough of the smelts' distribution and movements in the sea to understand the factors involved in the apparent distinction between the early and late spawners.

## TROUT

The Eastern Brook Trout (Salvelinus fontinalis) is the most popular sports fish of the Maritime Provinces, valuable both for the recreation of our people and for the encouragement of the tourist trade. Provincial governments have been much interested in making good angling available and the Dominion government has been active in the field through the Conservation

and Development Service of the Department of Fisheries. The aim of the Station's trout investigations, started on an intensive scale about twenty-five years ago, has been the development of methods for maintaining the trout stock and there has been close co-operation with the Conservation and Development Service.

Although complaints by anglers allege a decrease in trout production, the admittedly scanty information on the yield of long periods suggests that the total quantities taken from most waters have not decreased and may, in fact, have increased, and that the individual angler's catch has decreased because many more anglers are now sharing a limited production. The problem is to increase this production by positive measures and attempts to do so are showing some promise in our smaller waters in which some control is possible. In general we must evaluate trout production under a variety of natural conditions and develop procedures for overcoming adverse factors.

Early investigations have revealed much basic information on the biology of brook trout in Maritime Province waters. The Station played an important part in the development of poisoning of enemy and competitor fish, first with copper sulphate and later with rotenone, and this has become an effective means of improving trout production in certain shallow unstratified waters.

#### Fertilization and control of predators in natural lakes.

An intensive study of trout production and limnological conditions in eight Charlotte County lakes, which are typical of the infertile lake regions of the Maritime Provinces, showed that their very low yield was caused by a poor supply of nutrient salts. The planting of hatchery stock, whether fingerlings or yearlings, failed by itself to produce good angling in these waters. Experimental fertilization of Crecy Lake in 1946 and of Gibson Lake in 1947 did not produce results commensurate with the cost, an important factor in the failure being the action of predators. Both lakes were, therefore, fertilized again in 1951 and predators controlled in Crecy but not in Gibson.

In Crecy Lake (50 acres; mean depth 8 feet) with a natural phosphorus content of .015 mg. per litre, the addition in 1946 of 0.4 mg. phosphorus, 0.2 mg. nitrogen and of 0.3 mg. potassium per litre improved the growth of introduced fingerlings so that for the first time they entered the anglers' catches the year after planting. Of the yearlings and fingerlings planted in 1946, 16.7% and 3.6% respectively were caught in 1947 but although the growth continued good the catches declined in 1948 and 1949 to pre-fertilization levels with a coincident increase in predatory birds and mammals. Control of the latter was started in 1949 and made more effective in 1950 and later. Eels were trapped in 1950 and elvers kept out of the lake by a barrier dam starting in 1951. In 1950 more of the planted stock (28.6% of the yearlings) survived to be caught later, but growth declined. The lake was fertilized again in 1951 as in 1946. The combined effects of fertilization and predator control included survival of almost 20% of the fingerlings planted in 1950 to be caught in 1951 and 1952 as compared with a consistent capture of less than 1% in unfertilized Charlotte County lakes. In Gibson Lake (59 acres; mean depth

13 feet), fertilized again in 1951 but without predator control, there was only a slight improvement comparable with that resulting from the early fertilization of Crecy. In Gibson Lake only 10.2% of the unusually large yearlings planted in 1951 were caught in 1952, as compared with 81.6% of the same stock in Crecy. In Crecy Lake the yield of angled trout rose to 12.5 lb. per acre in 1952; in Gibson it rose only to 1.3 lb. per acre. (Appendix 64).

These results offer promise for fertilization as a means of improving trout angling only if it is accompanied by predator control. Hatchery stock was used effectively in this instance in which spawning facilities are poor.

Production of trout in fertile ponds. Contrasted with the low yield of lakes in infertile regions, the mill ponds of Prince Edward Island are highly productive. At Montague angling in a 23-acre pond has been recorded for ten years, during which the annual yield to the anglers has varied from 2,400 to 4,700 trout averaging eight to nine inches in length or 22.4 to 44.8 lb. per acre. There is no indication that the catch one year affected the catch the next and the variations in yield must be ascribed to natural causes. (Appendix 59). Pond formation has been demonstrated in this and other cases as an effective means of providing angling in this province where the brooks are highly productive of young trout but too small to rear them in abundance to angling size. There have, however, been instances in which an over-abundance of small trout seemed to have growth so low that good angling did not result. More information on the effects of density of population on growth and survival is needed before these ponds can be managed to the best advantage.

In Kelly's Pond (2.6 acres) for six years, in Simpson's Pond (2.3 acres) for five years, in Andrews' Pond (3.0 acres) for four years and in Stephenson's Pond (3 acres) for three years, plantings of up to 800 yearlings per acre have given yields (final total weight of marked planted trout less initial total weight) up to 48 pounds per acre. The yield has varied greatly without much relationship to density of planting. Although some of this variation is attributable to variation in season, in the character of the ponds and in size of the trout when planted, it seems that predators have played an important part. Control of bird predators is planned in future experiments. (Appendix 60).

In Kelly's Pond angling was permitted in 1952 before draining the pond in order to learn the effectiveness of angling and to test the estimation of the trout population from the recaptures of marked trout. Anglers considered the fishing became too poor when they had caught only 54% of the introduced and 10% of the slightly smaller native trout, the total take being 600 trout in five days during which the catch per rod-hour dropped from 2.7 to 0.1. It is interesting to note that the native trout were much more difficult to catch than the planted trout, and some of the latter much more difficult than others. (Appendix 61).

Populations and movements of trout in a Prince Edward Island stream. As noted above ponds on Prince Edward Island provide good trout angling by providing room for the abundant small trout of the brooks to grow to angling size. Their effectiveness for this purpose has been recognized and many dams are being built or re-built. On the other hand small trout also go to sea, grow there and return as highly-prized sea trout. As many of the dams are necessarily close to the head of tide, they might interfere with the production of sea trout. An experiment is in progress to show the effects of a dam on the population of the brook as a whole, including that part which goes to sea.

Since June, 1946, a two-way fish trap has been operated at the mouth of Ellerslie Brook which is about five miles long. Trout are counted, measured and tagged as they enter and leave the brook. As many as 5,000 trout have passed through the fence in a year. Since 1950 a second two-way trap has been operated at what will be the head of the proposed pond. A careful creel census has shown that from 1,000 to 2,000 trout have been angled each year, mostly in their third year of age. Most of the trout which pass through these traps have been caught again by anglers, by the traps, or by special fishing to estimate the population, but from a quarter to a half disappear without record. It is believed that fish-eating birds play an important part in this natural mortality, 16 tags having been found in two Great Blue Herons. Populations of trout and young salmon have been estimated by seining and electrical fishing in sample areas selected on the basis of a detailed survey. The estimated populations have varied between about 4,000 and about 15,000 trout fingerlings, between 5,000 and 10,000 older trout, and between 1,500 and 11,000 salmon parr. (Appendices 62 and 63).

A dam which will make a five-acre pond was completed across Ellerslie Brook at the head of tide in October, 1952. It is so constructed that the pond can be drained to the original stream level. Provision has been made for a screen and a fish ladder. The operation of the traps, creel census and population estimates will be continued. At first trout entering from the sea will be liberated in the pond, later they will be barred from the pond, and still later allowed to enter through a fish ladder. This will give information on the effects of the dam on the movements and numbers of the trout and on the efficacy of the fish ladder.

### SALMON

The Atlantic salmon supports a commercial fishery on the Canadian mainland which has an annual value of more than \$1,000,000. It apparently contributes even more to the income of the community through its importance to angling and the tourist industry. The Dominion government has responsibility for the administration of the commercial fishery and expends much effort to maintain the stocks through its protection services and through such fish cultural measures as the operation of hatcheries and maintenance of fish passes. The Provincial governments are interested through the tourist trade and, in some cases, the leasing of angling privileges.

Statistics on the commercial catch show that the abundance of salmon in coastal waters has varied greatly. From a high of about 6,600,000 lb. in 1874 the catch fell to 1,100,000 lb. in 1881; from 1,600,000 lb. in 1920 it rose to 5,000,000 lb. in 1924, fell to 2,300,000 lb. in 1928, rose again to 5,400,000 lb. in 1930 and then fell steadily to 1,400,000 lb. in 1945, since when it has remained below 2,000,000 lb. These fluctuations have had their counterparts in other areas and there is no reason to attribute them to fishing. The recent decline has, however, caused much concern and some demand, especially on the part of anglers, for more restriction of commercial fishing. The Station has played a major part in the efforts of the Department of Fisheries, through the Co-ordinating Committee on Atlantic Salmon, to bring about a more thorough co-operative attack on the salmon problem by all concerned. The combined program of administration, culture and research was reviewed at a special meeting in the summer of 1952 and is being expanded.

The first objective is to learn how to produce more salmon and this involves many activities concerned mainly with the life of salmon in fresh water where it is possible to influence the conditions for its survival. Sound administration also needs more knowledge of how one branch of the fishery affects another, involving the life and movements of salmon in the sea regarding which we know so little. The Station's investigations are concerned with both these aspects.

The planting of hatchery-produced fingerlings. The operation of hatcheries to produce salmon fingerlings for planting is a long-established practice which may have value in waters where natural production of young salmon is less than enough to make full use of the capacity of the waters to rear smolts. Experiments have been carried out to determine how densely fingerlings should be planted to get the best results.

The scattering of fingerlings along long stretches of stream is difficult and expensive and it is therefore usual to plant them fairly densely at accessible points -- a practice which has been subject to some criticism. In an experiment started in 1949 three similar stretches of the Pollett River, N. B., above Gordon Falls were seeded in three successive years with 4,000 marked fingerlings, each in concentrations of 5, 50 and 500 per yard of stream length, the concentrations being rotated among the sections. The final crop of two-year-old smolts was counted through a fence in 1952, leaving only one crop of less numerous three-year-olds. The experiment shows no effect of degree of dispersal at planting within these limits. It is noteworthy that in this experiment in an area where eels are scarce and merganser broods were removed, 28% of the planted fingerlings survived to migrate seaward as smolts. (Appendix 66).

An experiment to discover the optimum number of fingerlings to plant in the 11-mile stretch of the Middle Pollett River, above an impassable dam and below an impassable falls, was commenced in 1942 but abandoned when it was found that mergansers kept the numbers of the resulting smolts at a low level regardless of the numbers of fingerlings planted. The experiment

was resumed in 1950 with the birds controlled, 246,000 fingerlings being planted in 1950 and 925,000 in 1952. A lighter planting is planned in 1953.

Smolt production from spawning of known numbers of adults. Restrictions on salmon fishing are mainly for the purpose of assuring that enough spawners reach the spawning grounds to make full use of the capacity of the streams to produce salmon smolts, and yet little information is available on the numbers of parent salmon needed. After determining the smolt production resulting in the Middle Pollett from various numbers of fingerlings, it is proposed to determine the production from known and controlled numbers of spawning adults. A Denil-type fishway with a trap at its upper end was installed by the Conservation and Development Service for this purpose in 1950 at the dam barring the Middle Pollett to salmon. Small runs were recorded in 1950, 1951 and 1952. Information on numbers of spawning salmon and of the resulting smolts is also being obtained elsewhere.

Control of predatory birds to increase salmon production. The most promising means of increasing salmon production which has emerged from the Station's investigations is the reduction of the numbers of mergansers. An experiment on a branch of the Margaree River in 1937 and 1938 had indicated its value and a more thorough experiment was carried out on the Middle Pollett River, N. B., starting in 1947. With the counting of the 1952 smolt run through the trap at the lower end of the 11-mile section, results are now available from four plantings of fingerlings with protection from birds and from five without. The mean production with bird control was 19,000 as contrasted with 2,200 without. The average survival of fingerlings to the smolt stage was 8% with the birds controlled. An intensive program of seining and electrical fishing has shown that there was some increase in the numbers of other species of fish when bird control was started but that the populations of salmon enemies or competitors, including eels, reached an equilibrium without becoming so numerous as to offset the beneficial effects of merganser control.

On the Miramichi River, N. B., where smolt counting fences have been operated on the Northwest Miramichi and Dungarvon branches since 1950 (Appendix 73), merganser predation appears to have been heavy on both branches up to 1950 when merganser control was started on the Northwest alone. Estimation of the relative abundance of young salmon by seining in the Northwest since 1950 and in the Dungarvon in 1952 indicates that bird control increased the density of large salmon parr by about four times.

In this area a co-operative study of the means and effects of merganser control has been undertaken with the Canadian Wildlife Service assisting in the study of the distribution and habits of the birds, the Conservation and Development Service of the Department of Fisheries carrying out the merganser control and the Station studying the effects of the control on salmon stocks and giving some general supervision. The aim of this co-operative effort is to develop merganser control into an acceptable, practical procedure. (Appendix 68).

A survey of the St. Mary River, N. S., in 1952, in preparation for experimental bird control starting in 1953 confirmed the suitability of the river for this purpose. Evidence of serious merganser predation was found and the river is readily accessible. (Appendix 70).

The general study of the food of mergansers is being continued; the stomach contents of 662 American Mergansers and 58 Red-Breasted Mergansers from a number of streams have now been examined (Appendix 69). The Station's investigations indicate that predation by mergansers limits the production of salmon smolts in most Maritime Province streams. A bulletin is in the press on the habits of kingfishers and of their effects on salmon production, which are considered to be much less important than those of mergansers.

Eels as predators on young salmon. Electrical fishing has shown that eels are as abundant as salmon in some salmon waters and are potentially serious predators and competitors. In July and August, 1952, at twelve sites on four New Brunswick streams the numbers of different species of fish were estimated in closed-off sections of stream and the eels removed after a night's feeding and their stomach contents analysed. This preliminary investigation confirms the possible importance of the eel as a predator on young native salmon (Appendix 71). Further observations have also been made on the predation of eels on newly planted salmon fry. (Appendix 72).

Measuring smolt runs. The attempt to develop means of estimating the number of descending salmon smolts was continued. The use of two traps, one to mark a sample of the run and a second to discover some distance downstream what proportion is marked, was tried again. The results of three years show that these estimates are reliable only within wide limits, the main difficulty being to catch any considerable proportion of the smolt run with fences which do not cross the entire river. Because of freshet conditions, lumber drives, etc., the complete fences are so difficult to maintain on some rivers that experiments are being continued in the hope of developing some means of leading smolts into the partial fences. (Appendix 65).

Marking smolts to study movements of salmon in the sea. Although tagging of adult salmon has revealed something of their movements in the sea and of the influence of one fishery on another, the picture as a whole remains obscure. Young salmon can be studied in fresh water up to the time they enter the sea as smolts. They then disappear from view until they reappear in commercial catches as grilse or larger salmon. During this interval we do not know what proportion of them move away from the vicinity of the river nor how far; nor do we know the source of the salmon entering any river, although it is usually assumed that they are returning to their "home" river where they were produced. In order to obtain information on the movements of salmon of known origin and on their contribution to various fisheries, the marking of smolts on a large scale is being attempted in the Miramichi River system.

Fences have been operated on the Northwest and Dungarvon branches since 1950. In 1950 both were too late for the main run and only 8,231 smolt were marked; in 1951, 48,373 were marked; in 1952 a combination of freshets and timber drives prevented efficient operations and only 1,109 were marked. (Appendix 73). Some of those marked in 1950 reappeared as grilse in 1951 and larger salmon in 1952; some of those marked in 1951 reappeared as grilse in 1952 and are expected as larger salmon in 1953. In 1951, with so few marked fish extant, no special search was made other than observations in our own counting fences. In 1952 the program was publicized and rewards offered, information solicited from anglers by personal interviews, an observer assigned to the commercial fishery in the Miramichi area and some special fishing carried out in the estuary. It is planned in 1953 to sample the commercial and angling catches much more widely in co-operation with the Quebec Department of Fisheries and the Newfoundland Station and it is hoped that large-scale smolt marking will be carried out by each of these on a local river.

Only preliminary results are, of course, available as yet. A total of 149 marked in 1950 and of 478 marked in 1951 have been recovered. So far these reports give reliable indication only of the recapture of these salmon in the Miramichi area. The return of the grilse predominantly to the branch from which they came is indicated by the recapture in the Northwest trap of 225 fish marked there and only 3 from the Dungarvon, and the recapture in the Dungarvon trap of 91 fish marked there and none from the Northwest (Appendix 75). Recaptures by anglers and the commercial fishery did indicate some wandering.

Other investigations. In the course of these major investigations there has, of course, been opportunity to study many other aspects of the biology of the salmon. In the Miramichi area adult salmon are being tagged in the estuary and at the counting fences on the Northwest and Dungarvon branches to throw light on their movements within the river system and on the possible distinction between "early-run" and "late-run" parts of the stock. Observations are being made on such matters as when grilse and large salmon pass up- and down-stream and in what numbers.

#### COD-WORMS AND SEALS

The immature stage of a round-worm (Porrocaecum decipiens) occurs in the flesh of cod and several other species of fish and constitutes such an important hindrance to the marketing of cod in fresh and frozen form that a major effort has been made since 1945 to learn the complete life history of the worm and discover control measures.

Life history of Porrocaecum decipiens. Early in these investigations it was shown experimentally that when fish flesh containing these immature worms is fed to harbour seals they mature in about three weeks. The mature worms have since been found in nature in the stomachs of harbour, grey and harp seals.

No indication was found of what happened to the eggs of the worms after passing out of the seals until 1952 when small immature worms of this general sort were found in mysids (small crustacea) in the Bras d'Or Lakes where the cod-worms are unusually abundant. An attempt to feed infected mysids to cod failed to produce a measurable increase in the numbers of worms in the cod. In the late summer of 1952, however, harbour seals were fed with worms taken from cod and their faeces containing round-worm eggs were fed to mysids in which, as a result, young round-worms developed similar to those found in mysids in the Bras d'Or Lakes and similar to but smaller than the immature worms found in cod. It is planned to test the life cycle more thoroughly by feeding infected mysids to cod again, but there is in the meantime a strong indication that eggs from mature worms in seals develop in mysids, that when these are eaten by fish the worms grow in the fish and when the fish are eaten by seals the worms mature in the seals. (Appendix 32).

Cod-worms in seals. Mature Porrocaecum decipiens have been found to occur generally in the stomachs of harbour seals. Harp seals were thought for some time to be relatively free of cod-worms when in our waters, none having been found in harp seals on their southward migration in early January, or during the whelping and mating season (late February to mid-April) when they are not feeding actively. Harp seals feed actively in the Gulf of St. Lawrence only from about mid-January to late February and from mid-April to some time in June. Mature cod-worms have now been found in their stomachs during both these periods. The relatively small numbers of worms in the harp seal stomachs, most of them immature, and the harp seal's short sojourn in the Gulf, indicate that in spite of their great numbers harp seals are not as important as harbour and grey seals as hosts to the cod-worms in this area. (Appendix 82). Very few Porrocaecum and no mature specimens were found in the stomachs of 32 harbour porpoises examined in the Bay of Fundy in 1952. (Appendix 85).

Poor prospects for control of cod-worms by reduction of seals. Investigations indicate that harbour seals which breed in early summer in accessible areas could be reduced in numbers and that the increase in the bounty on adults of this species from \$5.00 to \$10.00 has caused a bigger kill of the breeding stock (Appendix 80). Prospects are poor, however, for reducing the numbers of the large grey seals which are important hosts of cod-worms in the Gulf of St. Lawrence. These seals are more wary, scattering when hunting is intensive, and have their pups in mid-winter in places very difficult to reach. Further attempts to find and attack them in these places are planned. (Appendix 81).

Harp seals can shed cod-worm eggs in the Gulf of St. Lawrence only in very cold water, being absent at other periods. Experiments in 1952 suggested that long exposure to low temperatures delays, and may even prevent, development of the eggs but these results are not yet conclusive enough to indicate that harp seals are not an important source of worm infection in this area. The possibility of control thus becomes very doubtful (Appendix 33).

## HARP SEALS

The Newfoundland fishery for the harp or Greenland seal had an average take of about 250,000 from 1895 to 1911 and of about 160,000 from 1912 to 1940. During the war the take was low but increased rapidly after 1946, both Norway and the mainland of Canada entering the fishery. The increasing catch caused concern about the possible need for restricting the fishery to protect the stock. Active investigations by this Station of the populations, movements and general biology of the harp seal were started in 1949.

Aerial photography of the breeding concentrations or "patches" in the early springs of 1950 and 1951 led to an estimate of pup production on the Front (east of Newfoundland) at about 430,000 annually which, with numbers of adults and immature both about twice this level, means a total population of about 2,150,000. The estimate for the Gulf of St. Lawrence population was about half this number. The kill of pups in 1951 east of Newfoundland rose to about 240,000, leaving only 180,000 pups to replace a kill of 30,000 immatures and 80,000 adults and the natural mortality of the stock (itself about 170,000 at 10%). It appeared that the fishery could not continue at this level without reducing the stock, and the need for restrictions was seriously considered. The 1952 kill was, however, considerably smaller, making the need for restriction appear less urgent.

Age estimation by examination of rings in the dentine of teeth has been applied successfully to this species. Examination of teeth and reproductive organs in large random samples netted in the Strait of Belle Isle during the southward migration has shown that about 34% of the females mature at 3 years of age, about 38% at 4 years, about 22% at 5 years and the remainder (6%) at 6 years, and that most males mature at about 6 or 7 years of age. Histological examination of ovaries and testes is now proceeding to check these conclusions. Age distribution in the samples indicates a total mortality rate in the Gulf of St. Lawrence population of about 22% after maturity. The sampling of stocks both at the breeding patches and at the Strait of Belle Isle is being continued (Appendix 83).

With the fishery taking about all that the stock on the Front can stand without reduction, and with a less intensively hunted stock in the Gulf of St. Lawrence, it is important to know whether these stocks are distinct or whether the former can be replenished from the latter. Emphasis is, therefore, being placed on the tagging of pups in both populations. About 950 have been tagged by Norwegian and Canadian workers since 1929 and more tagging is planned in the spring of 1953. The returns from the north are all from West Greenland, some of the pups reaching that area in three months. No seals tagged on the Front have yet been taken in the Gulf or vice versa; one tagged on the ice in the Gulf in 1950 was taken two years later at Neil's Harbour, N. S., about 50 miles away. (Appendix 84).

The Station has played a major part in discussions with the Canadian sealing industry and with representatives of

Norway, Denmark and France on the need for regulation of the fishery and for research. Exchange of plans and results has been arranged with Norwegian and Danish investigators. The Newfoundland Fisheries Research Station has assisted in sampling the stocks on the Front and in tagging there.

#### DEVELOPMENT OF FISHING EQUIPMENT

Work on the development of fishing gear has been reported in connection with various investigations outlined above. Further tests of the value of a "tickler chain" in flounder dragging again gave slightly better average catches with it than without, but catches were so variable as to leave the result inconclusive. A nylon drift-net without special heat treatment did not show any consistent superiority over cotton nets in catching herring and suffered serious slippage and distortion of meshes.

Of great potential value is the development of an inexpensive and convenient instrument to measure the tension in towing warps. It consists of a helical spring operating inside a metal cylinder. In preliminary tests, when a 35-foot flounder drag was towed by the "Mallotus" (55 ft.; 106 h.p. Cummins high-speed diesel) there was a pull of 200 to 300 lb. in each warp at normal towing speed (800 to 900 r.p.m.) and 500 lb. with the engine at full speed (1400 r.p.m.). When a "3/4-35 Yankee" trawl with a 51-foot foot rope was towed by the "J. J. Cowie" (65 ft.; 100 h.p. Caterpillar medium-speed diesel) there was a pull of 700 to 800 lb. on each warp at normal towing speed (450 r.p.m.) and 1,000 lb. at full speed (900 r.p.m.). It is planned to use this instrument, or a modification of it, in a general study of the pulls required by towed gear of various types and the pulls delivered by boats of various sizes, designs, powers and propellers. It is believed that this information will be very valuable to the development of inshore dragging with small vessels, to the design of boats and gear and to the formulation of government policies for the improvement of boats and gear. (Appendix 90).

#### NEW OR UNUSUAL RECORDS OF OCCURRENCE

New or unusual records in 1952 included a Beluga at Mace's Bay, N. B., in June, Sea Horses (Hippocampus hudsonius), Trumpetfish (Fistularia tabacaria), Chub Mackerel (Pneumatophorus grex), and Moonfish (Vomer setapinnis) from St. Margaret Bay, N. S., in September, and several other species of fish and invertebrates. (Appendix 92).

#### HYDROGRAPHY

The hydrographic investigations of the Atlantic Oceanographic Group, with headquarters at the Station, are of basic importance to the Station's work and close co-operation between the Station and the Group continued. The work of the Group is summarized in the report of the Joint Committee on Oceanography.

The program of regular quarterly cruises, making representative hydrographic sections of the waters of the Bay

of Fundy, Scotian Shelf and Gulf of St. Lawrence, which was developed by consultation between the Station and the Group, remains one of the Group's most important activities. It is supplemented by a long-term program of more frequent observations at nine coastal points. As these projects continue they are laying the basis for an understanding of the hydrographic changes responsible for many of the changes in abundance and movements of the organisms with which the Station's work is concerned. We hope that eventually, although perhaps in the distant future, prediction of these hydrographic changes will become possible. In the meanwhile, knowledge of them helps to explain changes in fisheries and to distinguish those which are man-made, and possibly controllable, from those which are natural.

The Group has co-operated with the Station in obtaining hydrographic information associated with a number of investigations, including those on herring drift-netting, occurrence of lobster larvae, and mortalities of scallops.

#### CO-OPERATION WITH OTHER BODIES

##### International Commission for the Northwest

Atlantic Fisheries. All of the ten countries which concluded a convention in 1949 "for the investigation, protection and conservation of the fisheries of the northwest Atlantic Ocean" have ratified except France, whose ratification is expected. A majority of the countries interested in the fisheries in each of the Commission's Sub-areas have now become members and action by the Commission is possible not only in Sub-area 5 (off New England) in which Canada's interest is only moderately great, but also in Sub-area 4 (Scotian Shelf and Gulf of St. Lawrence) and Sub-area 3 (Grand Banks and off Newfoundland) which are very important to our fisheries. As it is the expressed policy of the Commission to fulfil its purposes in so far as possible by co-ordinating research by the various nations themselves, the work of the Board's two biological stations on the Atlantic coast must be closely related to that of the Commission. The development of the Commission's membership to the stage where action is possible in the areas on which the Canadian fishery depends increases the value and urgency of the work of the two stations in the ground-fish field.

At the Commission's second annual meeting, at St. Andrews, N. B., in early July, 1952, special attention was paid to the development of an adequate program of research for the Convention area as a whole. A special committee of one or two scientists from each country was appointed to draft a program. The Station's Director, as scientific adviser to the Canadian Commissioners, represented Canada at a meeting of this committee at Copenhagen at the end of September. He was also re-elected chairman of the Commission's Standing Committee on Research and Statistics.

The Station continued to play an active part in co-operation with scientists of the U. S. Fish and Wildlife

Service in the formulation of recommendations of an experimental minimum mesh size for otter trawlers engaging in the haddock fishery in the New England area (Sub-area 5), the Director and members of the staff attending a third meeting for this purpose at Woods Hole in January, 1952. The Director, on behalf of the Department of Fisheries, discussed the proposals with the industry at Halifax in February and, with Mr. McCracken, attended the meeting of Panel 5 at Ottawa at the end of that month, at which the proposal was approved and recommended to the Commission which approved it at its meeting in July. The Station will continue to co-operate with the U. S. Fish and Wildlife Service in planning and interpreting the research to follow the results of the experiment.

At its July, 1952, meeting the Commission postponed the final selection of the site for its headquarters and the Station is providing space and some facilities for another year. Dr. Martin, on leave from the Station's staff, acted as the Commission's first Executive Secretary until November, 1952, when he was replaced by Dr. E. M. Poulsen of Denmark. Dr. Martin played a very important part in the development of the Commission's organization and work, especially good progress being made in the field of fisheries statistics.

#### Prince Edward Island Fisheries Development Committee.

The Director continued, in 1952, to represent the Dominion Government on this Committee, involving a number of meetings and some effort in bringing together information from government sources, including the Station itself. The Committee, in 1952, while paying some special attention to problems of the lobster industry, continued in its main work of formulating a program of development for the Province's fisheries as a whole. Completion of an interim report in the winter of 1952-53 is planned.

Joint Committee on Oceanography. The Station continues to co-operate closely with the Atlantic Oceanographic Group, which carries out hydrographic investigations planned to meet the Station's needs both general and particular. Dr. Lauzier of the Station's staff works with the Group on the Station's problems.

Newfoundland Fisheries Research Station. Close contact between the two Stations continued, their programs being planned so as to be complementary. There was mutual assistance in planning and in field work in groundfish, seal, salmon and other investigations.

Public Health. The close co-operation between the Department of National Health and Welfare, the Department of Fisheries and the Station continues to bear fruit. The Inter-departmental Shellfish Committee, of which the Director is Chairman, Mr. Logie secretary and Dr. Medcof a very active member, continued to discuss and plan the investigations and the administrative policies necessary to protect public health with a minimum of interference with the commercial use of the shellfish. The Committee's work has concerned mainly the various public health problems of the oyster, clam and scallop industries, including closure of polluted areas, self-purification of polluted

shellfish, closures of areas when paralytic shellfish poisoning is a threat, proper sanitary control of processing and transport and many other matters important both to the public health and to the fisheries. In 1952 the Station, the Fish Inspection Laboratory and the Laboratory of Hygiene co-operated in developing a practical procedure for the self-purification of clams which it is hoped to put into commercial practice in 1953.

Co-ordinating Committee on Atlantic Salmon. This Federal-Provincial advisory committee was formed in 1949 to co-ordinate research, regulation and development work by the governments of Canada and of the five Atlantic provinces. The Station has played an important part in the Committee's work, the Director being chairman and Dr. Kerswill secretary. At a special meeting called by the Deputy Minister of Fisheries in July, 1952, at Ottawa plans were laid for expansion both of research and of development work and the Station, through Dr. Kerswill, was given increased responsibility in the development of this expanded program as a whole. (Appendix 79).

Provincial Government Departments. The expanding research activities of the Quebec Department of Fisheries in the northern parts of the Gulf of St. Lawrence are of special interest to the Station's work. Exchange of information and mutual assistance is being arranged in a number of fields, especially hydrography, salmon (see above) and herring. The Station is in contact with the fisheries administrations of the three Maritime Provinces and Newfoundland with many instances of exchange of information and advice. The Station co-operated with the New Brunswick government (through Mr. R. A. Tweedie) in exploration of the prospects for developing salt-water sport fishing in the Passamaquoddy Bay area.

#### ASSISTANCE TO OTHER SCIENTISTS

Miss Constance MacFarlane of the Nova Scotia Research Foundation again used the Station's facilities for studies on the life histories of seaweeds.

Facilities were also provided again for work on the comparative cytology of blood by Miss Mary E. Needler for Dr. Vibeke Englebort of the University of Toronto.

Dr. W. B. Scott, of the Royal Ontario Museum, and two technicians, were assisted in the collection of material for displays on marine fish being prepared in co-operation with the Department of Fisheries.

Dr. Althea Warren of the University of New Brunswick was given assistance in obtaining material for research on the hardening of fish eggs.

Live four-spine sticklebacks (Apeltes quadracus) were shipped successfully to Mr. J. van Iersel of Leiden University, Holland, for use in a comparative behaviour study of other members of the stickleback family. (Appendix 91).

### PERSONNEL

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

Dr. W. R. Martin, on leave of absence since July 1, 1951, to act as Executive Secretary of the International Commission for the Northwest Atlantic Fisheries, returned to the Station's staff on November 25, 1952, and again took charge of its investigations on groundfish.

Dr. C. J. Kerswill, seconded to the Headquarters Unit since October 1, 1950, returned to the Station on October 1, 1952, in charge of its investigations on Atlantic salmon.

Mr. D. W. McLeese was appointed to the full-time staff of the Station on May 1, 1952, as Assistant Scientist assigned for the time being to investigation of factors influencing the survival of lobsters.

### MAJOR CHANGES IN PHYSICAL PLANT

The smaller double cottage at the Station at St. Andrews was winterized by the construction of a basement, the installation of a hot-water heating plant, the insulation of walls and ceilings and the provision of storm windows. The southern half was allotted as office space to the International Commission for the Northwest Atlantic Fisheries and the northern half rented to its Executive Secretary as living quarters.

During the summer public electricity became available to the Ellerslie sub-station, permitting the use of a wider range of equipment.

A dam was built during the summer at the head of tide on Ellerslie Brook as part of a long-term program of investigation of the effects of dams and ponds on the migrations and numbers of trout. It is provided with gates which permit draining of the pond, and with space for a fishway and screens.

### INFORMATION AND EDUCATION

Individual contacts and correspondence remain the principal means of bringing our results to those in the administration or in the industry. There is a great deal of correspondence in which information and advice is given to other branches of government or to the fishing industry. The volume of enquiries on matters of general interest in the fields of fisheries and marine biology has been increasing steadily. Many specimens are sent in for identification.

Publications, a list of which is attached, again show increase over the preceding year, and this is also true of publications in preparation.

In 1952 the Station made eighteen recordings for use by C.B.C. in its Fishermen's Broadcasts and elsewhere.

At the Grand Manan Hospital Fair, August 6 to 11, the Station presented an exhibit on lobsters which received much favourable comment. It included panels illustrating various aspects of the lobster investigations, live and preserved larvae and lobsters of various sizes, tanks with live lobsters showing moulting, etc., in one of which artificial sea water was used successfully. Departmental and Board publications were distributed. Display material was also provided to the Shediac Lobster Festival, July 9 to 12.

A number of addresses on the Station's work were given during the year, including those by Mr. J. W. Saunders on trout investigations to the combined Maritime Provinces' Fish and Game Associations and to certain local groups, and that by Mr. H. D. Fisher on seals to the annual convention of the Canadian Veterinary Medical Association at St. Andrews early in September.

The Director discussed the basis for lobster regulations with fishermen, principally from eastern Nova Scotia, as part of a short course by the Extension Department of St. Francis Xavier University in February, 1952.

Dr. M. W. Smith gave a seminar and a public address on trout investigations, and the Director a seminar on regulation of fisheries, using the proposed mesh experiments on George's Bank as the principal example, at the University of New Brunswick at the end of March, 1952.

#### ACKNOWLEDGEMENTS

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, 1952, except for seasonals)

Director

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

Scientific Assistant to Director

A. Scientific and Investigational Staff

1. Lobster

Sen. Scientist in charge	D. G. Wilder, Ph.D.
Assist. Scientist	D. W. McLeese, M.Sc.
Technician I	R. C. Murray
Technician I	L. G. Kervin
Assist. Tech. III	U. J. Walsh
Assist. Tech. III	L. P. Thibault, B.A.
Jun. Res. Assist. - Seasonal	Marjorie A. Myers, B.Sc.
Jun. Res. Assist. "	Anne S. Henry

2. Oyster

Assoc. Scientist in charge (also in charge of Prince Edward Island Biological Station)	R. R. Logie, M.A.
Technician I	A. A. Skinner, B.Sc.
Main. Supervisor II	P. C. MacCaul
Jun. Res. Assist. - Seasonal	Barbara L. Shaw, B.A.
Jun. Res. Assist. "	N. P. LeBlanc
Jun. Res. Assist. "	F. E. Warburton

3. Clam and Scallop

Sen. Scientist in charge	J. C. Medcof, Ph.D.
Technician I	J. S. MacPhail
Assist. Scientist - Seasonal	L. P. Chiasson, Ph.D.
Jun. Res. Assist. "	J. C. Duffield

4. Groundfish

Assist. Scientist in charge	F. D. McCracken, M.A.
Assist. Scientist	L. M. Dickie, M.Sc.
Technician II	G. J. W. Sullivan
Technician I	D. N. Fitzgerald
Technician I	M. F. Fraser
Assist. Tech. III	R. M. MacPherson
Assist. Tech. II	Jean M. Stuart, B.Sc.
Stenographer IIA	Shirley B. Cunningham
Stenographer IIA	Catherine Morrison
Sen. Res. Assist. - Seasonal	R. W. Wolfgang, Ph.D.
Sen. Res. Assist. "	D. M. Scott, Ph.D.
Jun. Res. Assist. "	W. L. Klawe

5. Herring

Sen. Scientist in charge	S. N. Tibbo, M.A.
Assist. Tech. III	E. G. Sollows
Assist. Tech. I	Phyllis J. Gibson
Jun. Scientist - Seasonal	H. D. Edwards-Davies

6. Smelt  
Assoc. Scientist in charge  
Assist. Tech. III  
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  
Sen. Res. Assist. - Seasonal  
Jun. Res. Assist. "  
M. W. Smith, Ph.D.  
J. W. Saunders, M.Sc.  
C. R. Hayes  
Colleen C. Carten, B.Sc.  
R. M. Spence, M.Sc.  
S. E. Vass, B.Sc.
8. Salmon  
Sen. Scientist in charge  
(seconded to HQ until  
Sept. 30, 1952)  
Sen. Scientist  
Assoc. Scientist  
Assist. Tech. III  
Assist. Tech. II  
Assist. Tech. II  
Assist. Tech. II - Term  
Jun. Scientist - Seasonal  
Jun. Res. Assist. "  
Jun. Res. Assist. "  
C. J. Kerswill, Ph.D.  
P. F. Elson, Ph.D.  
H. C. White, B.A.  
R. J. Wiley  
H. W. Coates  
P. R. Graves  
W. Curtis  
H. Godfrey, M.A.  
J. K. Lowther  
W. S. Huestis
9. Seals  
Assoc. Scientist in charge  
Technician I  
H. D. Fisher, M.A.  
B. A. Mackenzie, B.Sc.
10. Fish taxonomy and distribution  
Prin. Scientist  
A. H. Leim, Ph.D.
11. Eel-grass  
Jun. Scientist - Seasonal  
A. R. A. Taylor, B.A.
12. Miscellaneous (including Tuna,  
Museum and Library)  
Assoc. Scientist in charge  
Clerk IIB  
L. R. Day, M.A.  
M. Beryl Stinson
13. Statistical Consultant  
Assist. Scientist - Seasonal  
G. F. M. Smith, Ph.D.
14. Hydrographer  
Assoc. Scientist  
(see also Atlantic Oceanographic Group below)  
L. M. Lauzier, D.Sc.
15. Engineer  
Assist. Scientist  
C. E. Petite, B.Sc.
16. General Laboratory Assistance  
Assist. Tech. I  
Mary Holmes

B. Administrative and Maintenance Staff

1. Director's Secretary and Office

Clerk IV	Nina M. Parker
Stenographer III	Winifred E. Dougherty
Stenographer IIA	Lois G. McMullon
Stenographer IIA	Hazel L. Grant
Typist I (and switchboard operator)	Mary E. Johnston

2. Accounts, Stores and General

Administrative Officer II	J. A. Rogers, A.C.B.A.
Clerk III	Frances L. Stinson

3. Buildings, Grounds and Boats

Main. Supervisor V	H. Y. Brownrigg
Main. Supervisor I	F. E. Purton
Assist. Tech. III (Boatman)	W. G. Carson
Caretaker III	K. W. Johnston
Caretaker III (Watchman)	H. E. Lee
Caretaker III (Groundsman)	D. A. Stinson
Caretaker III	C. S. Tucker

"J. J. Cowie"

Tech. II (Captain)	H. H. Butler
Engineer	B. W. Hart
Three additional crew	

"Mallotus"

Tech. I (Captain)	R. H. McDonald
Two additional crew	

"Gulf Explorer"

Assist. Tech. III (Captain)	L. I. Cross
One additional crew	

"Pandalus"

Tech. I (Captain)	C. J. Bayers
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Atlantic Oceanographic Group  
(responsible to Joint Committee on Oceanography)

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

Associate Scientist	H. B. Hachey, M.Sc.
Assistant Scientist	H. J. McLellan, M.Sc.
Junior Scientist	W. B. Bailey, B.Sc.
Assist. Tech. III	R. W. Trites, B.Sc.
Assist. Tech. I	J. A. Sullivan, B.A.
Stenographer IIA	C. C. Cunningham
Assist. Scientist - Seasonal	Madelyn M. Meating
Jun. Res. Assist.	D. G. MacGregor, M.A.
"	Joyce E. Johnston

## STAFF

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(To December 1, 1952)

(Total full-time staff as of December 1 numbered 74, including 9 AOG)  
(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.	Principal Scientist
P.F. Elson, M.A., Ph.D.	Senior Scientist
C.J. Kerswill, M.A., Ph.D.	Senior Scientist (seconded to Headquarters to Sept. 30)
W.R. Martin, M.A., Ph.D.	Senior Scientist (on leave of absence to Nov. 24)
J.C. Medcof, M.A., Ph.D.	Senior Scientist
M.W. Smith, M.A., Ph.D.	Senior Scientist
S.N. Tibbo, M.A.	Senior Scientist
D.G. Wilder, M.A., Ph.D.	Senior Scientist
L.R. Day, M.A.	Assoc. Scientist
H.D. Fisher, M.A.	Assoc. Scientist (on educational leave to April 30, 1952; on educational leave from October 20, 1952)
L. Lauzier, M.Sc., D.Sc.	Assoc. Scientist
R.R. Logie, M.A.	Assoc. Scientist
F.D. McCracken, M.A.	Assoc. Scientist
R.A. McKenzie, M.A.	Assoc. Scientist
H.C. White, B.A.	Assoc. Scientist
L.M. Dickie, M.Sc.	Assist. Scientist
C.E. Petite, B.Sc., B.E.	Assist. Scientist
J.W. Saunders, M.Sc.	Assist. Scientist
D.W. McLeese, M.Sc.	Assist. Scientist (from May 1)
W.F. Black, B.Sc.	Junior Scientist (term employment to June 23)

Seasonal:

L.P. Chiasson, Ph.D.	Assist. Scientist (May 23 - Sept. 20)
G.F.M. Smith, Ph.D.	Assist. Scientist (May 1 - July 31)
A.R.A. Taylor, B.A.	Assist. Scientist (May 30 - Sept. 26)
H.D. Edwards-Davies	Junior Scientist (May 16 - Sept. 27)
H. Godfrey, M.A.	Junior Scientist (May 14 - Oct. 31)
D.M. Scott, Ph.D.	Junior Scientist (July 30 - Sept. 3)
R.M. Spence, M.Sc.	Sr. Res. Assist. (May 22 - Aug. 31)
R.W. Wolfgang, Ph.D.	Sr. Res. Assist. (May 2 - Sept. 30)
J.C. Duffield	Jr. Res. Assist. (June 5 - Aug. 28)
Anne S. Henry	Jr. Res. Assist. (May 12 - Sept. 12)
W.S. Huestis	Jr. Res. Assist. (May 22 - Aug. 31)
W.L. Klawe	Jr. Res. Assist. (May 23 - Sept. 15)
N.P. LeBlanc	Jr. Res. Assist. (May 21 - Sept. 9)
J.K. Lowther	Jr. Res. Assist. (May 12 - Sept. 30)
Marjorie A. Myers, B.Sc.	Jr. Res. Assist. (June 2 - Aug. 31)
Barbara L. Shaw, B.A.	Jr. Res. Assist. (June 5 - Aug. 31)
S.E. Vass, B.Sc.	Jr. Res. Assist. (May 19 - Sept. 30)
F.E. Warburton	Jr. Res. Assist. (May 12 - Sept. 19)

H.Y. Brownrigg	Maintenance Supervisor V
P.C. MacCaull	Maintenance Supervisor II
F.E. Purton	Maintenance Supervisor I
K.W. Johnston	Caretaker III
H.E. Lee	Caretaker III (Watchman)
D.A. Stinson	Caretaker III (Groundsman)
C.S. Tucker	Caretaker III
J.A. Rogers, A.C.B.A.	Administrative Officer II
Nina M. Parker	Clerk IV
Winifred E. Dougherty	Stenographer III
Frances L. Stinson	Clerk III
Shirley B. Cunningham	Stenographer IIB
M. Beryl Stinson	Clerk IIB
Hazel L. Grant	Stenographer IIA
Lois G. McMullon	Stenographer IIA
Catherine Morrison	Stenographer IIA (from June 2)
Mary E. Johnston	Typist I
G.J.W. Sullivan	Technician II
D.N. Fitzgerald	Technician I
M.F. Fraser	Technician I
I.M. Jones	Technician I
L.G. Kervin	Technician I
B.A. Mackenzie, B.Sc.	Technician I
J.S. MacPhail	Technician I
R.C. Murray	Technician I
A.A. Skinner, B.Sc.	Technician I (to October 15)
S.E. Vass, B.Sc.	Technician I (from October 1)
C.R. Hayes	Assist. Tech. III
R.M. MacPherson	Assist. Tech. III (from July 19)
E.G. Sollows	Assist. Tech. III
L.P. Thibault, B.A.	Assist. Tech. III (from July 2)
U.J. Walsh	Assist. Tech. III
R.J. Wiley	Assist. Tech. III (from June 30)
Colleen C. Carten, B.Sc.	Assist. Tech. II
H.W. Coates	Assist. Tech. II
Wm. Curtis	Assist. Tech. II (term employment to November 27)
P.R. Graves	Assist. Tech. II
Evelyn R. MacMillan	Assist. Tech. II
Jean M. Stuart, B.Sc.	Assist. Tech. II
W.W. Yorston	Assist. Tech. II (retired July 23)
Phyllis J. Gibson	Assist. Tech. I
Mary Holmes	Assist. Tech. I
Esther I. Lord	Assist. Tech. I ( $\frac{1}{2}$ time to March 31; $\frac{1}{2}$ time from Nov. 16)
H.H. Butler	Technician II (Captain)
C.J. Bayers	Technician I (Captain)
V.K. MacDonald	Technician I (Captain) (to January 15)
R.H. McDonald	Technician I (Captain)
W.G. Carson	Assist. Tech. III
L.I. Cross	Assist. Tech. III (Captain)
E.C. Gardner	Engineer (from June 6)
B.W. Hart	Engineer

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.	Junior Scientist (educational leave with half pay to May 1, and again from Sept.15)
J.A. Sullivan	Assist. Tech. III
J.H. Hull	Assist. Tech. II (from Oct. 6)
G.B. Taylor	Assist. Tech. II (from Sept. 14)
L.H. Brownrigg	Assist. Tech. I (to Aug. 7)
C.C. Cunningham	Assist. Tech. I
Madelyn M. Meating	Stenographer IIA

Seasonal:

D.G. MacGregor, M.A.	Assist. Scientist (June 11 - Sept. 14)
Joyce E. Johnston	Jr. Res. Assist. (May 26 - Sept. 20)

## 1952 PUBLICATIONS

### Fisheries Research Board Publications

#### Journal

- Battle, Helen I. A Morphological and Physiological Study of Developmental Processes in the Three-spined Stickleback (Gasterosteus aculeatus, L.). Submitted to Editor.
- Hachey, H. B. A Winter Incursion of Slope Water on the Scotian Shelf. (in press).  
Vertical Temperature Distribution in the Great Lakes. (in press).
- Ketchum, B. H., and D. J. Keen. The Exchanges of Fresh and Salt Waters in the Bay of Fundy and in Passamaquoddy Bay. Submitted to Editor.
- Lauzier, L. Effect of Storms on the Water Conditions in the Magdalen Shallows. Vol. 8, No. 5, pp. 332-339, January, 1952.  
Summer Salinities in the Magdalen Shallows. Accepted.
- MacGregor, D. G., and H. J. McLellan. Current Measurements in the Grand Manan Channel. Vol. 9, No. 5, pp. 213-222, November, 1952.
- McLellan, H. J., L. Lauzier, and W. B. Bailey. The Slope Water off the Scotian Shelf. Accepted.
- Smith, M. W. The Lake Whitefish in Kerr Lake, New Brunswick. Vol. 8, No. 5, pp. 340-346, January, 1952.  
Limnology and Trout Angling in Charlotte County Lakes, New Brunswick. Vol. 8, No. 6, pp. 383-452, April, 1952.
- Smith, Verna Z. Further Ostracoda of the Vancouver Island Region. Vol. 9, No. 1, pp. 16-41, July, 1952.
- Wilder, D. G. The Relative Toxicity of Certain Metals to Lobsters. Vol. 8, No. 7, pp. 486-487, May, 1952.  
A Comparative Study of Anadromous and Fresh-water Populations of Brook Trout (Salvelinus fontinalis (Mitchill)). Vol. 9, No. 4, pp. 169-203, October, 1952.  
The Growth Rate of the American Lobster. Accepted.

Bulletin

White, H. C.           The Eastern Belted Kingfisher in the Maritime Provinces. Accepted.

Progress Reports of the Atlantic Coast Stations

- Dickie, L. M.           Changes in Digby Scallop Landings - How and Why. No. 54, pp. 12-18.
- Lauzier, L.            Recent Water Temperatures along the Canadian Atlantic Coast. No. 53, pp. 5-7.
- McLellan, H. J.        Fluctuating Inshore Water Temperatures in Autumn. No. 53, pp. 3-5.
- Medcof, J. C.          Modification of Drags to Protect Small Scallops. No. 52, pp. 9-14.
- Medcof, J. C., and J. S. MacPhail. The Winter Flounder - a Clam Enemy. No. 52, pp. 3-8.
- Breakage - The Bug-bear in Clam Handling. No. 54, pp. 19-25.

Atlantic Biological Station Circulars  
(General Series)

- Day, L. R.            The Herring, Alewife and Shad. No. 19, December, 1951.
- Fisher, H. D.          Harp Seals of the Northwest Atlantic. No. 20, September, 1952.

(Statistical Series)

- Martin, W. R., and F. D. McCracken. 1947 Landings of Fresh Groundfish by Offshore Vessels at Nova Scotia Ports. No. 1.
- 1948 Landings of Fresh Groundfish by Offshore Vessels at Nova Scotia Ports. No. 2.

Other Scientific Publications

- Hachey, H. B.         Physical Oceanography in Canada, 1948-51. Assoc. Océanogr. Phys. Procès-Verbaux. No. 5, 86-89, 1952.
- Martin, W. R.         The Statistical Requirements of the International Commission for the Northwest Atlantic Fisheries. For FAO special meeting on fisheries statistics, Copenhagen, May, 1952. (to be published).

- McKenzie, R. A. Greenland Cod (Gadus ogac) in Miramichi Bay, New Brunswick. Copeia, 1952, No. 3, 199-200.
- Arctic or Polar Cod in Miramichi Bay, New Brunswick. Accepted for Copeia.
- Needler, A. W. H. The Biologists' Needs for Fisheries Statistics. For FAO special meeting on fisheries statistics, Copenhagen, May, 1952. (to be published).
- Estuarine Fisheries. Symposium on Estuarine Ecology, Amer. Assoc. Adv. Sci., Philadelphia, Dec. 30, 1952. (to be published).
- Smith, M. W. Fertilization and Predator Control to Improve Trout Production. Can. Fish Cult. (in press).

Miscellaneous

- Kerswill, C. J. First Report Co-ordinating Committee on Atlantic Salmon. 1950.
- Increased Production of Atlantic Salmon Smolts through Experimental Bird Control. Presented at meeting of Committee on Biological Investigations. January, 1952.
- Leim, A. H. Do Echo Sounders Frighten Fish? Canadian Fisherman, Vol. 39, No. 6, pp. 17-18, June, 1952.
- Medcof, J. C. Effect of Flounders and Drills on Clam Stocks. Presented at meeting of Committee on Biological Investigations. January, 1952.
- Summary of 1951 Canadian East Coast Clam Investigations. Report of Third Annual Conference on Clam Research. U. S. Fish and Wildlife. Boothbay Harbour, January 15-17, 1952.
- Smith, M. W. New Experimental Trout Pond. Department of Fisheries' "Trade News". (in press).
- Tibbo, S. N. Trawling for Sardines in Charlotte County Waters, 1952. Department of Fisheries' "Trade News". May, 1952.

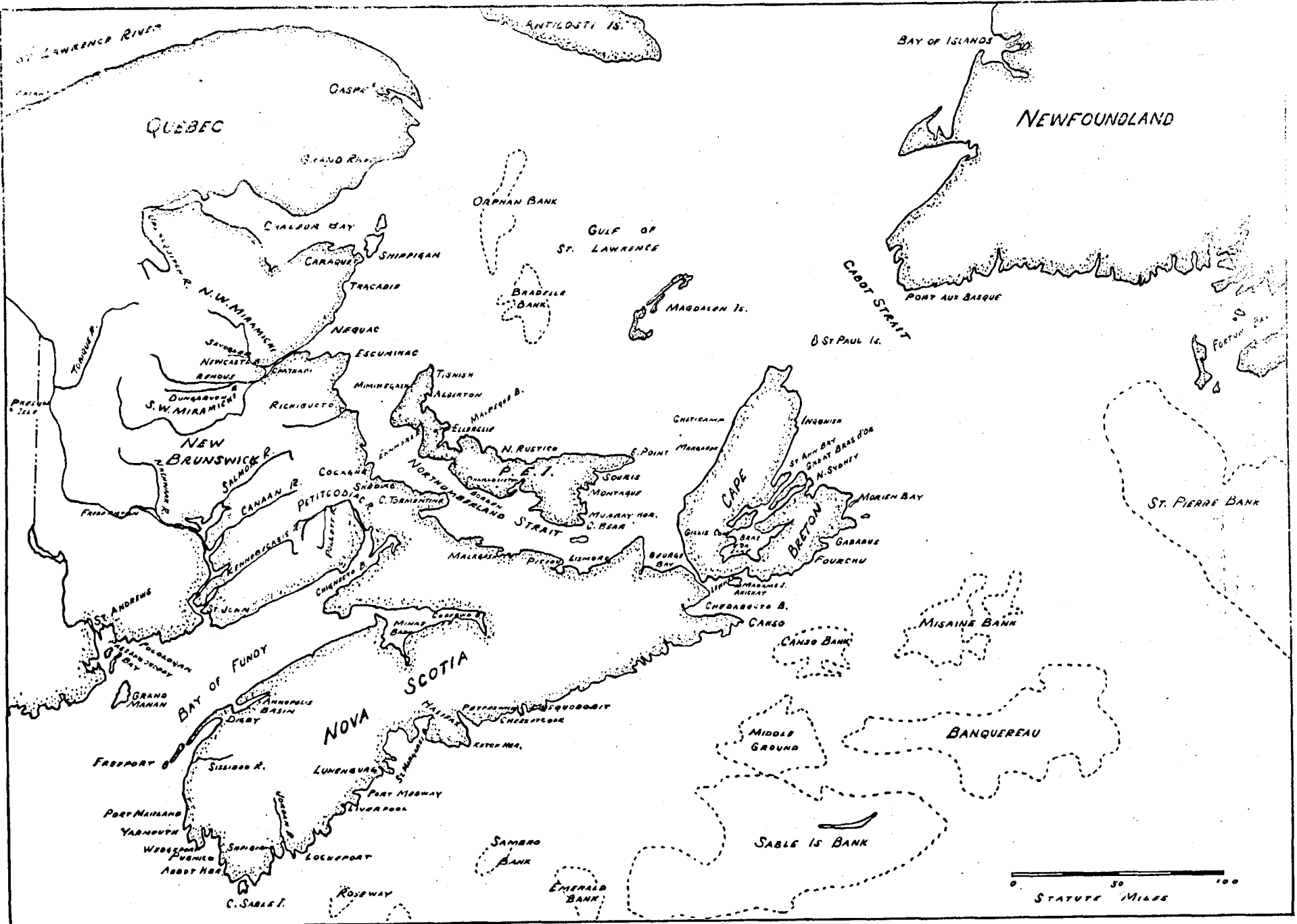
Manuscript Reports of the Biological Stations

- No. 440 Mullan, M. W., A. B. Williams, D. R. Colwell and J. C. Medcof. Preliminary Experiments in the Self-Cleansing of Clams (Mya arenaria L.).
- No. 443 McLellan, H. J. The Effect of Freezing on the Sulphate-Chlorinity Ratio of Sea Water.
- No. 447 Giglioli, M. E. C. Further Observations on the Biology of Whelks of the Family Naticidae including Polinices. Appendix to 1949 Manuscript Report No. 398.

- No. 448 Tibbo, S. N. The Migrations of Herring.
- No. 449 Chiasson, L. P. Scallop Investigations in the Gulf of St. Lawrence and off Eastern Cape Breton Island 1951.
- No. 452 Almy, Lloyd H. The Chemistry of Fish Flesh. A Bibliography.
- No. 453 Elson, P. F. Control of Mergansers to Increase Miramichi Salmon (1950).
- No. 454 Battle, Helen I. The Fundy Survey. The Hake Fishery (1931).
- No. 455 Hachey, H. B. The General Hydrography of the Waters of the Bay of Fundy.
- No. 456 Lauzier, L., and W. B. Bailey. Features of the Deeper Waters of the Gulf of St. Lawrence.
- No. 471 Kerswill, C. J. Factors Limiting the Distribution and Abundance of the Quahaug, Venus mercenaria L.
- No. 472 Adams, James R. Oyster Investigations at Malagash, 1939-1942.
- No. 473A Brannen, R. E. Preliminary Report of the Scallop Investigation at Digby, Nova Scotia, Summer of 1939.
- No. 473B Brannen, R. E. Report of the Scallop Investigation conducted by the Fisheries Research Board of Canada during the summer of 1939.
- No. 474 Rice, F. A. H. Investigations on Factors Influencing the Properties of Irish Moss Extracts, 1944.
- No. 475 McLellan, H. J. Temperature-salinity Relations and Mixing on the Scotian Shelf.
- No. 497A Leim, A. H. Report of Investigation of Pollution arising from Pulp Mills in Northern New Brunswick, September 1941.
- No. 497B Leim, A. H. Report on Pulp Mill Pollution Investigations in the Bay of Chaleur in 1942.
- No. 500 Lauzier, L. Variations of Temperature and Salinity in Shallow Waters of the Southwestern Gulf of St. Lawrence.

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ST. LAWRENCE RIVER

QUEBEC

NEWFOUNDLAND

GULF OF ST. LAWRENCE

NEW BRUNSWICK R.

NOVA SCOTIA

0 50 100  
STATUTE MILES

## LOBSTER POPULATION STUDIES

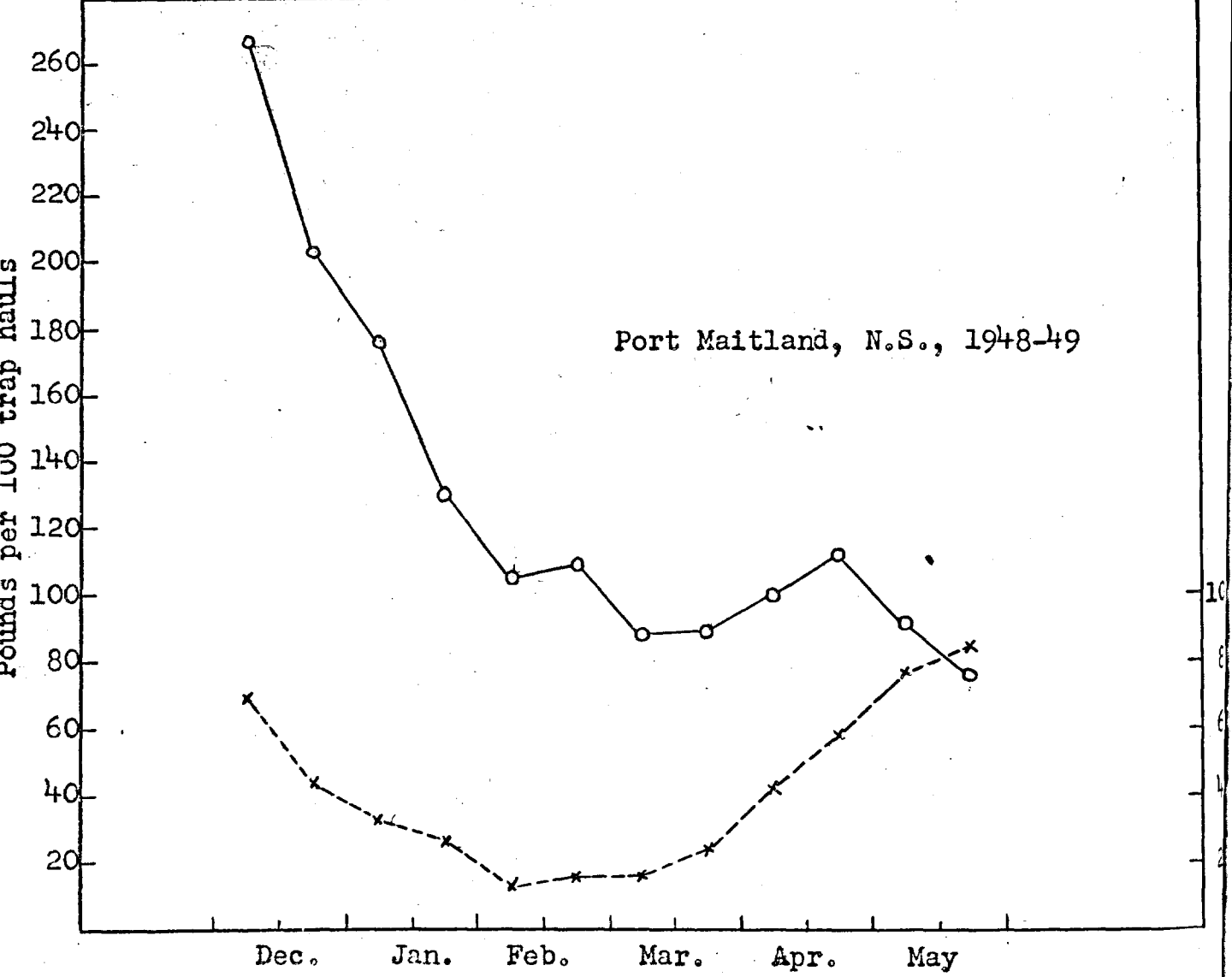
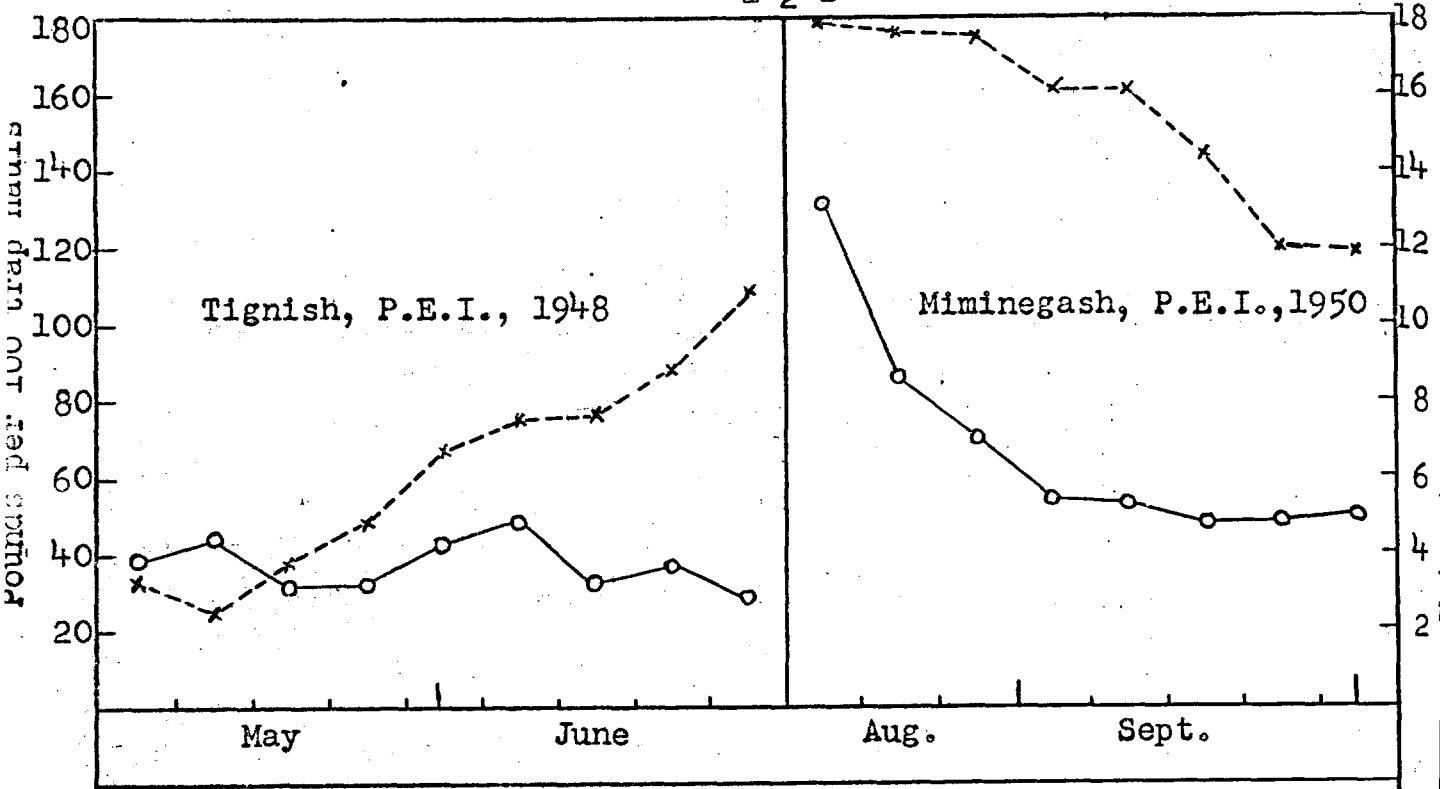
Intensive population studies were continued during 1952 at Tignish and Miminegash, P. E. I., Fourchu and Port Maitland, N. S., and at Grand Manan, N. B. Comparable data on landings, size distributions, catch per unit effort, fishing mortalities, etc., are now available for these ports for the past eight or nine years. Special observations have been made at various other ports as the need arose. Data of this type are voluminous and their analysis time-consuming, many years' observations usually being required to establish population trends and evaluate conservation measures.

As an example of the type of information collected, catch-per-unit-effort and temperature data are presented in the accompanying figure for three rather different lobster areas.

Port Maitland, N. S. In this market-lobster area in southern Nova Scotia, the open season extends from December 1 to May 31. Normally fishing is good during the first two weeks of December but drops off rapidly as the water cools and remains poor during the cold-water February-March period. During April, with rising temperatures, the catch per unit effort rises somewhat. By May the population has been so reduced (56% of tagged lobsters returned during season considered) that in spite of further temperature increases the catch per unit effort declines.

At Tignish, P. E. I., a small-lobster canning area on the north side of P. E. I. (season May 1 to June 30), the initial population usually provides relatively good fishing during the first week of the season. Then, as the population is reduced by the very intensive fishery, the catch per unit effort drops gradually in spite of rising water temperatures. Data for 1948, a relatively cold year, show an interesting departure from this normal pattern. This year the catch per unit effort was low at the start of the season and remained relatively constant during the season, the effect of population reduction apparently being balanced by rising temperatures. During this low-temperature season about 23,000 trap hauls per square mile were required to remove 69% of the stock.

At Miminegash, P. E. I., on Northumberland Strait the lobster population is similar in density and size composition to that of the nearby Tignish area, but the fishery is conducted during a warm-water period (August 10 to October 5). The 1950 catch-per-unit-effort data illustrate the normal pattern. During the first week of the season at the prevailing high temperature fishing is exceptionally good but falls off rapidly as the stock is quickly reduced. Often 50% of the catch is landed and 50% of tagged lobsters recaptured during the first two weeks of fishing. In this warm-water fishery only two-thirds as much effort (15,000 trap hauls per square mile) was required to effect the same reduction in stock as at Tignish.



Catch of lobsters per unit effort at Tignish, Miminegash, (weekly periods) and Port Maitland (half-monthly periods) —○— and average water temperature

Appendix No. 2

GROWTH RATE OF LOBSTERS

From 1947 to 1950 marking experiments were conducted in six widely separated areas to determine the growth rate of lobsters under natural conditions. In these experiments a total of 27,330 lobsters 15 to 25 cm. in total length were sorted into five or six size groups, distinctively marked by means of holes punched through the tail fan, and liberated on the fishing grounds. Of these, 2,419 were recovered four to twelve months after release.

During the winter of 1951-52 the results of these marking experiments were analysed in conjunction with (a) data on the seasonal occurrence and growth of the first four larval stages, (b) published data by Templeman on the effect of water temperature on the frequency of moulting, (c) average water temperatures, and (d) the seasonal occurrence of small lobsters in nature.

These studies show that in the southern Gulf of St. Lawrence 15 to 20 cm. lobsters grow 22 to 25 mm. (13 to 14%) in total length each year and 80 to 95 grams (45 to 53%) in weight. In southern Nova Scotia and Grand Manan 20 to 25 cm. lobsters grew 27 to 34 mm. (12 to 15%) in total length and 170 to 220 grams (43 to 54%) in weight. It is estimated that in the Northumberland Strait area lobsters reach a total length of 14 cm. (5½") at the end of the fifth growing season (4½ years old) and 24 cm. (9½") at the end of the ninth growing season (8½ years).

This material has been prepared and accepted for publication but actual publication will be delayed somewhat in order to incorporate new information collected this fall on the early bottom stages (Appendix 7).

D. G. Wilder

Appendix No. 3

PROPOSED SIZE LIMIT INCREASE FOR CANNER LOBSTERS

During the spring of 1952 the minimum size limit for canner lobsters was changed from 7" total length to 2 3/8" carapace length, a more accurate measure that would facilitate culling and improve size limit enforcement. On the average, the 2 3/8" measure corresponds to a total length of 6.9", as close to the previous 7" limit as possible without resorting to unreasonably small fractions of an inch. However, because of the variation in body form, some lobsters as small as 6.5" total length are now of legal size. The legal sale of lobsters below 7" in length has aroused numerous protests from the industry and as a result an increase in the minimum size to 2½" carapace length has been proposed.

In order to estimate the immediate effect of this 1/8" increase on the landings of lobsters, a total of more than 15,000 lobsters were measured to 1/32" in seven canning areas. The areas sampled differ considerably in the sizes of lobsters caught and can be considered generally representative of the Maritime lobster canning areas.

These figures indicate that during the first year in small-lobster areas such as Tignish and Miminegash, typical of the north side of Prince Edward Island and the northern Northumberland Strait area, the fishermen would land about 25% less lobsters in count, 17% less in weight and 15% less in value than they would have at the 2 3/8" minimum. Considerably less effect is anticipated for the other areas where larger lobsters are caught.

The measurements covered in this report were made by U. J. Walsh and R. C. Murray.

Area	Average carapace length of legal-sized lobsters (inches)	Lobsters 2 3/8" and over			Lobsters between 2 3/8" and 2 1/2"			% Decrease		
		No.	Lb.	Value*	No.	Lb.**	Value	No.	Lb.	Value
<u>P. E. I.</u>										
Tignish	2.71	4087	2494	540	1070	439	88	26.2	17.6	16.3
Miminegash	2.74	8213	4898	1057	1888	774	155	23.0	15.8	14.7
West Pt.	3.00	1047	817	196	60	25	5	5.7	3.1	2.6
Higgins Wharf	2.91	522	370	88	63	26	5	12.1	7.0	5.7
Cape Egmont	2.91	419	314	73	34	14	3	8.1	4.5	4.1
Summer-side	3.34	471	516	144	2	1	.2	.4	.2	.1
<u>N. S.</u>										
Gabarus	2.91	384	278	66	42	17	3	10.9	6.1	4.5

\* Cannery 20¢, markets 30¢

\*\* Calculated average weight 0.41 lb.

Appendix No. 4

FACTORS LIMITING THE SURVIVAL OF LOBSTERS

A knowledge of the effects of environment on the survival of lobsters is essential both for improvement of techniques for handling live lobsters and for better understanding of causes of fluctuations in lobster abundance. Experiments on the effects of temperature, salinity and oxygen on the survival of lobsters were initiated in the summer of 1949 and continued through the summers of 1950, 1951 and 1952.

The complete thermal tolerance range for the lobster was established from upper and lower lethal temperature experiments that were run at a series of acclimation temperatures between 5°C. and 28°C. The changing lethal values consequent upon different conditioning temperatures confirmed previous suggestions that lobsters acclimate to temperature, and complete acclimation for a temperature rise from 14°C. to 24°C. was found to occur in 22 to 24 days.

Concurrently, lower lethal salinities were determined with lobsters acclimated to temperatures between 5°C. and 25°C. The lower lethal salinity was shown to be related to temperature, at least for the time limit of the experiment (48 to 72 hours). Low salinities that are rapidly lethal at high temperatures failed to produce lethal effects when exposure occurred at low temperatures.

Lethal oxygen experiments conducted at 5, 15 and 25°C. revealed that the lethal level of oxygen is low, lying between 0.5 and 0.9 cc./litre and related to temperature. The experiments were done at reduced levels of CO<sub>2</sub> which might explain the unexpectedly low lethal level of oxygen.

It becomes evident from a consideration of these results that environmental factors cannot be considered independently and still present a clear picture of the responses of the lobster to all three factors as they would occur in nature or in commercial holding practices. It was pointed out that acclimation temperature influences markedly the effect of elevated temperature, lowered salinity and lowered oxygen content on the survival of lobsters. Similarly it seemed likely that acclimation salinity (normal sea water in all cases so far discussed) would influence survival in high temperature, low salinity or low oxygen. The same may be said for different levels of oxygen acclimation.

A factorial experiment in which the three environmental factors in question would vary simultaneously was designed and started in the summer of 1952.

It is planned to acclimate lobsters to three temperature levels (5, 15 and 25°C.), three salinity levels (20, 25 and 30‰) and three oxygen levels (2, 3 and 4.5 cc./litre) varying each of these three factors simultaneously, which makes 27 sets of acclimation conditions. Three lethal determinations (upper

temperature, lower salinity and lower oxygen) are to be made with each of the 27 acclimation groups -- 81 determinations in all. Each lethal determination requires 40 lobsters so that, allowing for some holding losses, 4,000 lobsters will be required for the complete experiment.

The size of the experiment and the necessity of observation at irregular hours made it imperative to hold the experiment within its present limits. It was necessary to eliminate such promising factors as size and geographical differences in response to temperature, salinity and oxygen. These factors were controlled by using Charlotte County, N. B., lobsters that measured between 23 and 26 centimeters total length. Further experiments at a later date will consider these factors.

The lethal determinations on lobsters acclimated at 15°C. and one third of the lethal determinations with those acclimated at 25°C., that is 36 lethals in all, have been completed during the summer of 1952. Experiments with lobsters acclimated at 5°C. are planned for January and February, 1953, when they are naturally acclimated to low temperatures. The experiments remaining after this are planned to be completed in the period May to July, 1953.

The results have not been analysed but the following tentative conclusions may be drawn:

(a) Lowered salinity acclimation lowers the lethal temperature and the lethal salinity and may affect the lethal oxygen. A drop of 5% in the salinity acclimation lowers the lethal temperature approximately 2°C. and lowers the lethal salinity approximately 3%.

(b) Lowered oxygen acclimation lowers the lethal temperature, lowers the lethal oxygen and apparently does not affect the lethal salinity. A drop of 2.5 cc./litre (from 4.5 cc./l. to 2.0 cc./l.) lowers the lethal temperature 2°C. and lowers the lethal oxygen approximately 0.2 cc./l.

These tentative conclusions indicate that the experiment as designed will provide information that is basic to the understanding of the combined effects of temperature, salinity and oxygen on the survival of lobsters.

Many of the acclimations and observations involved in this experiment were capably handled by Miss Marjorie Myers and Miss Anne Henry.

D. W. McLeese

Appendix No. 5

LOBSTER HOLDING EXPERIMENTS

Experiments conducted in the winter of 1951 indicated that the inland holding of commercial quantities of lobsters in aerated, artificial sea water was feasible, fifty-pound lots surviving well for several weeks at approximately 50°F. In these experiments the water was not filtered and became very dirty within a few days, making culling difficult and possible increasing mortalities.

During the winter of 1952 further experiments were conducted in order to find a simple filtering technique, to test the efficiency of various filters and to determine the effect of filtration on the survival rate.

To filter the water without resorting to expensive pumps possibly made of toxic metals, a simple air lift was used. A piece of rubber hose (1½" inside diameter) open at both ends was fitted over a 1 1/16" diameter spherical air stone, about ½" above the floor of the tank. Water, forced by air pressure to about 6" above the surface, was allowed to drain back into the tank through the filter material which was held in a small open wooden box. By this means it was possible to filter up to 550 gallons daily.

The first experiment was intended to compare survivals in natural sea water, artificial sea water (Schmalz formula) and in sea water made by re-dissolving salts obtained by the complete evaporation of natural sea water. The filter material used in each tank was glass wool. The lobsters in each tank survived well for 12 days, then weakened and died rapidly. Since mortalities were much higher than in previous non-filtered experiments, the glass wool filter material was suspected of having caused mortalities through mechanical injury to delicate gill tissues, etc. Examination of the water revealed numerous, short glass fibres.

In the second experiment 50 lobsters (50 lb.) were placed in each of three tanks filled with 50 imperial gallons of artificial sea water. One tank was filtered with glass wool, one with cotton gauze and one not filtered. After 14 days the lobsters in the non-filtered tank and in the tank filtered with glass wool started to weaken, 50% dying within 18 days and 100% within 20 days. In the tank filtered with cotton gauze the lobsters survived well for 21 days then started to weaken and 50% died within 26 days. On the 26th day 10 of the weakest survivors were transferred to a tank of fresh artificial sea water, the remainder all dying in the next two days. The 10 transfers responded quickly to the fresh artificial sea water and after 7 days, when the experiment was terminated, 9 were alive and in excellent condition.

In both of the filtered tanks the water remained clear throughout the experiment but with early heavy mortalities occurring in the tank filtered with glass wool this material continues to be regarded with suspicion. Filtration through cotton gauze resulted in a worth-while increase in survival time. Survival times in this experiment, which was run at an average temperature

of 55°F., were considerably shorter than in previous experiments run at 50°F. This suggests that in such closed systems a slight rise in temperature, even though well within the zone of tolerance, may greatly hasten deaths through self-pollution. Further experiments to study the effects of various temperatures are planned.

Many of the observations connected with these experiments were made by R. C. Murray and L. G. Kervin. The lobsters were provided through the courtesy of Conley's Lobsters Ltd.

D. G. Wilder

Appendix No. 6

RELATIVE ABUNDANCE OF LOBSTER LARVAE IN NORTHUMBERLAND STRAIT

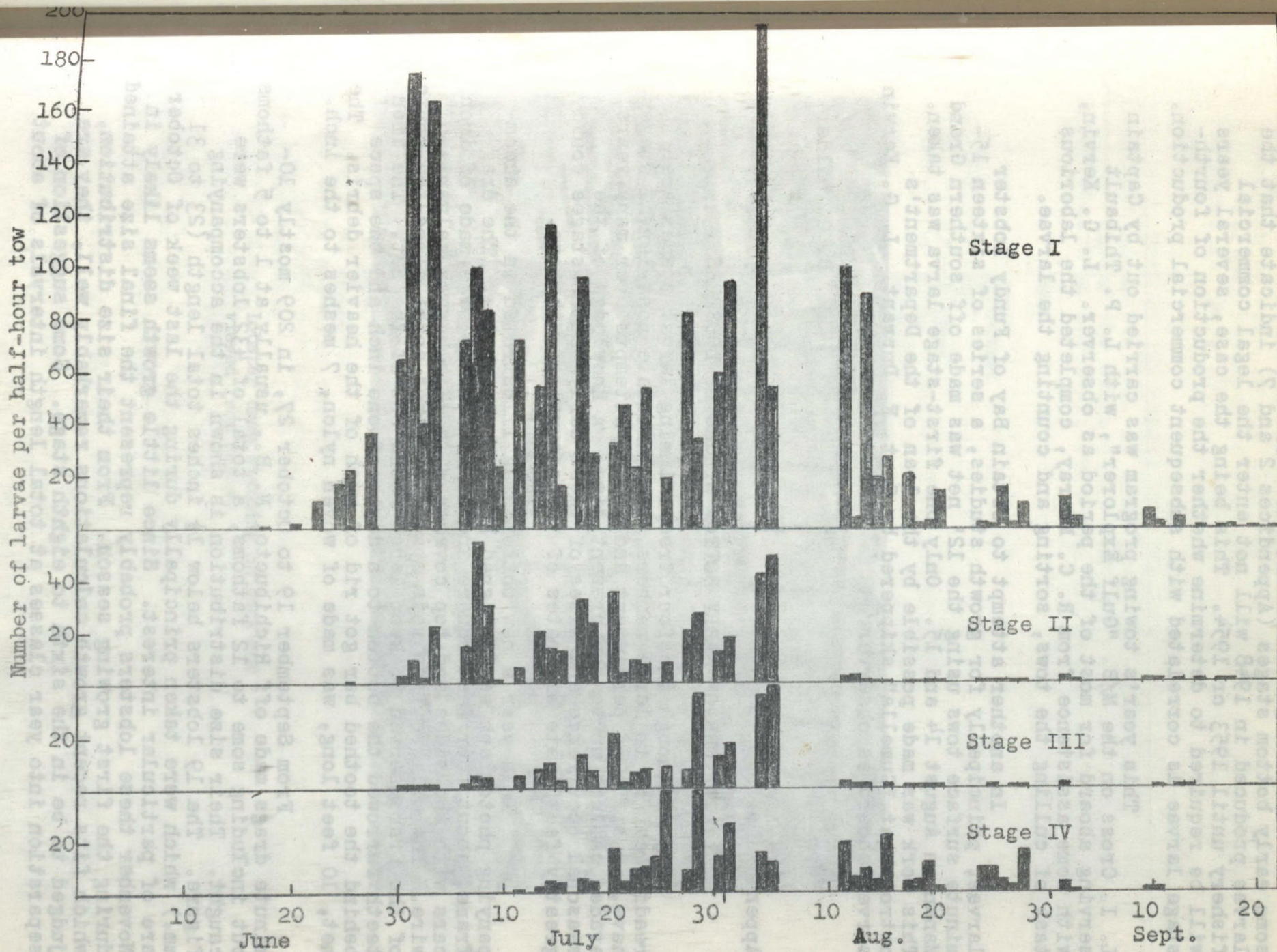
The program of systematic towing started in 1948 to determine the relative abundance of lobster larvae in the Richibucto-Miminegash area of Northumberland Strait was continued in 1952. The seasonal distribution of the four larval stages this year as represented by the daily average catch per tow is shown in the accompanying figure. 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

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

This year for the first time there was a combination of good first-stage production and excellent survival through to the fourth stage; over twenty times as many fourth-stage were taken per tow this year as in 1949. The period of maximum abundance of third-stage larvae may have been missed this year when operations were suspended from August 6 to 11 inclusive for boat maintenance. This may account for the somewhat smaller catches of third-stage larvae as compared to fourths.



Daily average catch-per-tow of lobster larvae, Richibucto, N.B., 1952.

Recent growth estimates, supported by the capture of some early bottom stages (Appendices 2 and 7) indicate that the larvae produced in 1948 will not enter the legal commercial fishery until 1953 or 1954. This being the case, several years will be required to determine whether the production of fourth-stage larvae is correlated with subsequent commercial production.

This year's towing program was carried out by Captain L. I. Cross on the M/B. "Gulf Explorer", with L. P. Thibault serving aboard for most of the period as observer. L. G. Kervin, with some assistance from R. C. Murray, completed the laborious task of culling the tows, sorting and counting the larvae.

In another attempt to obtain Bay of Fundy lobster larvae, principally for growth studies, a series of sixteen 15-minute surface tows using the 12' net was made off southern Grand Manan on August 14 and 15. Only one first-stage larva was taken. This work was made possible by the loan of the Department's patrol boat "Cumella" skippered by Capt. F. Durrant. L. G. Kervin served aboard as observer.

D. G. Wilder

#### Appendix No. 7

#### CAPTURE OF EARLY BOTTOM STAGES OF LOBSTERS

Although the four free-swimming larval stages are readily caught in large numbers, the immediate post-larval stages have, in spite of persistent and varied attempts over many years, evaded capture up to the present time. A knowledge of the seasonal occurrence and sizes of these early bottom stages would greatly facilitate estimates of the natural growth rate.

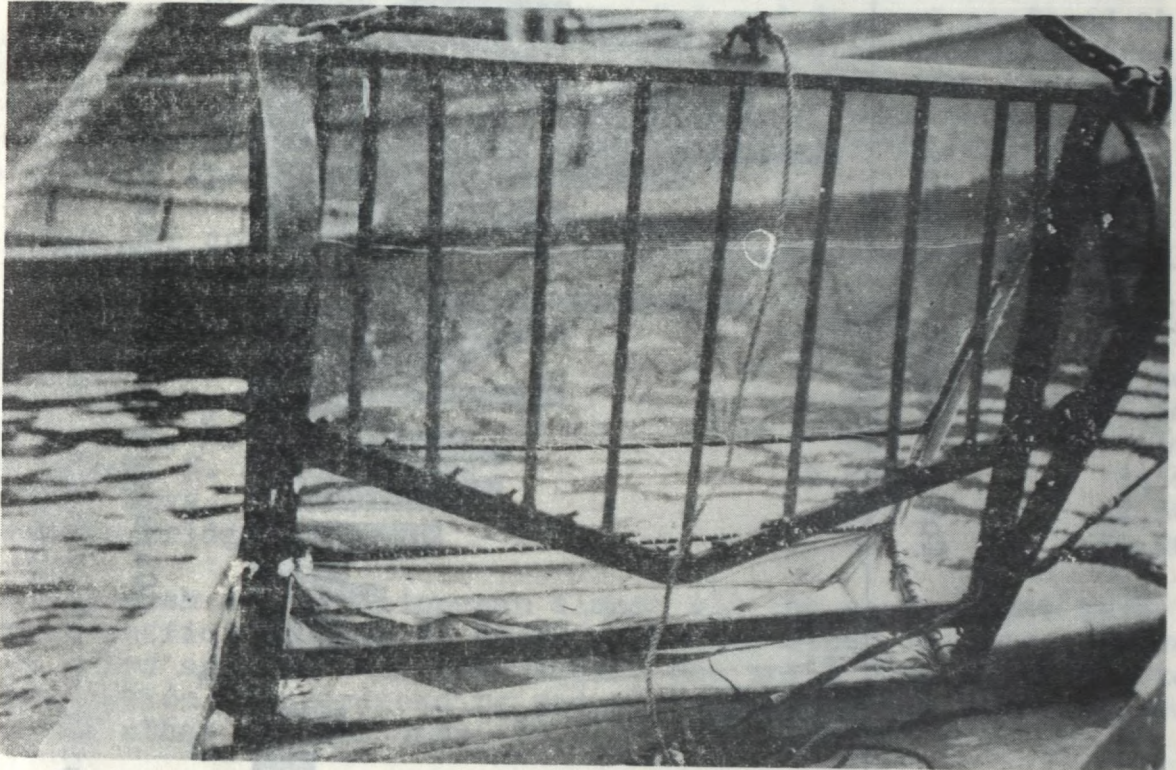
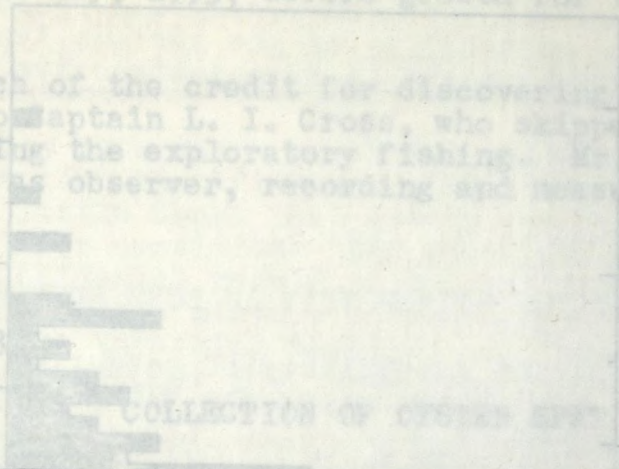
This year a new bottom drag illustrated in the accompanying photograph was designed by H. Y. Brownrigg. The drag frame, about four feet square and one foot deep, was made of iron bars with the sides and top covered with  $\frac{1}{4}$ -inch mesh galvanized wire. The oblique iron rods spaced 6 inches apart along the mouth of the frame served to keep large rocks out of the net. The iron teeth furrowed the bottom to a depth of one inch and the space behind the toothed bar got rid of much of the heavier debris. The net, 10 feet long, was made of woven nylon, 7 meshes to the inch.

From September 19 to October 27, in 209 mostly 10-minute drags made off Richibucto, N. B., usually at 1 to 5 fathoms but including some to 12 fathoms, a total of 432 lobsters were caught. Their size distribution is shown in the accompanying figure. The 19 lobsters below  $1\frac{1}{2}$  inches total length (23 to 31 mm.) which were taken principally during the last week of October are of particular interest. Since little growth seems likely in November these lobsters probably represent the final size attained during the first growing season. From their size distribution, which fits recent growth calculations remarkably well, they are judged to be in the sixth to eighth stage. Some suggestion of separation into year classes at total length intervals of about

which can be seen in the size distribution of the whole  
sample. Further attempts to sample these early bottom stages  
planned for May, 1953, before growth for last year has  
advanced.

Much of the credit for discovering these early bottom  
stages goes to Captain L. I. Cross, who skippered the M/V "Gulf  
Star" during the exploratory fishing. Mr. L. P. Thibault  
was aboard as observer, recording and measuring the catches.

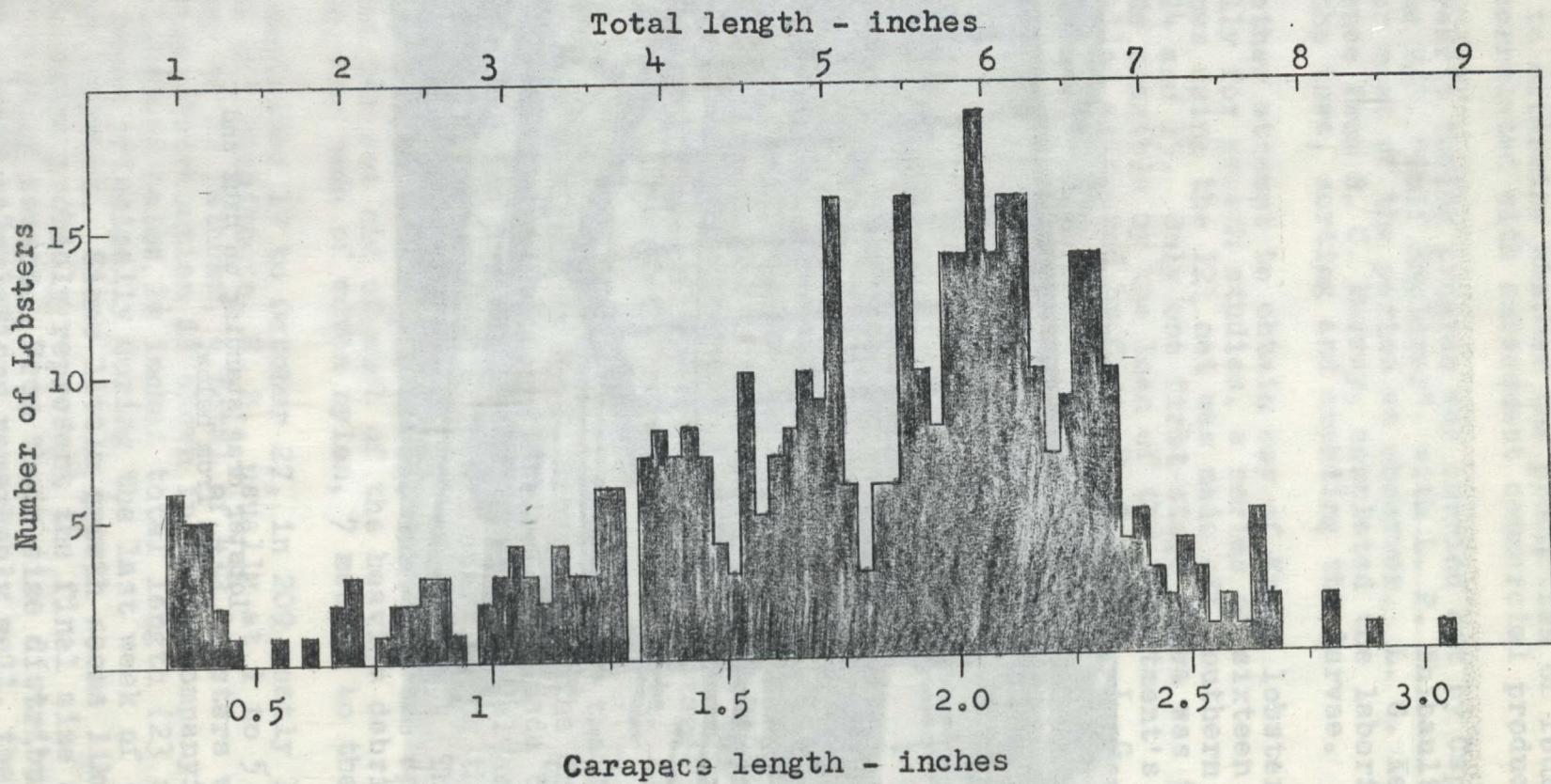
U.S. Fish and Wildlife Service  
Bureau of Fisheries  
Washington, D.C.



Lobster drag standing on back end  
viewed from below.

At Marshe three sets were set on July 17, 1951, and  
there were also one about mid-August. These were first  
sets of maximum size but all were heavy. The sets were  
of maximum size on July 5, and the sets on July 19 of maximum  
size. The sets were set on or about July 15. This was the  
first set that took place this year since the sets were set  
earlier and that the larvae developed in about four days less  
than would be expected.

For the purpose of reproduction, the type of material used  
was tested as cultch. In 1951, a year of larval scarcity, cultch  
was set on concrete-coated filters and on shell. In 1952, a  
year of larval abundance, they set on large rocks on all the  
cultch offered, including the following: concrete-coated



Size composition of lobsters caught by dragging off Richibucto, N.B.  
September 19 to October 27, 1952.

one inch can be seen in the size distribution of the whole sample. Further attempts to sample these early bottom stages are planned for May, 1953, before growth for that year has commenced.

Much of the credit for discovering these early bottom stages goes to Captain L. I. Cross, who skippered the M/B "Gulf Explorer" during the exploratory fishing. Mr. L. P. Thibault served aboard as observer, recording and measuring the catches.

D. G. Wilder

Appendix No. 8

COLLECTION OF OYSTER SPAT

The summer of 1952 was hot and dry and produced abnormally high water temperatures in the oyster-producing areas. As a result spawning was early, heavy and complete; the growth of the larvae was rapid and generally heavy sets occurred. For comparison the 1951 and 1952 sets estimated from counts made in each year are shown below.

Catch per concrete-coated egg-crate filler (700 square inches)

	<u>1951</u>	<u>1952</u>
Bideford River, P. E. I.	200	10,000
Trout River, P. E. I.	700	5,000
Shippegan, N. B.	525	600
Malagash, N. S.	2,700	1,500
Gillis Cove, N. S.	490	1,500
Crowdis Bridge, N. S.	---	14,000

At Malagash and at Shippegan almost all the spat caught have grown sufficiently to be usable. At the other locations between one third and one half are usable, the small size being due to a combination of overcrowding and a late, heavy set superimposed on the other earlier ones.

At Ellerslie three sets occurred on July 17, 19 and 25 and there was also one about mid-August. Of these the first one was maximal, but all were heavy. The set of July 17 was a result of spawning on July 3, and that of July 19 of a spawning of July 5; the spawning responsible for the later sets was not certainly identifiable, but it is probable that the July 25 set resulted from a spawning on or about July 10. This means that the maximal set took place this year some ten days earlier than is usual and that the larvae developed in about four days less than could be expected.

For the past two years, various types of material have been tested as cultch. In 1951, a year of larval scarcity, spat set only on concrete-coated fillers and on shell. In 1952, a year of larval abundance, they set in large numbers on all the cultch offered, including the following: concrete-coated

fillers, crushed oyster shell, birch and alder brush, tarred boards, sheets of polyvinyl plastic, aluminum foil, saran window screening and streamers of dried eel-grass. Neither the year of very light nor the year of very heavy spatfall produced much information about the suitability of the various types of cultch. A year of normal spatfall might be more instructive.

R. R. Logie

#### Appendix No. 9

##### EXPLORING FOR OYSTER BOTTOM WITH AN ECHO SOUNDER

In late May the feasibility of detecting oyster bottom with an echo sounder was tested using the M/B "Gulf Explorer" equipped with a Bendix DR 8.

The boat was first run over known unsuitable bottom and then over leaseholds under cultivation. A comparison of these records gave sufficient confidence to attempt some exploration. A previously known but not exactly located bed was discovered off Grand River, P. E. I., and the bottom of Egmont Bay, P. E. I., was studied.

The least that can be said for this method is that it clearly differentiates the areas of flat, firm bottom, which can be oyster ground, from the surrounding mud. At its best it offers promise of giving much information of a more precise nature concerning the particular type of firm bottom encountered. It is planned to investigate its possibilities further.

R. R. Logie

#### Appendix No. 10

##### RAISING SPAT IN A DYKE

For some years the Department of Fisheries has maintained a dyke, on the Olympia model, at its experimental oyster farm at Malagash, N. S., and recently another was built there. These are low retaining walls built of sand and stone on the tidal flats and are intended to hold water over oysters behind them at low tide. By opening a gate they can be drained at low tide when desired.

They have been used to raise separated spat to planting size by first raising the spat on trays until the collector paper had sloughed away and then holding for a further period until the young oysters were deemed big enough to hold the bottom during storms. This method represented little advantage over ordinary tray raising for an open-water season.

This year a quantity of spat was planted on the bottom of the new dyke directly after separation with the collector paper still adhering. A similar quantity was placed on trays

until the paper had disappeared and then planted in the new dyke at the same concentration. The plots contained three hundred square feet each and received about one hundred and twenty thousand spat each. By mid-September the survivors were slightly in excess of one hundred thousand in each plot but growth was less than was hoped for. All traces of collector paper had vanished.

While this was a small and initial experiment it is of great potential significance. The survival was phenomenal and there is little doubt that growth can be improved by planting at much lower densities. The great density employed this year was an accidental result of the difficulty of assessing the number of spat in the mixture of water, paper, cement and spat issuing from the thrashing machine. If these results can be reproduced, we have for the first time a method which eliminates the costly rearing trays and appreciably lessens the present high cost of planting stock. Every effort will be made to replicate this experiment on a larger scale, but using lower planting densities.

R. R. Logie

#### Appendix No. 11

#### OYSTER INVESTIGATIONS AT RICHIBUCTO

Further to the 1951 work, Mr. Nil LeBlanc, a seasonal research assistant, spent the months of June, July and August investigating the possibilities of predicting the set and of catching the spat.

This year oyster larvae were common in the water and no difficulty was encountered in prediction. Three broods were present and three sets resulted in Richibucto River and two in Mill Creek, a small sheltered tributary entering it from the north some three miles above Rexton.

Because of storm damage to collectors in the main river last year, most of the collectors were placed this year in Mill Creek with only controls in the main river. Again these latter suffered severe damage and it must be concluded that concrete-coated cardboard egg-crate fillers are unsuitable in the main river. No damage resulted to them in Mill Creek however.

The catch was rather lower than was expected from the numbers of larvae present but growth was excellent and this went far towards rendering the catch commercially valuable. In the main river the set amounted to approximately 450 per filler, whereas that in Mill Creek varied from 125 to 700. In the Creek both the best catches and the best growth resulted when the collectors were placed in areas free of eel-grass.

This investigation was designed to determine whether or not spat could be caught by growers using our usual methods

should an oyster farming industry arise there. It has now been demonstrated that the spatfall can be predicted and the set caught in sheltered areas free of eel-grass.

R. R. Logie  
(Condensed from report by Nil LeBlanc)

Appendix No. 12

DDT AND THE BARNACLE SET

In 1949 the dipping of collectors in a 5% solution of DDT in stove oil a few days before putting them out appeared virtually to prevent the settlement of barnacles on the collectors at Shippegan without reducing the set of oysters. At that time strong indications that barnacle sets were sharply localized made it advisable to replicate this experiment. Accordingly the attempt has since been made every summer but to no avail until this summer due to the failure of barnacle sets.

This year the barnacle set was very heavy and we were very fortunate in that it cut across the collectors put out by the Department's experimental oyster farm. Its path could be clearly followed and it could be shown that it swept over some experimental collectors and entirely missed others only a few feet away. Our suspicion that the 1949 results were misleading was amply confirmed. The 1949 and 1952 results of a random sampling of experimental collectors are shown below for untreated collectors and for those dipped in 5% DDT.

	<u>Oyster spat per filler</u>		<u>Barnacles per filler</u>	
	<u>Untreated</u>	<u>Treated</u>	<u>Untreated</u>	<u>Treated</u>
1949	982	957	4771	29
1952	359	430	597	520

In 1952 other collectors near by caught no barnacles regardless of their treatment and it would appear that the proper explanation of the 1949 results is that the untreated collectors were in the path of the barnacle set while the treated ones were not. It is now clear that the DDT treatment is of little or no value in preventing the attachment of barnacles. It may be necessary to move our collector site to an area more frequently free of barnacles than the one now used and it would be desirable to know more about the larval life of the barnacle.

It should be noted here that at Shippegan this year the slipper limpet constituted an additional fouling organism for the first time in the writer's experience.

R. R. Logie

Appendix No. 13

OYSTER DISEASES

(a) The Malpeque disease

The experiments summarized and reported upon in Appendix 11 to the Report of the Atlantic Biological Station for 1951 have been continued.

In Johnston River native oysters of the 1949 year class continue to show a much lower mortality than those of previous year classes. It would also seem that the 1950 and 1951 year classes are exhibiting similar low mortalities of the order of those in the Malpeque controls.

If this be indeed the development of effective resistance to the disease, it means that natural recovery of the oyster population has been accomplished in about fifteen years after the onset of the disease. It is, however, too soon to be certain of this point and observations will be continued.

The results from Enmore River are as yet too few to present any definite pattern.

(b) The West River disease

The background of this investigation is set forth in Appendix 10 to the Report of the Atlantic Biological Station for 1950 and further results are in Appendix 12 to the Report of the Atlantic Biological Station for 1951.

Oysters were fished from West River and placed in cold air storage in Charlottetown on the following dates in 1951: October 18, November 3, November 15 and December 3.

Samples of fifty oysters each were withdrawn from each lot and examined at fortnightly intervals commencing on November 15 and ending on May 3, with the exception of the month of February when road conditions made travel to Charlottetown impossible.

Results were quite similar to those obtained in 1951. About ten per cent of the oysters died showing black gills; a further number developed black gills but lived and these rose to a peak of thirty to forty per cent and then declined. This peak occurred at the same time regardless of the spread of some seven weeks in the times of fishing, but it occurred in February rather than in mid-January as before. The oysters fished earliest, October 18, gave the poorest performance both in the number dying with black gills and in the number exhibiting the conditions in the living state but there was no progressive improvement with fishing dates later than this. Probably those fished on October 18 were not hibernating, whereas the others were.

It should also be noted that although the black-gilled condition has not developed in our experimental trays in East and

West Rivers, it has now been found in a very small number of instances in oysters taken from the affected beds in West River. Eight oysters in four thousand showed the condition in its early stages. However, this has also been noted in oysters from our own Cooper Bed in Bideford River, Malpeque Bay, and in oysters entering the market from the Wallace-Malagash area of Nova Scotia. Our failure so far to associate the blackness in the gills with any pathological condition in these tissues, together with the observations above, renders it probable that this blackness is an indication of poor condition rather than a specific symptom of the West River disease. Since it is so rare except in West River oysters in cold air storage, its usefulness in diagnosis of the West River disease is very little impaired by this realization.

Thanks should be expressed to the Department of Industry and Resources of Prince Edward Island for the free use of the facilities of their cold storage plant and to Mr. Durbar, the manager of this plant, for his courteous co-operation; also to Dr. Harold Shaw of the Department of Health and Welfare of Prince Edward Island for the preparation of routine and of frozen sections of affected oysters.

R. R. Logie

#### Appendix No. 14

#### THE EFFECTS OF BORING SPONGES ON OYSTERS

By a process which is still unknown, Cliona celata excavates extensive cavities in the shells of living and dead oysters. Wax models of these have shown that often most of the shell is destroyed, leaving thin outer and inner layers of calcium carbonate held together by slender pillars, and perforated by many holes. Such shells frequently break when the oyster is opened, exposing either the living sponge or an odoriferous black mass of dead sponge. This is offensive to the trade and has been the subject of complaint, particularly in Malpeque Bay.

Borings usually first appear in the lower valve near the hinge, and separate oysters less than 2½ inches long are seldom affected. However, small oysters attached to spongy shell are frequently entered through the region of attachment; oysters less than one inch long may become heavily infested in this way. The sponge usually passes into the upper valve at the hinge, possibly damaging the hinge ligament since small masses of sponge often occur at the hinge end of the interior of dead shells which have remained closed, and which appear to be held together only by sponge tissue.

When the sponge penetrates to the interior of the shell, the perforation is usually capped by the oyster with a thin layer of conchiolin. However, if the perforation is in the area to which the muscle is attached, a white "pimple" of calcium carbonate is laid over it. In any case, particularly in the spring, a yellowish pustule is likely to occur

in the tissues of the oyster at the point of penetration. Microscopic examination of such a region in the mantle showed a heavy infiltration of amoeboid blood cells into the tissues. In the muscle, a region of almost complete necrosis was surrounded by a large area in which the blood sinuses were enlarged and filled with amoeboid cells.

A technique was developed by which the muscle of an oyster could be detached from the shell without cutting it. Paraffin sections of muscles in which healed sponge perforations occurred showed that the muscle fibres were disarranged in the region of the "pimple" and that a loose pad of fibrous connective tissue lay between them and the white calcium carbonate of the "pimple". Probably the attachment of the muscle to such an area is insecure. Since enough such pimples may occur on the scar to occupy a large fraction of its area, the weakening of the muscle attachment may be serious or even fatal.

Open perforations and pustules became less common as the water of the bay became warmer. Therefore, in July, several spongy oysters were submerged in fifteen fathoms of water outside Malpeque Bay, where the salinity was high but the water temperature was about 6°C. Oysters and sponge survived two weeks of such exposure before their container was lost. The oysters showed many complete perforations of the shell, which did not occur in controls in the warm water of the bay; the oysters in the cold water failed to repair artificial holes in their shells, and the sponge was expanded in feeding position when withdrawn from the cold water. Probably the sponge remains active and capable of boring at temperatures below those at which the oyster can repair its shell, so that serious damage to oysters may occur during the winter and spring. Experiments have been set up to test this supposition.

A small area of the Cooper Bed, on the Department of Fisheries' experimental oyster farm in the Bideford River, was selected for a statistical study of the severity of infestation of oysters. Material for study was obtained by dredge hauls close to a line permanently marked by two concrete blocks. The oysters so obtained are probably representative, in age and size, of those throughout the bed, but the degree of sponge infestation is known to differ significantly in different areas of the bed, being lightest in the shallow water on the crown of the bed and becoming more severe in the deeper water at its edges. The survey is located near one edge of the bed.

The oysters sampled may conveniently be divided into two size groups, greater and less than 7 cm. in length. Of the larger oysters, 66% showed sponge borings, and living sponge was present in 30%. Of the smaller oysters, only 38% were infested, but the sponge was still alive in 33%. However, 67% of the small oysters which were infested were attached to larger oysters or shells which were occupied by Cliona and the upper valve was attacked in only 6%, indicating that infestation had occurred through the region of attachment. The upper valves of large oysters were bored less frequently than the lower valves, but the difference was not nearly as great.

Living oysters, "cluckers", and separated pieces of oyster shell appeared to be attacked with the same frequency, but empty quahaug shells were probably bored significantly less often, perhaps because they are more likely to be buried in mud.

Since the sponge almost invariably spreads from the hinge end of an oyster shell, the distance from the hinge to the boring farthest from it has been used as an index of the degree of infestation of individual oysters. The sample obtained this year was studied in this way, but the figures are uninteresting except as a basis for comparison with other times and places. An annual check of the Cooper Bed is planned and the system may be extended to other key areas to detect any change in the status of the sponge.

F. E. Warburton

## Appendix No. 15

### ECOLOGY OF THE BORING SPONGE, CLIONA CELATA

Cliona celata is the common boring sponge in Malpeque Bay, P. E. I. It inhabits the shells of living and dead oysters, and dead quahaugs and bar clams, and rarely the shells of dead mussels; the writer has not yet found it in shells of soft-shelled clams or slipper limpets, although both are common within its range. The reason for this apparent selectivity is unknown. Usually the sponge is confined to borings within the material of the shell, but in several dead oysters and one dead quahaug, in which the valves of the shell remained attached, the sponge had nearly filled the cavity of the shell.

The local distribution of the sponge depends on several factors, in addition to the availability of suitable shells.

1. Salinity. Laboratory experiments indicate that the threshold of tolerance of C. celata for lowered salinities lies between 14 and 15‰. Specimens in floating trays were killed by run-off after rain during May and June.

2. Exposure at low tide. Sponges suspended just above the extreme low-tide level during August, when surface salinities were constantly high, died within a few weeks although they were exposed for only a few hours every two weeks.

3. The nature of the bottom. Boring sponge is commonest in shells which lie on a firm bottom. A heavy fall of silt killed experimental specimens, but not the oysters infested by them.

The cavities of the living sponge are inhabited by large numbers of nematode and annelid worms, including the mud-worm, Polydora, and by various fungi and algae. Some of these may be parasitic. Two other sponges, Microciona prolifera (the Redbeard) and Halichondria panicea (the Crumb-of-bread), as well as various red algae, often grow on Cliona-inhabited shells.

Limpets of two species, Crepidula fornicata and C. plana, often occur on such shells but settle less densely than on sponge-free shell. C. fornicata deposits layers of calcium carbonate over the borings covered by its foot, although the presence of spicules in its stomach and faeces shows that it grazes on the sponge. Oyster spat appeared to settle more lightly on spongy than on sponge-free shell, but the sample counted was too small for confidence. Several organisms, including limpets and sea anemones, show apparent irritation of the parts of the body attached to shells and in contact with the living sponge.

F. E. Warburton

#### Appendix No. 16

#### SEARCH FOR CONTROL MEASURES FOR CLIONA CELATA

Salinities below about 15‰ are destructive to the cells of Cliona celata, the time required to cause death falling rapidly as the salinity is decreased below this level until, in fresh water, small masses of sponge tissue lose their capacity for repair in ten minutes. That this is largely an osmotic phenomenon is shown by the survival of similar fragments after immersion for three hours in a salt-free solution isotonic with sea water. Sponge within its borings in the shell is so well protected from the penetration of fresh water that it may regenerate, in large shells, after as much as eight hours' exposure; therefore, to be a safe control measure, immersion of spongy oysters in fresh water would have to be carried out for several hours. Drying is also fatal to Cliona, but the rate of drying depends largely on the size of the shell, and in experiments sponges have survived air-drying for more than twenty-four hours.

In both these cases, the outer layers of the sponge may be killed while the interior survives. Certain poisons act differently. Two and one half per cent potassium permanganate solutions, which were used because their colour permitted a study of their penetration, killed entire sponges which were immersed for only a few minutes, and into which the solution penetrated for a millimeter or less. Benoclor suspensions in concentrations similar to those used to kill eel-grass also killed the sponges although their penetration was very slight. Apparently these agents exert a fixative effect on the outer layer of the sponge so that it remains in place and interferes with the activities of the rest of the organism. Most fixative reagents, however, require high concentrations to act, and we are not optimistic in the search for a cheap chemical which will be effective when spread on the oyster beds. However, dipping in poisonous solutions could be incidental to the annual raising of oysters for cleaning, a practice which has often been recommended. At any rate, control measures, even on an experimental scale, should await further knowledge of the reproduction of the sponge.

No data on the sexual reproduction of Cliona celata in Malpeque Bay have yet been obtained. Shells were exposed as

collectors for larvae, plankton tows were examined, aquarium specimens were watched, and a few smears, stained and unstained, were made, all with negative results. A heavy set of other species of sponges occurred in July and August, but no young individuals of Cliona were found. Unfortunately, the preparation of boring sponges for microscopical study presents some severe difficulties, and almost none of the methods described in the literature are applicable to such organisms. However, experiments carried out this summer have overcome many of the difficulties and a large-scale program will be carried out next summer to detect the reproductive period of this species and of C. vastifica, the boring sponge infesting scallops off Digby, N. S., by attempting to detect the development of reproductive cells within the adult.

Most sponges are difficult to keep alive in aquaria, but Cliona celata is relatively easy and appears to be insensitive to foul water. Specimens of it have survived in small containers in which other sponges, placed at the same time, had died and decayed. However, even in frequently changed water, Cliona underwent a gradual decrease in vigour and shrank in size.

F. E. Warburton

#### Appendix No. 17

#### MARINE SPONGES OF THE MARITIME PROVINCES

With the boring sponge investigations, an incidental collection of marine sponges from the Maritime Provinces was begun. About twelve species have been collected, none of which were unexpected, but a little effort would undoubtedly disclose many more. Our records of three species of Cliona are the most northerly yet reported for the Atlantic coast of North America. These specimens were prepared and identified by A. A. Skinner.

Cliona celata Grant. Very common in Malpeque Bay, and occurs frequently on other parts of the coast of the Island.

Cliona vastifica Hancock. Very common in the Bay of Fundy. We have also received specimens of it from Hare Bay, Newfoundland.

Cliona lobata Hancock. From the Miramichi area, N. B., and from Royalty Point, P. E. I.

None of the other species is known to be of any economic importance. However, in Darnley Basin, P. E. I., Mycale ovulum O. Schmidt, Esperella lobata (Montague) and possibly E. modesta Lambe grow in great numbers as masses, often as large as an orange, on Irish Moss. Casual observation showed that clumps of moss bearing such sponges were considerably smaller and appeared less vigorous than those free from them. Such sponges could potentially injure the Irish Moss industry.

F. E. Warburton

Appendix No. 18

CLAM FARMING EXPERIMENT AT POCOLOGAN

By clam farming we mean the transfer of naturally-produced stocks of small clams from their native areas, where for one reason or another they will not mature properly, to barren or thinly populated areas where survival, growth and quality are good. The hope has been that after a period of growth in the new ground the volume of the transplanted clams would be sufficiently greater than it was at planting to make clam farming commercially worth while.

Starting in 1944 many clam farming trials have been made in what seemed to be promising grounds in the Bay of Fundy area, on the outer coast of Nova Scotia and in the Gulf of St. Lawrence. The results have been discouraging. Until this year the volume of the stocks recovered from plantings has been less, not more, than that of the stock planted. In some places growth was reasonably good but survivals low; in others, vice versa. In still others both growth and survivals were low. Nowhere, it seemed, could the right combination be found.

The single exception was observed this year on the Kate's Ledge flat in Pocologan Harbour, N. B. Six bushels of clams, averaging  $1\frac{3}{4}$ " in length, were planted there in May, 1950. Twelve bushels were recovered in June, 1952. In the two seasons the clams showed an average increase in length of 60%; 64% of the number planted had survived. The meat-yield was unusually high and in other respects, according to the processor who purchased the harvested stock, the quality was superior. This field work was carried out by J. S. MacPhail.

It seems worth while continuing clam farming trials at Pocologan on a small scale to learn why transplants succeeded there when they failed in all the other trials. An understanding of the conditions there may make it possible to find other favourable areas.

J. C. Medcof

Appendix No. 19

EXPLORATIONS FOR UNUSED CLAM STOCKS

The demand for clams is greater than the supply. To bring about full use of this resource explorations for stocks of clams that are not being fully used have been extended year by year. The new stocks discovered have to some extent offset the declining production in areas where the intensive fishery has removed the "accumulated" stocks and is finding a new equilibrium based on the actual annual crop.

This year the Bay of Chaleur shore of New Brunswick was examined. There has never been a fishery there and clams have been taken only with long-handled shovels or flat-tined

garden forks. Heavy stocks were found at Heron Island and in Bathurst Harbour. Smaller quantities were found at Millstream Gully, Jacquet River, Charlo, Eel River Bar and Dalhousie Junction. Unfortunately Bathurst Harbour is closed on account of pollution, but Heron Island and the lesser areas mentioned seem capable of producing about 300 barrels of marketable clams a year for a few seasons at least. There are lobster canneries in the district that could pack clams each year after the lobster season ends without costly plant alterations if the local fishermen learned to dig them on a commercial scale with efficient clam digging tools. One canner with whom the possibilities were discussed is definitely interested in a trial next year.

Lunenburg County was the only other area visited this year. There the stocks are being fished but not fully used. For the last two years much controversy has attended a limited fishery of clams for shucking outside the county. Residents claim that there are only enough to satisfy the bait requirements of line fishermen. The examination showed that there are certainly more clams than are needed for bait and local domestic use. The area of flats is small, however, and the district will never assume great importance as a clam producer. It seems probable that, besides those that are used for bait, 200 to 400 barrels of clams could be harvested there each year. The bait interests could be protected by establishment of bait reserves at suitable places.

J. S. MacPhail

#### Appendix No. 20

#### CLEANSING OF SEWAGE-CONTAMINATED CLAMS (MYA)

In 1951 a series of experiments was conducted at St. Andrews, through the joint efforts of the Fish Inspection Laboratory and the Atlantic Biological Station, but not completely reported in the 1951 Annual Report (Appendix 26). The bacteriological tests carried out in a mobile laboratory showed that heavily contaminated clams taken from near the sewer mouth in St. Andrews Harbour cleanse themselves rapidly when properly placed in water with temperatures ranging from 10 to 18°C., with salinities from 30 to 33‰ and with most probable numbers of coliform bacteria (M.P.N.'s) less than 20.

There are three phases in the cleansing process: an initial 24-hour phase of rapid cleansing during which the M.P.N. usually drops to less than 2,400, a 24-hour period of no cleansing during which the M.P.N. sometimes rises, and a final phase of 24 or more hours when there is rapid cleansing and M.P.N.'s drop to very low levels.

Crowding of clams to a considerable degree has no effect on cleansing. The rate is the same in all parts of full half-bushel hods built of laths with  $\frac{1}{4}$ " spaces between laths. Regular intertidal exposure for 3- to 4-hour intervals had no appreciable effect on the rate or extent of cleansing. Storing clams in air for 24 hours after digging and before exposing them to clean water has very little effect but washing all the mud

from the outsides of clams hastens cleansing somewhat. Broken clams do not cleanse themselves. The degree of initial contamination has little effect on the rate of cleansing but does affect the M.P.N. at the end of the first phase at which stage the M.P.N. is higher for those clams which start with heavier bacterial loads.

These 1951 results encouraged belief that advantage could be taken of self-cleansing of clams in natural waters on an industrial scale with two sorts of benefits: (1) The total catch of clams would be increased; (2) Densities of stocks in contaminated areas would be reduced and this would reduce the illegal direct marketing of contaminated clams with all the attendant risks to public health. In 1952, therefore, the work was continued and expanded. Mobile laboratories from both the Department of National Health and Welfare and the Fish Inspection Laboratory were assigned part time to the work in co-operation with this Station.

Early spring experiments showed that cleansing takes place within 48 hours even at temperatures between 5 and 10°C. and follows essentially the same pattern as that described above from last year's results.

A floating car holding 26 half-bushel hods and designed for quick loading and unloading under industrial conditions was tested at two cleansing stations in Passamaquoddy Bay -- the Bar Road and Holt's Point. These "pilot-plant" operations showed that this particular design of car could be used satisfactorily in large-scale operations. It is seaworthy and handles easily and cleansing proceeds uniformly throughout the car at a rate essentially the same as in the smaller experimental car used in 1951.

Trial shucking in a commercial shucking plant of a 5-bushel lot of cleansed clams has shown that they are preferable to the stocks regularly received directly from diggers in clean areas. They give higher meat yields per bushel and can be handled more quickly. All the increase in yield and part of the speed-up in handling is attributed to the absence of broken clams, which must be removed before cleansing. The freedom of cleansed clams from mud and dirt on the shells and in the mantle cavity accounts for the rest of the speed-up in processing (shucking and meat-washing).

It was found that the water at the Bar Road, the cleansing station selected for these trials, was "clean" under ordinary conditions but subject to contamination, apparently from St. Andrews Harbour and the St. Croix River, at the times of spring tides when the heavy flushing of these basins spreads their pollution over a wider area than usual. This relationship between the spring and neap tidal cycle and the extent of pollution has apparently not been demonstrated or even suspected before. It has wide significance in the execution and interpretation of bacteriological examinations of shellfish-producing waters. The periodic pollution has ruled out the Bar Road area as a suitable site for a cleansing station. Several examinations

of the Holt's Point area, which is farther removed from obvious sources of pollution but still in Passamaquoddy Bay, have shown it to be satisfactory even during heavy run-offs succeeding rain storms.

The prospects are bright for setting up supervised industrial cleansing operations at Holt's Point in 1953. We should be able to assist in working out policies and regulations under which this might be carried on without jeopardy to the public health. If the operation is successful a search should be started for suitable cleansing stations in other areas such as the Annapolis Basin, N. S., where there are large stocks of sewage-contaminated clams that are now under quarantine but could be marketed after treatment.

J. C. Medcof

#### Appendix No. 21

#### PERIODIC CLOSURE OF CLAM FLATS TO INCREASE PRODUCTION

For several years Latin-square plot experiments have been under way and are continuing on the Sissiboo River and at West Chezzetcook, N. S., and at St. Andrews, N. B., to discover how the frequency of systematic digging affects clam production. Equilibrium conditions are now being approximated in some of the plots and it appears that two diggings per year result in an annual production that is only about half that which is realized from a single digging. This lower yield is attributed to the heavy destruction (about 50%) of small clams every time diggers turn a flat in search of clams that are large enough to be used. Other observations show that the rate of digging of flats has increased greatly in the last few years and that in many areas flats are dug over, on the average, more often than once a year.

These facts suggest that if diggers were prevented from digging the public flats so frequently they would realize a higher long-term yield. However, digging operations in the test plots and on the public beds are different. Test plots are dug completely at regular intervals and let rest between diggings, whereas diggers work public beds wherever and whenever they please -- that is, at irregular intervals. The problem of controlling the frequency of digging where it is intensive without undesirable restriction elsewhere is a difficult one, and periodic closures alone may provide a satisfactory solution.

An experiment in management to increase production by reducing frequency of digging is proposed at the Sissiboo River, N. S. The flats are being divided into two equal parts to be open to public fishing in alternate years. A quota is being set which should prevent more than one complete digging of the ground that is open each year. Catch per man per day and the total annual yield of each part will be followed. A backlog of records for this area of catch per man per day for the last several years is available for comparison.

Next year it is proposed to inaugurate another test of this kind in Charlotte County, N. B., where conditions are different to see if the scheme warrants wide application. It will require several years' observations to judge the value of such management schemes.

J. C. Medcof

Appendix No. 22

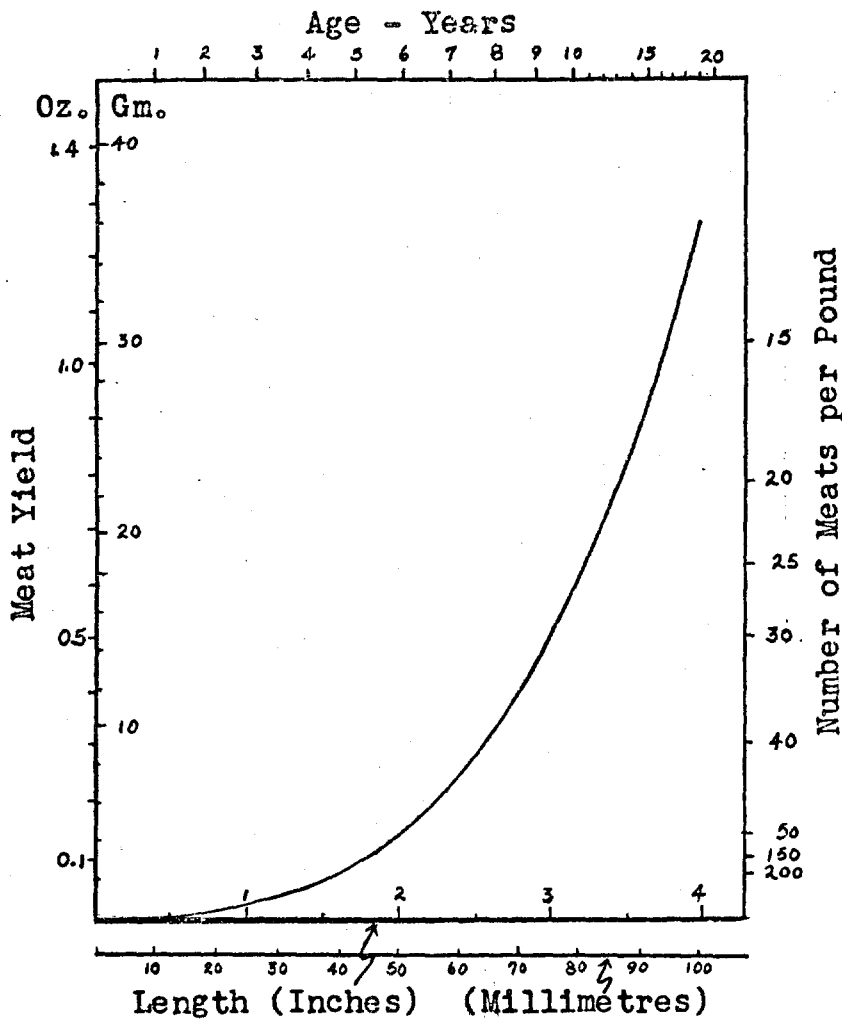
CRITIQUE OF 2" MINIMUM LEGAL SIZE FOR CLAMS

The United States markets have always demanded small shucked clams and until 1947 Canadian producers supplying the northeastern States felt they were at a disadvantage in competing with Maine dealers because the size limit was then 2 $\frac{1}{4}$ " in the Maritimes and 2" in Maine. In 1947 our size limit was reduced to 2" at the request of the industry which hoped thereby to improve its competitive position. At that time too little was known about the clam fishery and the biology of clams to estimate how this change might affect the long-term yield and the value of the clam resources to this country or to criticize the opinions sometimes expressed that the size limit should be dropped to 1 $\frac{3}{4}$ ", or abandoned completely. Since then data on annual growth rates, natural mortality rates, fishing mortality rates (proportions of the available stocks annually taken by the fishery) and on meat-yield from various sizes of clams, have been assembled. Several phases of this work have been referred to only briefly, if at all, in the Station's Annual Reports but they all have an important bearing on the size-limit problem which is being studied now.

Growth Rate and Meat-Yield data pertaining to stocks in the two principal clam-producing regions of the Maritimes, the Bay of Fundy area and the outer coast of Nova Scotia, are summarized in the accompanying figure.

Natural Mortality Rates have been shown to vary greatly from place to place and in the same place depending on the frequency of digging of flats and to a lesser extent on beach level. In undisturbed plots at half-tide levels in the clayey soil of the Sissiboo River, N. S., the rate averaged 27% per year over a four-year period. In similar Sissiboo plots with one complete digging per year (in May) it averaged 74%. In the light sandy soils of harbours on the outer coast of Nova Scotia (Petpeswick and Chezzetcook Harbours) it was much lower. Over a three-year period it averaged 4% in undisturbed plots but in plots that were completely dug once a year it averaged 41%. Conditions in the Gulf of St. Lawrence have not been studied.

Fishing Mortality Rates have varied greatly from time to time and from place to place. The place-to-place differences were greatest in the years previous to 1945, when some beds were regularly dug and others never touched. More recently there has been greater uniformity because most beds have been regularly dug no matter how inaccessible they might be or how poor the quality of the clams they produce.



Relationships of length and age of Bay of Fundy and outer-coast Nova Scotia clams to their yield of untrimmed meat.

It is easy to measure fishing mortality in test plots where digging can be controlled and such observations show that in one digging the average digger removes 60% of the marketable clams in a plot. It is not easy, however, to estimate the fishing mortality over a whole flat that is subject to public fishing because there is no orderliness in the way diggers dig a flat. The outlines of the areas dug at any one tide are most irregular and are quickly obliterated so that, without his knowledge, a digger's successive diggings frequently overlap. Thus in the course of a year one part of a flat may be completely dug over several times while an adjacent part that is less heavily populated with market-sized clams may be left untouched. Observations of the area of beach a man digs per tide and the number of man-tides diggers spend on different flats indicate that in the course of a year the summation of the digging is equivalent to at least one complete digging of all of the productive parts of many flats. This means that, at a minimum, the fishing mortality is 60% on these grounds.

The value of a minimum legal size limit in maintaining the highest possible sustained yields from a fishery ordinarily increases with increasing growth rates, with decreasing natural mortality rates and with increasing fishing mortality

rates. In the clam fishery these relationships seem to be more complex than in some others that have been studied because the natural mortality rates are affected to such a great extent by changes in the frequency of digging (which is proportional to fishing mortality rates). For instance, on the Sissiboo River in undisturbed plots (fishing mortality = 0) the natural mortality was 27%, whereas in plots dug once a year (fishing mortality = 60%) it was 74%.

Taking these complexities into consideration, it appears that when flats are dug over completely once a year or more, observance of the 2" minimum size limit should not be expected to effect any increase in sustained yield over what might be expected from unrestricted digging. The same kind of analysis, now under way, suggests that when digging frequencies are less than once per year the size limit should increase yields under some conditions but not under others.

How closely these deductions apply to the clam fishery as it exists with all its complexity has yet to be decided. They are based, for instance, on the assumption that all the clams fished are used by processors. A study of industrial practice shows that this assumption is unjustified. Openers in shucking plants are paid on the piece-work basis and openly or surreptitiously discard a high proportion of the smallest clams that come to them because, although it takes just as long to open, the meat-yield from a small clam (wage return to the opener) is much less than from a large. This means that stocks will be more efficiently used when there are few clams in the catches that give the appearance of being very much smaller than the average, i.e. when there is a properly observed minimum legal size limit. Most plant operators are seriously concerned with the way the per-pound processing cost rises when the size of the clams being processed goes down as well as with the wastage problem, and favour a minimum size limit of some kind.

The first conclusion from this criticism is that the value of the size limit by itself in maintaining high sustained yields of clams has been vastly over-rated. The demonstrated rapid increases in natural mortality rates which attend increases in frequency of digging (fishing mortality rates) indicate that a minimum size limit may be effective in maintaining higher sustained yields only if there is a simultaneous control of the frequency of digging.

The second conclusion is that there are important arguments, other than those involving the level of the sustained yield, which should be considered in weighing the value of a size limit for clams.

J. C. Medcof

Appendix No. 23

RAZOR CLAM FISHERY IN ST. MARY BAY, N. S.

Last year we reported (Appendix 24 of 1951 Annual Report) on efforts to encourage the commercial use of St. Mary Bay, N. S., stocks of razor clams (Ensis directus) which we have known about for many years. A Digby shucker of raw shellfish, who tried a sample lot with which we supplied him, decided he could not handle them to advantage, but a canner whom we interested had such encouraging results from his 1951 trials that this year he processed about 200,000 pounds in the period April to September. They were packed as trimmed steamed meats or as chowder. Both are enjoying a vigorous sale in Nova Scotia and in other provinces to which they have been shipped.

The decline in the Digby County, N. S., production of soft-shelled clams has continued. This year the catch was only about two thirds of that in 1951 but the razor clam production has more than compensated for the drop. The combined poundage production of the two species to the end of September exceeded the 1951 yield of soft-shelled clams for the same months by more than 30,000 pounds and has greatly stimulated the industry in that section.

A superficial study shows this stock of razor clams to be different from others in the Maritimes with which we are acquainted in having an unusually good and consistent reproduction and in living in soil below which there is hard pan which prevents escape by the usual rapid burrowing of this species. Statistics on catch per man per tide have been assembled which show that a digger averages  $3\frac{1}{2}$  to 4 bushels per low-tide digging period of 3 to 4 hours. Practically nothing is known of the biology of the species, however, and it is impossible to predict what the future of the St. Mary Bay fishery will be.

J. C. Medcof

Appendix No. 24

DEVELOPMENT OF A BAIT WORM INDUSTRY IN NOVA SCOTIA

Vast numbers of "blood worms" (Glycera) are used every year in the salt-water sports fishery of the eastern United States and, because local supplies are inadequate, there has long been a fishery for these worms in Maine and regular air shipment of them to the south. Recently we have investigated Canadian supplies and assisted in the development of a Canadian industry to meet the expanding demand.

Following a trip to Maine in 1951 to study methods, the writer explored several parts of our coast and found what seemed to be commercial quantities of good-quality worms in Yarmouth County, N. S. Trial shipments of samples of these to the New York market in 1951, discussions with prospective buyers

and producers, and a shortage of bait in New England in the spring of 1952 resulted in three shippers setting up operations at Wedgeport, Comeau Hill and Yarmouth, N. S. -- all in Yarmouth County. Digging operations have been confined almost entirely to Goose Bay, Little River and Yarmouth Harbour. Although they have explored the coast in both directions as far as Annapolis Basin to the north and Liverpool to the east, only in Yarmouth County have commercial quantities been found.

On the average, a digger spends 5 hours a day on the intertidal flats and digs 600 to 1,000 worms for which he gets one to one and a quarter cents apiece. Altogether about a hundred diggers were engaged this year, and during the five-month period, May to September, slightly over 2½ million worms were shipped by air to United States distributing points. Worm digging is seasonal because it caters to a seasonal sports fishery.

There is some speculation as to how long the Yarmouth County stocks of worms can stand this kind of exploitation. Practically nothing is known of the biology of this worm that would be helpful in judging the prospects of the industry. United States dealers report that some New England areas which have been dug steadily for over twenty years remain highly productive, while others have been barren since their first thorough digging. Several Yarmouth County flats were dug thoroughly this summer and the local shippers believe that conditions on these flats in 1953 will indicate the prospects of the southwestern Nova Scotia industry.

A preliminary study of the biology of blood worms is planned for 1953.

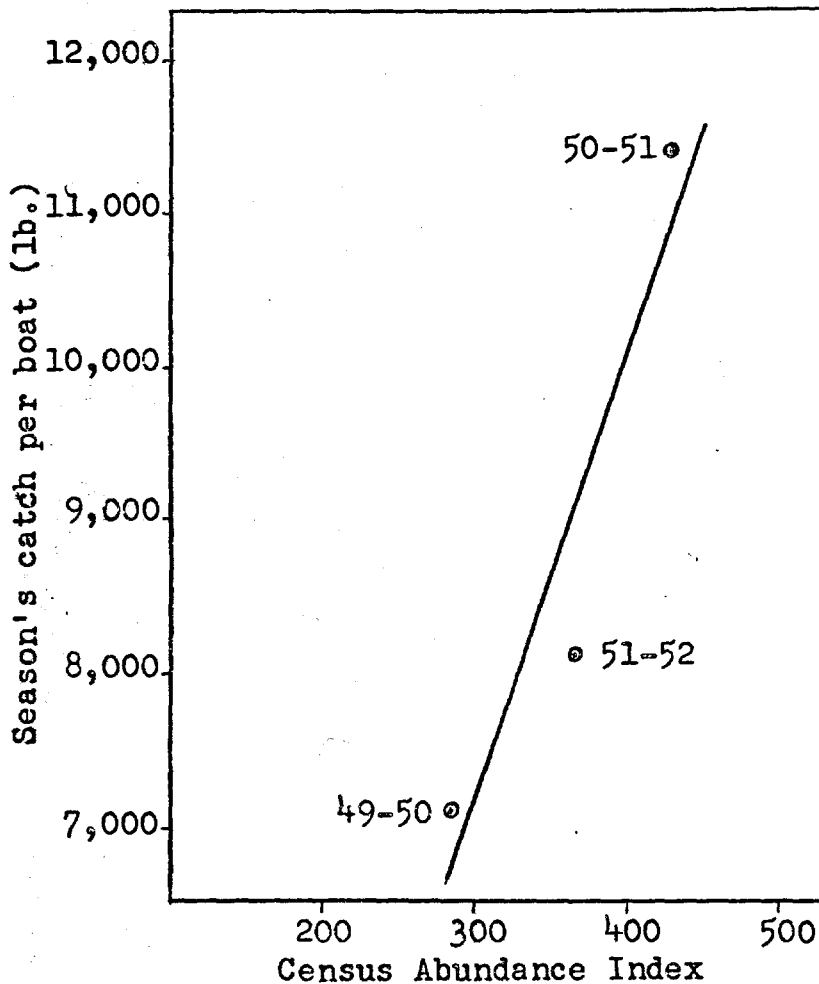
J. S. MacPhail

#### Appendix No. 25

#### FORECASTS OF PRODUCTION OF DIGBY SCALLOPS

Forecasts of the Digby scallop production were seen as a possibility in 1948 when it was shown (Appendix 29 of 1951 Annual Report) that: (1) production depends on abundance of commercial-sized scallops rather than on weather, price and fishing intensity, and (2) abundant year classes had been spawned in years with high water temperatures at spawning time, and poor year classes in cold years. It was concluded that the low production about 1948 was largely the result of naturally poor stocks spawned during the cold-water years 1939 to 1942, but that a recent upward trend of water temperatures should lead to increased production starting about 1952.

The results of sampling (strip census) of the four principal beds in each summer since 1948 indicate that this method of prediction can be depended upon in a general way. Great refinement of the system is impossible because the landings from any given year class are affected to some extent by unpredictable changes in the number of days fished per season,



Relationship between summer census abundance index and the Digby scallop fleet's average catch per boat in the following winter seasons (1949-50 to 1951-52).

in the size of the fleet and in the relative amount of time the fleet spends on this or that bed. Another uncontrollable factor influencing the reliability of the predictions is the variability of weather and tidal conditions during the brief period of the census itself. These conditions are known to have an important effect on catch per haul and they will therefore limit the precision of predictions. Nevertheless predictions useful to industry and government are possible.

In the strip census 15-minute hauls with regular commercial scallop gear are spaced at equal intervals across the principal beds. The numbers of all scallops caught per haul and their size-frequency distribution are recorded and compared with earlier records to predict the trends of the fishery during the next few seasons. In the same way the conditions in the season immediately following may be forecast using a crude index based on the sizes as well as the relative abundance of scallops and thus indicating the relative amounts of scallop meat available. The index used is the average number per haul of scallops greater than 4" plus half the number between 3" and 4". How it is related to catch per boat per season is shown in the accompanying figure, which includes results of the 1949 to 1951 censuses.

The "40-minute ground" is the only census area where an important increase in the numbers of legally usable scallops seems to have taken place since 1951. In the others the numbers are slightly lower. The value of the abundance index for 1952 was 344. Using this value, the graph suggests that the 1952-53 season's catch per boat will be about 8,500 pounds. In other words, there will be little change from 1951-52.

In the 1952 census, catches of small scallops (<3") were higher than last year on two inshore areas, indicating that there will be a gradual improvement in fishing there in the next few years as was predicted in 1948. The small scallops did not show up in large numbers in the other two census areas, although we believe that scallops of the same ages are present. Their absence from catches is attributed to the slower growth of scallops on the beds farther from shore.

L. M. Dickie

#### Appendix No. 26

#### "SAVINGS GEAR" TO PROTECT SMALL SCALLOPS

Conventional Digby-type scallop gear brings up large numbers of sub-legal-sized scallops (less than 4" in diameter), and the fishermen shuck many of these. The conditions of the fishery are such that the size limit cannot be enforced without inordinate cost, although there is evidence that the long-term yield of our beds would be higher if the small scallops were allowed to grow to 4" before being used.

Work started in 1949 has shown that by using drag bags knit of steel rings with an inside diameter of 3 $\frac{1}{4}$ " instead of the conventional 2  $\frac{5}{8}$ ", the take of scallops less than 4" is reduced by half. Experimental fishing in 1951 with several types of rings of this diameter indicated that the best performance is to be obtained from rings that differ from the conventional not only in their greater diameter but also in the gauge and in the temper of the wire from which they are wound. Rings of 11/64" instead of 10/64" wire and of slightly higher temper, resisted wear and distortion and maintained their size selection of scallops and efficiency throughout the trials. Compared with conventional rings they took many fewer scallops less than 4" but more scallops greater than 4" in diameter (figure 1). Their efficiency in taking the larger scallops appeared to be just sufficiently greater than that of the conventional ring to balance nicely the loss fishermen would suffer from the absence from their catches of the usable sub-legal-sized scallops which conventional rings take but which the large rings ("savings gear") allow to escape (figure 2).

In the spring of 1952 a commercial fishing boat was chartered for 32 fishing days. Conventional and "savings" gears were fished on alternate days and the poundage catch of scallop meat per hour of dragging with each type of gear was measured under a great variety of fishing conditions on all the

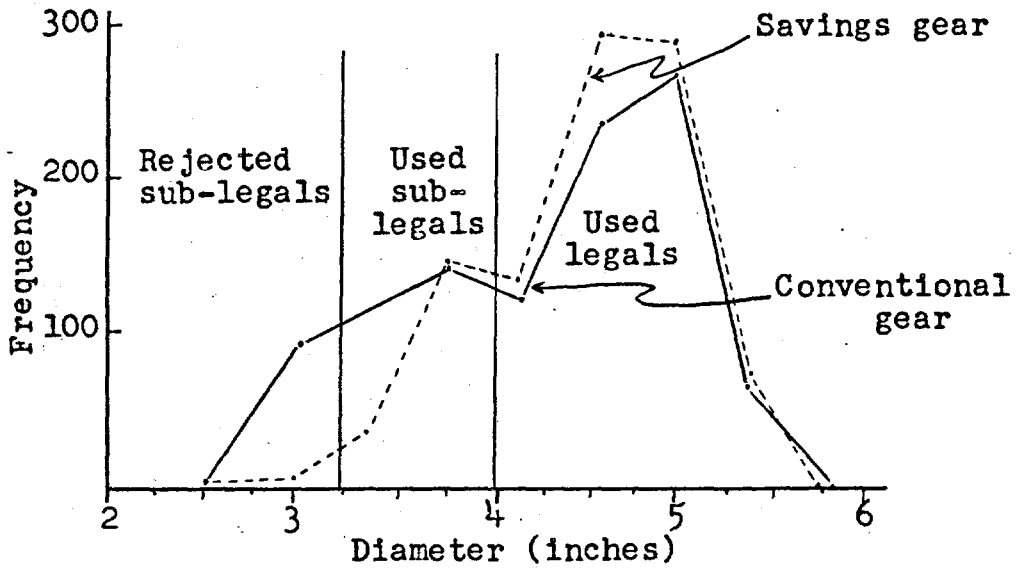


Figure 1. Relative numbers of scallops of various sizes taken in catches with "savings" and conventional gear, and how these are treated by the industry.

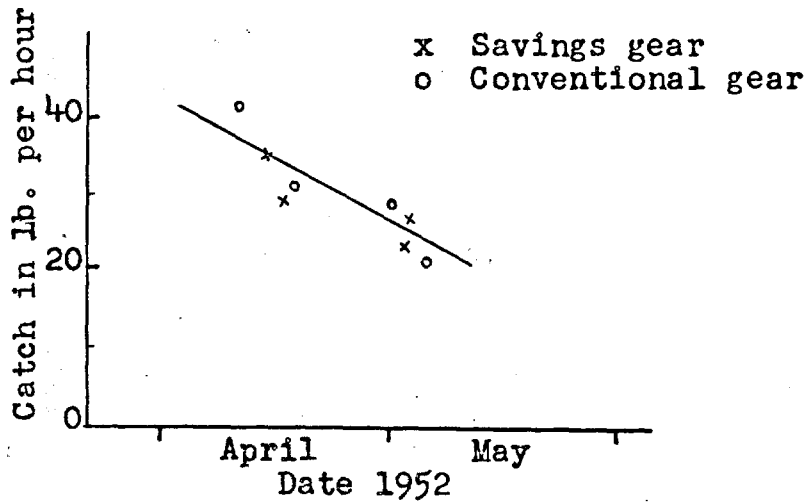


Figure 2. Catch of scallop meat in pounds per hour of dragging with "savings" and conventional gear on one of the several Digby, N. S., beds fished during 1952 gear trials.

principal beds off Digby. At the end of this period the gear was so badly worn that it was ready for a complete overhaul.

The trials established three points:

(1) The lifetime of the "savings" gear is the same as that of conventional gear.

(2) Throughout its life the "savings" gear retained its size-selection characteristics (figure 1), taking fewer small and more large scallops than the conventional gear.

(3) There was no appreciable difference in the poundage catch per hour of dragging with the two kinds of gear in spite of the fact that the fishermen on the chartered boat shucked all scallops (legal and sub-legal) from the catches with both types of gear that were large enough to be attractive to them (figure 2).

The heavier-gauge, higher-tempered wire from which the "savings" gear rings are wound is more expensive than that used for conventional rings, but analysis of annual boat operation costs and earnings indicates that this would amount to less than 2% of the earnings. The increase in the long-term annual yields to be expected from the protection of small scallops by the "savings" gear is of the order of 10 to 15%. Because of this it is recommended that the use of "savings" gear be made obligatory in the Bay of Fundy area.

Some further commercial trials are planned using rings of the same size and wire of the same gauge but of a different temper, which would be cheaper and probably more readily available.

J. C. Medcof

Appendix No. 27

#### DEVELOPMENT OF A COMMERCIAL SCALLOP FISHERY ON THE "RICHIBUCTO BED"

In 1950 a bed of scallops roughly two square miles in area was discovered during our explorations of Northumberland Strait about 10 miles east-northeast of Richibucto Harbour, N. B. These were of almost uniform size measuring  $2\frac{1}{2}$  - 3" in diameter and apparently all belonged to the 1946 year class. Investigations that year and in 1951 (Appendix 24 of 1950 Annual Report, and Appendix 31 of 1951 Annual Report) indicated that these scallops should reach commercially usable size in 1952, and that the type of scallop drag long used from small boats in Lunenburg County, N. S., could be operated successfully on this bed from lobster boats with mechanical pot haulers. In late May and early June of 1952, a 10-day commercial-scale fishing trial was carried out using four Lunenburg drags each 30" wide, from a chartered 38-foot, two-man lobster boat. The results confirmed the predictions; good catches of up to 160 pounds per day were obtained. The landed value of scallop meat was 45-50¢ per pound

which meant that there were prospects of really profitable operation.

In view of the ever-present danger of sudden mass mortalities of scallops in the southern Gulf of St. Lawrence, the location and potentialities of this bed were immediately made known to the public by press and radio releases arranged through the Department's Information Service. Besides this a mimeographed circular containing more detailed information was distributed to interested parties and drags were lent as patterns to those who wished to have them built. As a result several fishermen from Richibucto, N. B., and Miminegash and Alberton, P. E. I., have started scallop fishing on this bed this summer and fall and are reporting regular and good catches (150-200 pounds per day). The statistics of the fishery are being followed carefully.

There are unconfirmed rumours that fishermen have recently discovered another bed. It is hoped that this is true because the fishery on the Richibucto bed is not expected to last long because there is only one year class of scallops to support it.

L. P. Chiasson

#### Appendix No. 28

#### TOLERANCE LIMITS OF SCALLOPS TO TEMPERATURE AND SALINITY CHANGES

Unexplained sudden mass mortalities of scallops in the southern Gulf of St. Lawrence occur not infrequently and seem to be responsible for the erratic nature of the scallop production of that region. If we knew their causes they could perhaps be predicted and the scallop stocks used to better advantage.

Rapid changes in the water temperature and/or salinity over the scallop beds have been suggested as causes of these mortalities but we have scant information on the nature and extent of these hydrographic changes and we know very little of the ability of scallops to tolerate them. Last summer data on both these subjects were assembled. Lethal temperatures for Bay of Fundy scallops previously acclimated in tanks to several different water temperatures were determined in the laboratory at St. Andrews. Field data were collected to show the range and rapidity of temperature and salinity fluctuations on scallop beds at the eastern end of the Northumberland Strait where mass mortalities are common, and at the northern end where they are rare.

The experiments showed that acclimation from 10 to 15°C. is practically complete after three days, i.e. in this temperature range the average upward acclimation rate is 1.7°C. per day.

After acclimation to temperatures of 10 - 11°C. and 15 - 16°C., the upper lethal temperatures (producing 50% mortality in 24 hours) were found to be 21.5 and 23.2°C. respectively.

To effect a rise of 1°C. in the upper lethal temperature, the acclimation temperature must be increased by 2.6°C.

Tests conducted so far have included only scallops 77 to 133 mm. in diameter, but so far the lethal temperatures seem to be the same for all sizes.

Salinity tolerance tests at temperatures between 15 and 17°C. showed that for scallops acclimated to salinities of approximately 31‰, the lower lethal salinity is 16.5‰. Since this is far below the lowest levels observed or likely to occur on scallop beds in the Northumberland Strait, salinity changes are discounted as a possible cause of mass mortalities.

All summer, weekly bathythermographic and salinity data applicable to this study were gathered by the M/B "Gulf Explorer" in connection with her work on lobster larvae at the northern end of Northumberland Strait. Similar occasional observations were made by the writer independently over one bed in the eastern end of the Strait from June to September and with members of the Atlantic Oceanographic Group aboard the C.N.A.V. "Sackville" over all the important beds in that area on July 22-23. The hydrographic data have yet to be analyzed with relation to the scallop problem.

It is planned to carry out further experiments, especially on temperature tolerance of scallops acclimated to lower temperatures, and to continue hydrographic observations over Northumberland Strait scallop beds.

L. P. Chiasson

#### Appendix No. 29

##### HOW LONG DO SHELLS OF DEAD SCALLOPS REMAIN ATTACHED?

The paired empty shells of scallops, sometimes called "cluckers" or "bivalves", separate after a time because the hinge ligament rots. If we knew the length of time following the death of the scallop that is required for this separation to take place, it would help in determining the dates, and perhaps the causes, of mass mortalities (such as those in the Gulf of St. Lawrence) and in estimating mortality rates generally.

In the summer of 1950 the shells of 66 Bay of Fundy scallops, from which the meats had been carefully removed to avoid damage to the ligaments, were placed in tanks of running sea water at the Biological Station and kept under observation. In this test the shells of the smallest scallops separated first and of the largest last. Half of the 4" shells had separated after 32 days, half of the 5" after 110 days and half of the 6" after 150 days.

The 1951 field observations in the Gulf of St. Lawrence cast doubt on the applicability of these laboratory results in judging the dates of mortalities. "Cluckers" seemed to have a longer lifetime on beds than in tanks. For this

reason the 1950 laboratory tank experiment was repeated this year at St. Andrews and a field test in which "cluckers" were held in a lobster crate was carried out on the bottom off Pictou, N. S.

In the tank experiment no very small "cluckers" were included, but in those tested ( $3\frac{1}{2}$  - 6" range) there was no apparent relationship between size and lifetime. Fifty per cent had separated after 31 days and 60% after 85 days. In other words, the results were confirmatory, at least in part, of the 1950 experiment.

In the field test two types of "cluckers" were used. Some were "naturals", so called because they were found as "cluckers" in catches of scallop drags. Others were termed "artificial" because they were obtained in the same way as those used in the tank experiments, by carefully removing the soft parts of living scallops from their shells. The first examination of the crate was after 25 days' exposure and showed that 3 out of 128 (2.4%) natural cluckers and 27 out of 242 (11.1%) artificial cluckers had separated. In both cases the cluckers that separated were the smallest in their group.

Further experiments are planned.

L. P. Chiasson and J. C. Medcof

#### Appendix No. 30

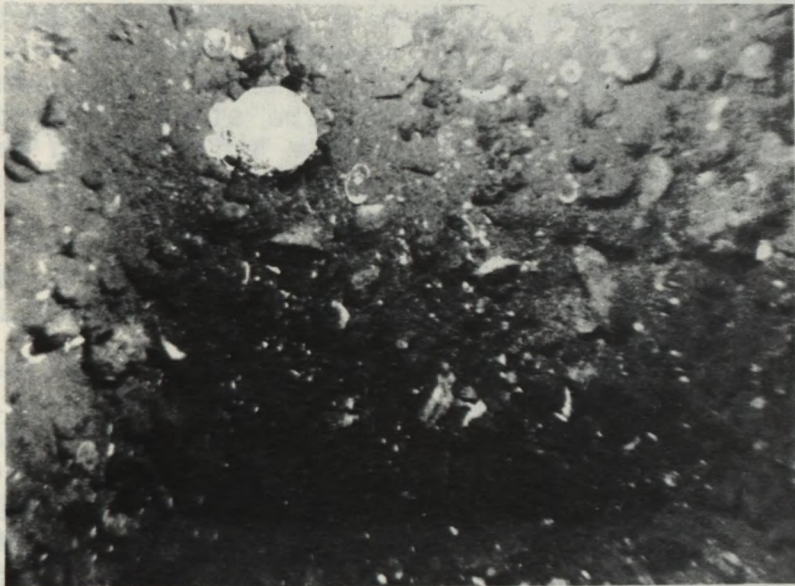
#### UNDERWATER PHOTOGRAPHY TO STUDY SCALLOP POPULATION DENSITIES AND BOTTOM CHARACTERISTICS

In 1950 trial use of an underwater camera, purchased from the Woods Hole Oceanographic Institution, showed that scallops of commercial size are suitable subjects for underwater photography. They are large and distinctive in appearance and live upon the bottom, not imbedded in it. For these reasons they can usually be identified and counted even in underwater photographs whose definition is too poor to show other species very well. From these experiments submarine photography seemed to provide a direct method for estimating densities of scallops of commercial size on our inshore beds and for describing the kind of bottom on which they live.

In May, 1952, after trials in the Grand Manan, N. B., area, a photographic survey was made of scallop beds in the Bay of Fundy off Digby, N. S. Despite some mechanical and technical difficulties with operation of the instrument, the results were encouraging. Eighty-two exposures were made on May 2 in Duck Island Sound off the east coast of Grand Manan in water 10-12 fathoms deep. Twenty-two of these gave clear pictures, showing type of bottom and allowing positive identification of all scallops larger than 3 inches in diameter. Besides this, many other species of the benthos with distinctive appearance like starfish could be identified and counted. Forty-two exposures were partially fogged because the camera moved while

the shutter was open, but they were clear enough to permit identification of scallops of commercial size when they are present. Eighteen exposures were too fogged for interpretation.

The results obtained off Digby were less satisfactory. Most of the beds are at 45-55 fathoms and at these depths the pressure was so great that the camera housing leaked and distortion of some of the images resulted from drops of water that ran over the glass window of the housing. Furthermore, the strong tides and the great length and weight of the suspending cable made it hard to tell when the instrument touched bottom. For both these reasons the camera assembly was often at an angle instead of



Photograph of a scallop taken with the submarine photographic apparatus at a depth of about 10 fathoms in Duck Island Sound, Grand Manan, N. B., May 2, 1952. (Camera to bottom 8 ft.; focused at 10 ft.; Secchi disc reading of surface water 15 ft.; flash bulb to bottom  $2\frac{1}{2}$  ft.; shutter speed  $1/25$  sec. at f16.)

perpendicular when it reached the bottom and "fired". This meant that the distance from camera to object was different from that for which the camera was set. The depth of focus, which might compensate for this in air, is small in such a dense medium as water, and as a result many pictures were poor.

In spite of these difficulties several good photographs were obtained. From the 221 exposures made in six days in early May, 36 were good; 77 were fogged but clear enough to permit identification and counting of large scallops; 75 were too fogged or blurred to permit interpretation and 33 exposures were ruined because of excessive water leakage or other

mechanical difficulties such as tipping of the assembly or poor synchronization of flash bulb and shutter. From the 113 usable pictures a great deal of information on type of bottom has been obtained and 59 living scallops and 17 scallop shells were positively identified. On the 77 pictures which had parts of the negative obscured by moisture or fogging, 69 additional objects, which are almost certainly scallops, could be discerned. At the time of writing the total area of scallop bottom represented in the photographs has not yet been carefully worked out but rough calculations suggest that the earlier estimates of scallop population density (0.6 per square yard) based on tagging and recovery (Appendix 24 of 1949 Annual Report) are not far wrong.

Most methods of population census of marine animals are based on indirect evidence such as tagging and catch records and are subject to errors, inherent in basic assumptions, that are difficult or impossible to assess. This direct method of studying densities of scallop populations, combined with indirect methods which have been and are still being used, seems likely to provide the kind of precise information that is needed as a basis for sound management of the fishery. It is planned to continue work with the underwater camera.

L. M. Dickie

Appendix No. 31

#### PARALYTIC SHELLFISH POISON

Over the past ten years a great deal of effort has been expended in gathering samples of shellfish, preparing extracts for toxicity assays, arranging equipment for experiments, studying records, discussing and reporting results as they affected programs of research and administration. Much of the work was done as part of an investigational program that has resulted in development of policies which permit industrial use of all available stocks of affected shellfish without jeopardy to public health.

In the last few years very little investigational work has been done. The effort has been co-operative with the Department of National Health and Welfare and the Department of Fisheries and of an almost strictly routine nature designed to supply the information and advice needed for administrative control of the fishery. In November, 1952, the Fish Inspection Laboratory, with a new branch laboratory at St. Andrews, is taking over the routine investigation.

Year by year manuscript reports on this subject have been prepared and distributed to those most concerned with the problem. This series of reports describes in detail the various phases of work undertaken, lists the results and discusses their bearing on the toxicity problem as a whole. The work is being turned over to the Fish Inspection Laboratory with clear, complete and up-to-date records of all past efforts.

This year, like 1951, was peculiar in that no major rise in toxicity took place in any of the areas under survey. This reduced the control effort somewhat and pleased the industry because their programs were not interrupted in the busy summer season as they have been in 8 of the 10 years during which this problem has been under review. We can offer no explanation for this condition.

J. C. Medcof

Appendix No. 32

THE LIFE HISTORY OF PORROCAECUM DECIPIENS - THE "COD-WORM"

Strong evidence has been obtained that the shrimp-like crustaceans, Mysidacea, are at least one of the primary hosts for P. decipiens. Previously it was known that the adult of P. decipiens occurred in the stomachs of the harbour, grey and harp seals and that one of its larval stages occurred in the flesh of fish. Comparison of the food of cod from areas of high infection in Bras d'Or Lakes with that from areas of low infection suggested examination of the Mysidacea for larval nematodes.

Examination of mysids in Bras d'Or Lakes and Passamaquoddy Bay

Bottom fauna collected in the summer and fall of 1951 were identified during the winter of 1952 and examination of some of the mysids was carried out. Three larval nematodes were recovered from the mysid collection by May, 1952. Positive identification by morphological characteristics was not possible in such young stages, but the similarity of their mouth parts to those of small P. decipiens taken from cod flesh was suggestive. The collection of mysids from Bras d'Or Lakes was continued during the summer of 1952 and larval nematodes were found in three of the four species examined.

Mysidacea collected from Bras d'Or Lakes during 1952 and the percentage of infection with nematodes

<u>Species</u>	<u>No. of Mysids</u>	<u>No. of Nematodes</u>	<u>Per cent Infection</u>
<u>Erythrope erythrope</u>	20	0	0
<u>Mysis mixta</u>	327	14	4.3
<u>Mysis stenolepis</u>	118	4	3.4
<u>Neomysis americana</u>	2,055	33	1.6

Mysids were collected in Passamaquoddy Bay between July 23 and August 21, 1952. None were found to be infected with larval nematodes but most were juvenile Mysis stenolepis in which no infection was observed in the Bras d'Or Lakes. A better representation of mysid species might be obtained by sampling at another season.

Attempts to infect cod artificially with larval nematodes in mysids

Cod were collected from Whycocomagh Bay, an area of low infection, in April, 1952, and successfully held in Baddeck Bay until mid-July. During this time approximately 33,000 mysids were placed in sausage casings (cow gut) with the ends tied and these were fed to the cod. It is estimated that about 1,200 larval nematodes were contained in the mysids within the sausages. As can be seen from the following table, no positive result was obtained:

Average number of *P. decipiens* in experimental and control cod

<u>Date of examination</u>	<u>No. of cod Examined</u>	<u>Mysid-fed Cod</u> Average no. of cod-worms	<u>Control Cod</u> Average no. of cod-worms
May 31, 1952	19	2.0	
June 11, 1952	8	1.5	
	10		1.1
June 23, 1952	5	3.2	
	5		2.0
July 9, 1952	7	1.4	
July 11-14, 1952	19		3.8

Available evidence suggests that the feeding technique was faulty. It is planned to do more experiments using a different feeding technique to seek direct evidence on whether the larval nematode found in mysids of the Bras d'Or Lakes is *P. decipiens*.

Artificial infection of mysids with larval nematodes

Three harbour seals were fed with larval nematodes taken from the flesh of cod. Their faeces containing nematode eggs were fed to specimens of *Mysis stenolepis* taken from Passamaquoddy Bay which were free from larval nematodes. After two feedings five mysids were removed and eleven larval nematodes recovered from them. These were about four times the size of larval nematodes hatched from *P. decipiens* eggs and correspond to those from *Neomysis americana* and other mysid species in Bras d'Or Lakes.

It is almost certain that the larval nematodes found in these mysids came from *P. decipiens* in the harbour seals, since all larval nematodes fed to the seals were obtained from cod flesh and thus were almost certainly the "cod-worm". Mass mortalities among the infected mysids prevented an attempt to infect winter flounders to grow the nematodes to an identifiable stage. Further experiments are planned.

Three seasonal assistants carried out this work: W. F. Black during the winter and early spring months of 1951-52, W. Klawe during the spring and summer of 1952, R. W. Wolfgang

giving part of his time to the problem during August and September.

A synthesis of summaries by W. F. Black, W. L. Klawe and R. W. Wolfgang, November 13, 1952, by F. D. McCracken.

### Appendix No. 33

#### DEVELOPMENT OF THE EGGS OF PORROCAECUM DECIPIENS - THE "COD-WORM"

Previous observations on the development of the eggs of P. decipiens may be summarized briefly as follows: (1) hatching takes place when eggs are held in sea water, (2) larvae live approximately one week, (3) early stages of the eggs (two, four and eight-cell stages) may be obtained from the uteri of worms in the stomach of seals. Further information on the development of the eggs and larvae and on the viability of the eggs when exposed to low temperatures was obtained in 1952. The latter is of particular importance because mature P. decipiens carried by harp seals in the Gulf of St. Lawrence can shed eggs there only during the early spring when the water temperatures are low.

P. decipiens eggs held in 1%  $K_2Cr_2O_7$  and sea water did not hatch, while those held in sea water alone did. This indicates that hatching of the eggs in vitro depends, at least partially, on bacterial action.

Developed eggs and hatched larvae from P. decipiens were injected into the stomachs of lobsters by hypodermic syringe. There, all the eggs hatched; some larvae died but others survived. Larvae taken from the stomach of the lobster penetrated lobster muscle on which they were placed. These observations indicate two characteristics of the primary larvae: to hatch in digestive juice and to penetrate muscle.

The P. decipiens larva when hatched in vitro is covered by the cuticle of the first larva, which is retained under these conditions. When hatched in the lobster stomach this coat was lost, indicating that a moult had taken place there.

Eggs in the two to eight-cell stage, dissected from the uteri of mature P. decipiens from the stomach of a harbour seal, were divided into twelve lots of about 100 each and placed in wetted slides sealed with petroleum jelly. Three lots were held at each of the following temperatures:  $-32^{\circ}C.$ ,  $1^{\circ}C.$ ,  $14^{\circ}-16^{\circ}C.$ , and  $20^{\circ}-26^{\circ}C.$ , and examined after three, nine and twenty-seven days.

The results shown in the accompanying table indicate that eggs frozen or exposed to low temperatures developed very slowly and that the development of those exposed for 27 days was arrested. However, the fact that they did develop after transfer to fresh sea water indicates that they were not killed. Whether the short life of larvae from these eggs was a result of

Observations on the development of eggs of *P. decipiens*  
at -32°C., 1°C., 14°-16°C. and 20°-26°C.

Development after transferring to  
fresh sea water at 21°-26°C.

Exposure Time Days	Exposure Temperature	Stage of Development	Further Development	Hatched	Life of larvae After hatching
3	-32°C	8-16 cells	Yes	Yes	Normal (7 days)
3	1°C	8-16 cells	Yes	Yes	Normal (7 days)
3	14°-16°C	16-32 cells	Yes	Yes	Normal (7 days)
3	20°-26°C	32 and over	Yes	Yes	Normal (7 days)
9	-32°C	16-32 cells	Yes	4 days	1 day
9	1°C	16-32 cells	Yes	3 days	2 days
9	14°-16°C	32 and over	Yes	2 days	about 4 days
9	20°-26°C	more than 32	Yes	2 days	about 4 days
*27	-32°C	8-32+ cells	Yes	No	
*27	1°C	16-32+ cells	Yes	No	
27	14°-16°C	(lost when cover glass came unsealed)			
*27	20°-26°C	more than 32	No	No	

\* Transferred to fresh sea water at 19°-23°C.

exposure to low temperature may be questioned as it may have been caused by holding in welled slides. Eggs held in sea water in uncovered watch glasses at room temperature hatched in one week, while the development of those held in sealed welled slides at the same temperatures was arrested and they did not hatch. Thus the results indicate that *P. decipiens* eggs shed in the cold water of the Gulf of St. Lawrence in early spring may well be viable.

Condensation of R. W. Wolfgang's report.

Appendix No. 34

COD-WORM INCIDENCE IN COD OF THE BRAS D'OR LAKES

Sampling of cod from the Bras d'Or Lakes for cod-worms was continued in 1952 at the same stations as in 1951. The purpose was to provide a basis for assessing the effects of proposed reduction of seals on the abundance of the worms (see Annual Reports for 1949, 1950 and 1951). Results to date are summarized in the table:

Average numbers of immature Porrocaecum per cod  
in the Bras d'Or Lakes in 1950, 1951 and 1952

Age Group	Baddeck Bay			Kempt Head			Whycocomagh Bay		
	1950	1951	1952	1950	1951	1952	1950	1951	1952
I	<u>2.3</u>	1.7	<u>0.4</u>	<u>5.4</u>	4.0	<u>2.2</u>	<u>0.1</u>	<u>0.1</u>	<u>0.2</u>
II	<u>11.0</u>	<u>11.1</u>	<u>3.9</u>	<u>8.3</u>	<u>8.3</u>	<u>7.7</u>	<u>0.3</u>	<u>0.2</u>	<u>1.5</u>
III	<u>9.7</u>	<u>18.2</u>	<u>21.4</u>	<u>16.0</u>	<u>13.2</u>	<u>21.5</u>	-	<u>0.3</u>	<u>1.0</u>
IV	<u>11.9</u>	<u>12.3</u>	<u>28.6</u>	<u>14.6</u>	<u>13.0</u>	<u>29.1</u>	<u>0.5</u>	<u>0.5</u>	<u>0.9</u>
V	<u>15.2</u>	<u>21.2</u>	<u>17.0</u>	<u>16.8</u>	<u>20.5</u>	-	<u>1.3</u>	<u>1.8</u>	<u>1.0</u>

Underlining indicates samples of 20 or more cod

Whycocomagh Bay can be recognized again as an area of low infection, while Baddeck Bay and Kempt Head continue to be areas of high infection, but the observations in 1952 indicate greater fluctuations in the numbers of worms from year to year than do those in 1950 and 1951 alone.

The data for 1952 continue to show that cod in Baddeck Bay and at Kempt Head become more heavily infected with worms as they become older. No distinct trend of this sort appears from the Whycocomagh Bay data.

Sampling and examination of cod for cod-worms was carried out by C. J. Bayers, the otoliths were read by Mrs. J. Stuart, and the data were compiled in part by W. Klawe.

F. D. McCracken

### Appendix No. 35

## BIOLOGY OF STEPHANOSTOMUM HISTRIX ON THE CANADIAN ATLANTIC COAST

Metacercarial cysts of the trematode Stephanostomum histrix (Dujardin, 1845) had caused difficulty in marketing winter flounders and an investigation of its life history was begun in 1950 and concluded in 1952. The results are summarized below.

Adults of the Acanthocolpidae, to which this species belongs, are found in the alimentary tract of marine teleosts, the metacercarial larvae in marine teleosts and annelids, and the redial stages in marine gastropods. There is a free-swimming bioculate cercarial stage between the primary gastropod and secondary intermediate stage.

Definitive host. The sea raven (Hemitripterus americanus) is the major definitive host for Stephanostomum histrix in Canadian waters. Infected sea ravens have been found from Labrador to Passamaquoddy Bay in depths from 120 fathoms to the low-water mark.

Experimental infection of the common eelpout (Macrozoarces americanus), which is uninfected in nature, with metacercariae taken from the winter flounder (Pseudopleuronectes americanus) demonstrated the relationship between the adult worm in the rectum of carnivorous fish and the larvae found encysted in tissue of flatfish.

Besides the sea raven the definitive hosts include: the wrymouth (Cryptacanthodes maculatus), the Arctic eelpout (Lycodes reticulatus), the halibut (Hippoglossus hippoglossus) and the short-horned sculpin (Myoxocephalus (Scorpius) groenlandicus). The long-horned sculpin (Myoxocephalus octodecimspinosus) has been infected artificially but has not been found infected in nature.

Metacercarial cysts in flatfish. All six of the common Canadian Atlantic species of pleuronectid fishes are

infected with metacercarial cysts; of the inshore species the winter flounder is heavily infected but the brill (Lophopsetta aquosa) and smooth flounder (Liopsetta putnami) are seldom infected and then only with a few cysts each. Of the offshore species the plaice (Hippoglossoides platessoides) and yellowtail (Limanda ferruginea) may be heavily infected but the witch (Glyptocephalus cynoglossus) is infected to a very low degree.

A survey of inshore and offshore commercial catches of flatfish showed the area with heaviest infection to be the lower Bay of Fundy (Passamaquoddy Bay, St. Mary Bay and Annapolis Basin). The northern Gulf of St. Lawrence is almost free of Stephanostomum histrix but the infection extends along the eastern shore of Nova Scotia and Newfoundland to the Davis Strait and Greenland. Offshore banks show a very low incidence of infection. Samples below Nantucket Point, Mass., show no infection.

In the summers of 1950 and 1951 winter flounders were examined in Passamaquoddy Bay and the following characteristics of the infection were demonstrated:

- (1) It increases from the St. Croix River to the mouth of the Bay at Letite.
- (2) It increased at any given place with increasing depth, partly because there are larger flounders in deeper water.
- (3) Its intensity is proportional to the size of the fish, larger fish being more heavily infected than smaller.
- (4) It does not affect the growth of winter flounders. Age determinations on about 2,500 fish show that growth rates of infected and uninfected fish are about the same.
- (5) No appreciable change in infection could be demonstrated as the summer progressed. Small fish entering the catches late in the summer did tend to lower the average infection but incidence in commercial-sized fish did not change.

Primary intermediate host. In 1952 the primary intermediate host was discovered in about 10 fathoms in the mouth of the St. Croix River near Navy Island, St. Andrews, N. B. Further sampling showed that two species of snails are commonly infected: Buccinum undatum and the closely related Neptunea decemcostatum. The latter species is the more heavily infected when taken in an area where Buccinum is common. Infected specimens have been taken from just above extreme low tide to as deep as 20 fathoms.

Infected snails have been collected from Joe's Point in the St. Croix River, and from Lepreau Ledges and Grand Manan in the Bay of Fundy. In the samples from the St. Croix River, constituting the only large collection, 0.6% of 789 specimens of Buccinum were infected as contrasted with 6.0% of the deeper-water Neptunea.

The infection in the gastropod is confined to the digestive gland and gonad. It frequently, in fully gravid infections, destroys the gonad completely. Larval forms found in

the snail are: mother rediae which give rise asexually to daughter rediae which in turn give rise in the same method to cercariae. The cercariae are liberated into the gland and feed as do the two previous forms on gland cell.

The cercariae are of bioculate modified xiphidiocercaria type but lack an oral spine. They give the gonad in a completely gravid infection a dirty grey or brown colour. The process of liberation of cercariae into sea water was not observed but it is probably by rupture of the mantle membrane. Cercariae are negatively phototactic, for in the presence of strong light they react violently. They are poor swimmers preferring, unless irritated, to crawl slowly about.

Infection of the flounder is by penetration of the host integument. Encystment is normally confined to the ventral surface which is in intimate contact with the larva. The cercaria penetrates the flounder at a point of least resistance (fin, beneath a scale or lateral line), separates the muscle fibres for a short distance and finally encysts, forming a clear transparent wall about itself which is later supplemented by a wall of connective tissue laid down by the host.

Cysts are either colourless or the colour of host muscle connective tissue but seldom bear melanin granules.

Pathology in both definitive and secondary intermediate host is slight and of a local nature. Pathology in the snail is extensive and in some cases probably castrates the mollusc.

Geographic distribution. Stephanostomum histrix is a widely distributed parasite occurring in flounder populations across the North Atlantic Ocean. There are four known vectors which occur on both sides of the Atlantic: halibut (Hippoglossus hippoglossus), a definitive host, plaice or long rough dab (Hippoglossoides platessoides) and witch (Glyptocephalus cynoglossus), two secondary intermediate hosts, and the rough whelk (Buccinum undatum), a primary intermediate host. Samples received from Great Britain and Norway, as well as reports from Greenland and Denmark, have confirmed the discontinuous distribution of the parasite. The nature of the infection in Europe has not been well studied but records from there indicate heavy inshore and light offshore infection as is the case here.

Control and medical importance. The condition of heavily infected flounders known commonly as "measley flounders", which caused wholesale packers to stop the purchase of winter flounders in 1949, arises from the presence in muscle and fin of the metacercarial cysts of Stephanostomum histrix. The objection is aesthetic only, as the parasite matures only in marine teleosts. No control is suggested as all stages of the parasite are marine and widely spread. The only practical solution to the marketing problem is to discard heavily infected fillets and to fish in low-infection areas. Freezing of fillets will help to mask the presence of cysts, which are usually colourless, and skin-on fillets have been marketed with some success. It is worthy of note that there have been no complaints from the

industry about infected flounders since 1949.

R. W. Wolfgang

Appendix No. 36

DEVELOPMENT OF INSHORE DRAGGING IN THE MARITIME PROVINCES

Exploratory inshore dragging by this Station, beginning in 1947, has contributed greatly to the development of an inshore dragging industry, particularly for a number of flounder species, and the results have been reported in previous Annual Reports. No explorations were carried out in 1952 but the work of disseminating information on where and with what gear flounders may be caught has continued. The growth of the inshore dragging industry has been followed closely. Developments in 1952 can be summarized briefly as follows:

1. The number of small fishing boats converted to dragging, most only seasonally, increased to about 90 in 1952 from about 50 in 1951. Their landings, including all species, were over five and a quarter million pounds to September 16 as compared with about two and a half million pounds to the end of September in 1951. The 1952 catch will be worth over \$200,000 to the fishermen.

2. The most marked expansion in 1952 was in eastern Nova Scotia. Dragging activity here has been concentrated in the Chedabucto Bay and George Bay regions, with some in other shoal water regions off Cape Breton Island. Catches have been mainly flatfish (witch, plaice and winter flounder) in Chedabucto Bay, while in George Bay haddock have also been important.

3. A trend toward the reduction of the minimum acceptable commercial size of flounders from 30 cm. (12 inches) to 25 cm. (10 inches) has continued during 1952. This has permitted new dragging in widely separated areas, including especially Argyle Sound and Jordan Bay in southwestern Nova Scotia, and the Northumberland Strait region, particularly around Pictou, Richibucto and the mouth of the Miramichi River. This trend will, if continued, permit the exploitation of stocks of slower growing flounders in a number of other areas.

4. The various flounder species make up over 60% of the total landings by these small druggers, 55% being winter flounders. The balance includes haddock, catfish, hake and cod in that order, with haddock the preponderant species. A trend toward fishing for these species is apparent.

This relatively new fishery is being followed closely by collection of statistics on catch and effort, by sampling to determine size and age composition of the catch and by intensive study in particular areas such as St. Mary Bay (see Appendix 43).

F. D. McCracken

Appendix No. 37

EXPLORATORY DRAGGING IN THE SOUTHEASTERN GULF OF ST. LAWRENCE

During the summer and fall of 1951 the M/B "Mallotus" carried out exploratory dragging in the southeastern Gulf of St. Lawrence, including George Bay and Northumberland Strait west to Baie Verte. Preliminary results to September 20 were reported in this Station's Annual Report for 1951 (Appendix 37). Results to mid-November confirm the relatively good catches of haddock and hake previously reported. Fuller analysis of all results indicates that possibilities for a successful winter flounder fishery exist in the southeastern Gulf.

In contrast to haddock, hake and witch, which were taken mostly at about 20 to 22 fathoms, winter flounders were most abundant in water less than 15 fathoms. Catches of importance were made in 11 to 15 fathoms along the Nova Scotia coast from George Bay to Baie Verte and in the Rollo Bay region of Prince Edward Island. In waters shallower than 11 fathoms flounders were too small to be of commercial importance.

Within a depth range of 11 to 15 fathoms catches of winter flounders with a 50-ft. flounder drag averaged 102 pounds per half-hour tow but were as high as 150 to 200 pounds in George Bay and from Amet Shoals to Baie Verte. Of these catches, 89% of the flounders (by number) were larger than 10 inches and 41% larger than 12 inches.

Even when the trade refuses flounders smaller than 12 inches, a profitable winter flounder fishery is possible in these areas. The present trend to drop the minimum acceptable size from 12 inches to 10 inches makes such a development much more likely.

L. M. Dickie

Appendix No. 38

EXPLORATORY DRAGGING FOR REDFISH

Exploration to assess the potentiality for redfish dragging by small draggers was begun in the fall of 1951 and the winter of 1952. Such a redfish fishery has developed in the Gulf of Maine for small draggers operating from such ports as Rockland, Portland, etc. Here, small draggers (approximately the size of the "J. J. Cowie" but with more power) operate successfully even though the area is no longer considered profitable for larger trawlers. Areas where deep water occurs close to shore along the Canadian Atlantic coast and where redfish populations have been exploited by large American trawlers might thus offer possibilities for small draggers operating from local ports. On the basis of fishery statistics and charts, areas in the Bay of Fundy, off Canso and off Gaspé appear to hold the most promise.

The M/V "J. J. Cowie", with a registered length of 56 ft., gross tonnage of 49 and 100-horsepower diesel engine, was used in

preliminary trials beginning in October, 1951. L. M. Dickie was the observer during the fall of 1951, and E. G. Sollows the observer during the winter of 1952.

Dragging began off Canso on October 18, the period to November 19 (during which the boat operated 11 days) being used almost entirely in adjusting gear. Doors, net, winch and hook-up gear had to be adjusted to the "Cowie's" needs and eventually new doors had to be ordered. Catch during this period was negligible. It was found that the "Cowie" could tow at an estimated three miles per hour in depths of about 100 fathoms, using a three-quarter No. 35 Yankee trawl and doors weighing 425 pounds each.

From November 10 to December 4 two tows (of 12 one-hour tows completed) in 60-90 fathoms produced commercially interesting results. Total catches of commercial species in these tows were 776 pounds and 605 pounds, of which 359 pounds and 498 pounds, respectively, were redfish.

From February 26 to March 29, 1952, the "Cowie" operated in the Bay of Fundy mainly along the Digby Neck shore. Persistently strong N. E. winds limited fishing operations to ten days or parts of days, six of which occurred in the last ten days of March. All catches were small, skate being the most abundant species taken. No other draggers were working in the vicinity, and information on existing fisheries indicates that prospects would be better at another season of the year.

These trials show that boats of the size and power of the "Cowie" can tow commercial-sized gear in deep water. Plans include further exploration during the spring, summer and early autumn when weather is more suitable for reaching deep-water areas and when the program can be planned to fit present knowledge of the redfish fishery.

F. D. McCracken

Appendix No. 39

#### DANISH SEINING

Exploratory Danish seining in 1949 was followed up by active participation (through loan of gear) in commercial trials in 1951 in Chedabucto Bay, the most promising area discovered. Advice and assistance in purchasing and installing equipment was given to one commercial fisherman who operated a Danish seiner there during the summer of 1952. An attempt is being made to arrange similar commercial trials in George Bay and the southeastern Northumberland Strait.

The commercial fisherman operating in Chedabucto Bay used a 39-ft. converted flounder dragger. Records of his operations were compared with those of six draggers of about the same size and power operating in Chedabucto Bay during July and August. This comparison shows that for the same period the

Danish seiner landed 116 per cent more fish by weight than the average and 97 per cent more than the best dragger.

Details of expenses are not available but it appears that the Danish seiner's expenses were similar to the draggers' even though most of the latter operated with two-man crews as compared to three for the Danish seiner.

Danish seining appears to be a more efficient method of taking flatfish than dragging for boats of this size but it has a major limitation in that large areas of smooth bottom are necessary for its operation. Whether such areas are available in accessible regions and whether concentrations of flatfish can be found in such areas remains to be shown by further exploration.

F. D. McCracken

#### Appendix No. 40

#### RECENT TRENDS IN THE OFFSHORE COD FISHERY OF THE CANADIAN MAINLAND

Cod makes up the bulk of the groundfish landings on the Canadian Atlantic coast. Even on the mainland where its preponderance is not as great as in Newfoundland it now contributes more than four times as much weight as haddock, the next most important species. Some statistics of the cod catch are shown in an accompanying figure (fig. 1).

The total landings and offshore landings are at a higher level than in the 1930's but have declined gradually from the recent peak of over 300 million pounds in 1946. The sharp break in 1947 is the result of a strike.

Catch-per-trip for four large otter trawlers and four large vessels reached a maximum in 1944 and 1945, respectively, two or three years before the maximum total catch was reached. Catch-per-trip for these otter trawlers, while much below that of the period 1943-1946, is, since 1948, at about the same level as in the late 1930's. During the war years activities of European and United States fleets on the Nova Scotia and Newfoundland Banks were greatly curtailed. Canadian fishermen were able to take advantage of an accumulated stock resulting from this reduced effort and continued good recruitment and growth.

Catch-per-trip for four large otter trawlers, by quarters, showing the weight of each of the three size-categories landed (steak, market and scrod) is included in figure 2. Catch-per-trip of market cod has remained relatively constant since 1947 and compares favourably with that shown for 1938 and 1939. Scrod remains a relatively negligible portion of the otter-trawl landings. Catch-per-trip of steak cod shows a marked downward trend since 1947 and is at present reduced to a low level in all quarters of the year.

Fig. 1

Cod Statistics

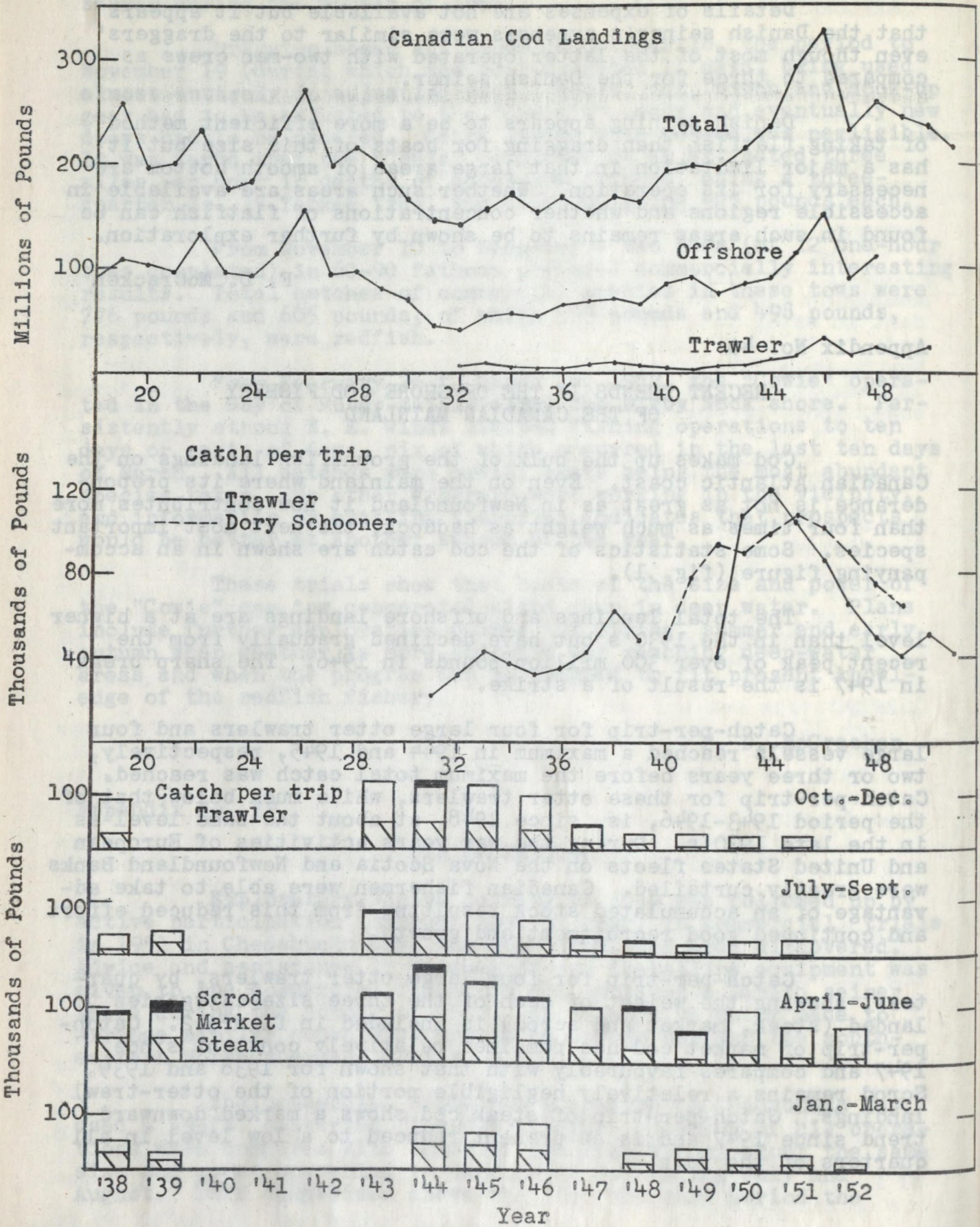
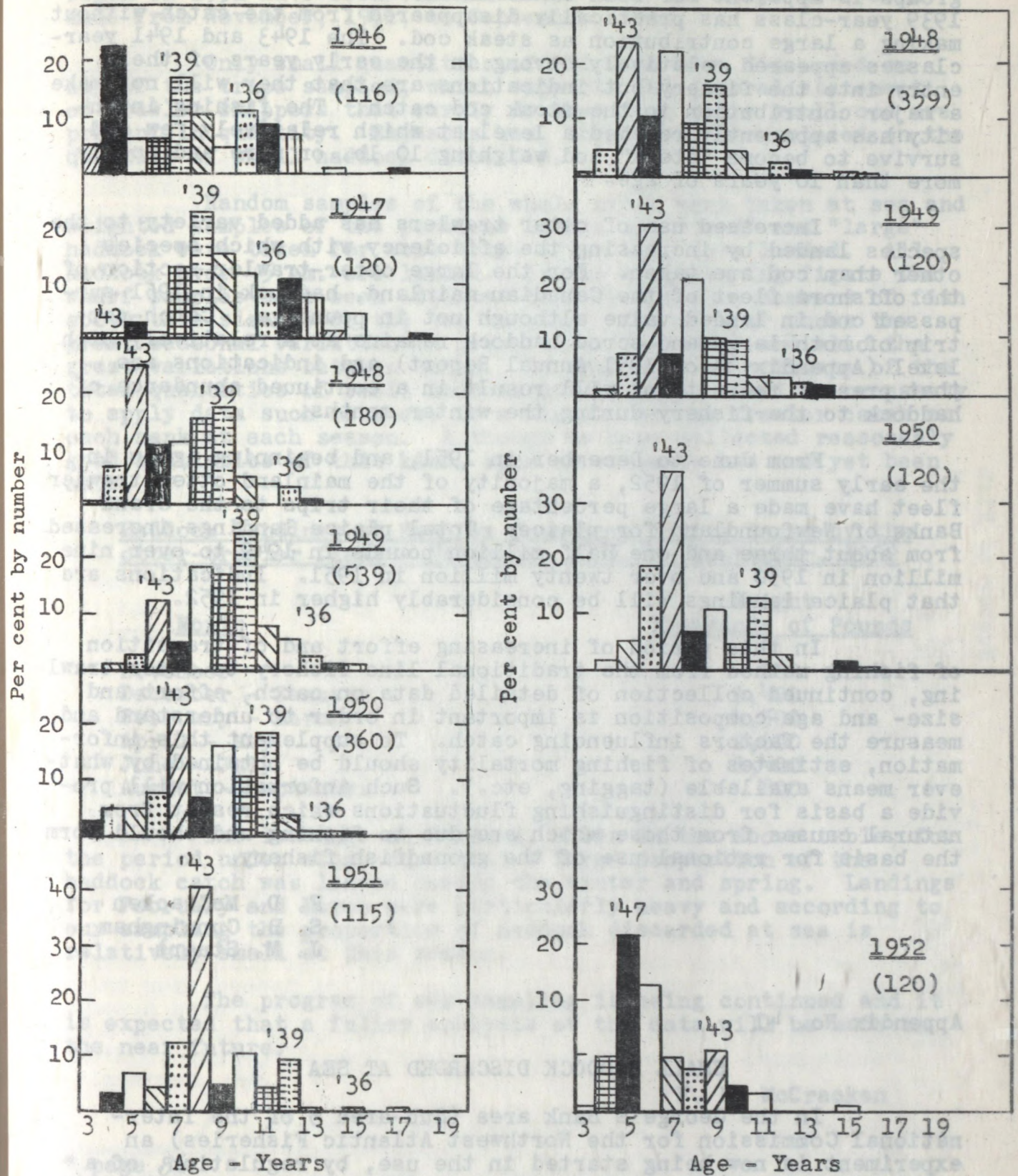


Fig. 2

Age Composition of Otter-Trawl Cod Landings

Western Bank  
Feb.-April

Banquereau  
May-July



Age composition of the cod landings from Western Bank during the winter months and from Banquereau during the spring is shown for a number of years. A reduced proportion of older year-groups is apparent for both banks in the more recent years. The 1939 year-class has practically disappeared from the catch without making a large contribution as steak cod. The 1943 and 1941 year-classes appeared relatively strong in the early years of their entry into the fishery but indications are that they will not make a major contribution to the steak cod catch. The fishing intensity has apparently reached a level at which relatively few cod survive to become "steak" cod weighing 10 lb. or more and mostly more than 10 years of age.

Increased use of otter trawlers has added variety to the species landed by increasing the efficiency with which species other than cod are taken. For the large otter-trawler section of the offshore fleet of the Canadian mainland, haddock in 1951 surpassed cod in landed value although not in poundage. Catch-per-trip of both large and scrod haddock remains at a relatively high level (Appendix 33 of 1951 Annual Report) and indications are that present recruitment will result in a continued abundance of haddock to the fishery during the winter months.

From June to December in 1951, and beginning again in the early summer of 1952, a majority of the mainland otter-trawler fleet have made a large percentage of their trips to the Grand Banks of Newfoundland for plaice. Total plaice landings increased from about three and one half million pounds in 1949 to over nine million in 1950 and over twenty million in 1951. Indications are that plaice landings will be considerably higher in 1952.

In this period of increasing effort and of transition of fishing method from the traditional line fishery to otter trawling, continued collection of detailed data on catch, effort and size- and age-composition is important in order to understand and measure the factors influencing catch. To supplement this information, estimates of fishing mortality should be obtained by whatever means available (tagging, etc.). Such information will provide a basis for distinguishing fluctuations which result from natural causes from those which are due to fishing and should form the basis for rational use of the groundfish fishery.

F. D. McCracken  
S. B. Cunningham  
J. M. Stuart

Appendix No. 41

#### SMALL HADDOCK DISCARDED AT SEA

In the George's Bank area (Sub-area 5 of the International Commission for the Northwest Atlantic Fisheries) an experiment is now being started in the use, by regulation, of a mesh in the cod-ends of otter trawls which will permit the escape of most of the small haddock which are not now used while affecting the catch of the used sizes very little. Information

on the small haddock discarded at sea by our trawlers is being obtained in order to assess the possible merits of such a regulation on the grounds off the Canadian coast. Investigations begun in 1951 have been continued and five sea trips have been made from November, 1951, to September, 1952.

Only small quantities of cod have been discarded on any of the trips sampled, which supports the general statement of trawler skippers that rarely do they fish where small cod are present in quantity. Emphasis has, therefore, been placed on the quantity of small haddock discarded.

Random samples of the whole catch were taken at sea and weighted samples of the portions landed as "scrod" and "large" haddock were taken for some trips after they were landed. All haddock over 45 cm. are landed. In the accompanying figure the wharf samples have been adjusted to give the same numbers of fish above this size as do the sea samples. The figure\* shows the great seasonal variation in proportions discarded and also the great variations between banks. To arrive at an estimate of the total quantities of small haddock discarded it would be necessary to apply data such as these to a figure for the trawler catch on each bank at each season. Although we have collected reasonably good statistics of this kind, such an estimate has not yet been made.

Haddock landings at Halifax from Nova Scotia Banks by the otter-trawler fleet - November, 1951, to September, 1952

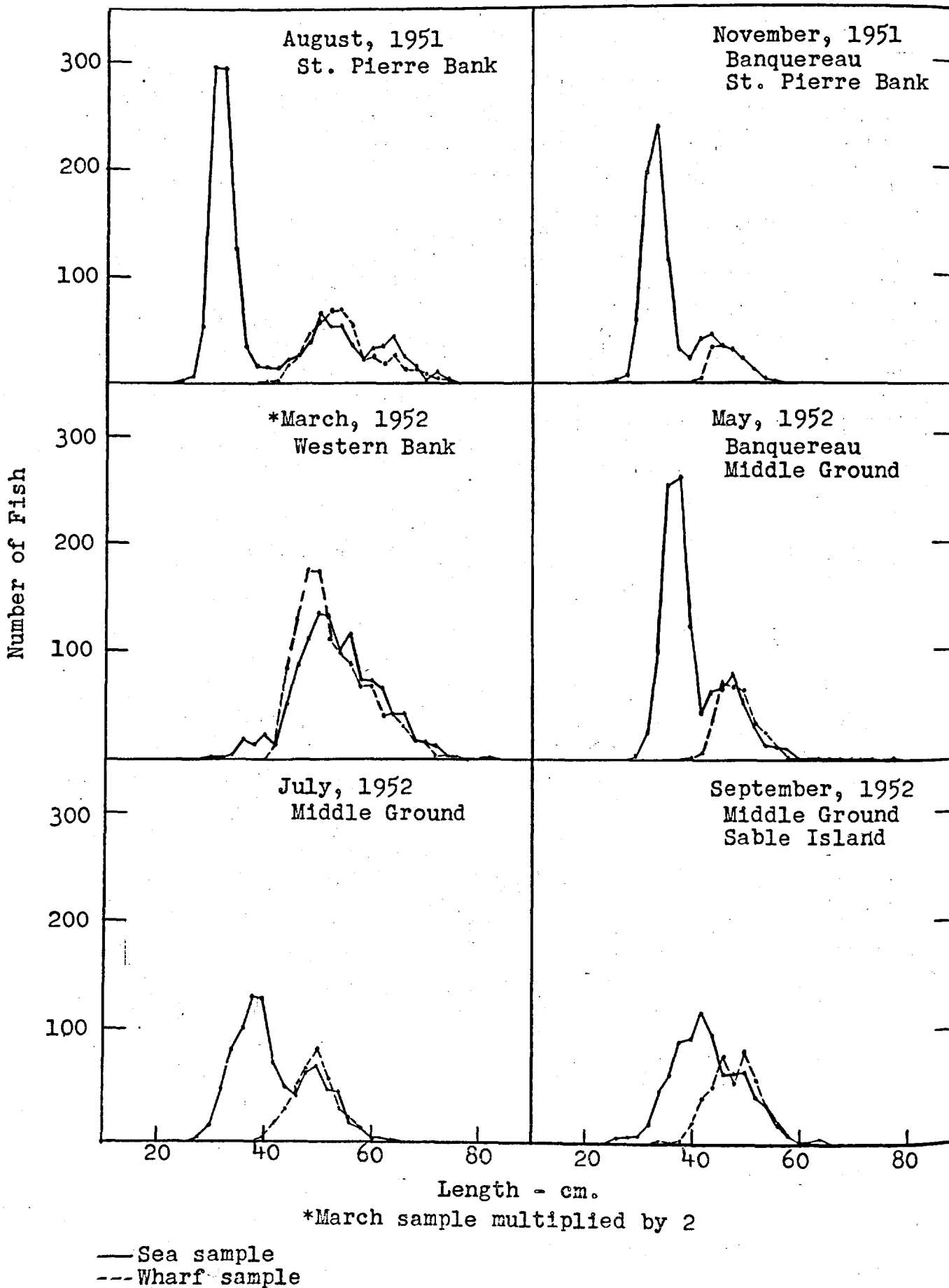
<u>Month</u>	<u>Weight Thousands of Pounds</u>
November	200
December - January	1,400
February - March	4,500
April - May	2,600
June - July	1,400
August - September	800

The landings at Halifax, shown in the above table, for the period under study show that a large proportion of the haddock catch was landed during the winter and spring. Landings for February and March were particularly heavy and according to our sampling the proportion of haddock discarded at sea is relatively small at this season.

The program of sea sampling is being continued and it is expected that a fuller analysis of the data will be made in the near future.

F. D. McCracken

Haddock discarded at sea by Canadian trawlers  
Offshore Banks



Appendix No. 42

AN ATTEMPT TO TAG GROUND FISH WITHOUT LANDING THEM

Assessment of fishing mortality ("proportion caught") for haddock and cod is one of the basic requirements for estimating the value of any proposed regulatory measure. One means of obtaining information on the proportion caught is to tag fish and record the proportion of tags returned, setting a minimum figure for this "fishing mortality". Unfortunately no method of tagging haddock has been devised which does not kill a large and unknown proportion of the tagged fish, although cod can apparently be tagged at the surface without excessive mortality if care is used.

Results of preliminary experiments to test the possibility of tagging haddock and cod without bringing them to the surface are not encouraging. The method used was to hand-line fish using a thread between the hook and sinker which would break and leave a marked hook in the mouth of the fish. In this method it is necessary to estimate the numbers and kinds of fish tagged by landing a fixed proportion of the fish hooked.

Hand-lining was carried out for several days to ascertain what species and sizes of fish were being caught and to obtain sufficient data to estimate the accuracy of sampling. While these data have not been analyzed statistically, it is apparent that large variations occur between different persons both in species and sizes of fish caught, making it extremely difficult to obtain an estimate of the kinds and sizes of fish tagged.

It was found possible to set a hook in a fish's mouth and then break the connection between the hook and the sinker when a single strand of #35 shoemakers' linen thread was used. One hundred hooks were marked with a plastic ribbon and snapped off the line in a depth of 30 fathoms off Lockeport, presumably in the mouths of fishes. Of six marked hooks recovered, however, five with the attached plastic were in the stomach of cod and the other was caught in a cod's throat. All recoveries came from cod and were made in the same general area as released -- three by a local fisherman and three by the "Mallotus" crew.

All fish brought to the surface were examined to see where the hook had entered and records show that the great majority were hooked either in the upper or lower jaw. Why the tags should have been retaken in the stomach is not explained, but the fact that they were puts obvious limitation on this tagging method, since they would not be readily seen by commercial fishermen.

There was a large preponderance of cod in the catches though haddock were present in some of the areas fished, and it may be worth while trying this method again where more haddock can be caught.

The experiments were carried out on grounds off Lockeport from July 14 to July 23 using the M/B "Mallotus" with H. Edwards-Davies and D. N. Fitzgerald as observers.

F. D. McCracken

Appendix No. 43

#### WINTER FLOUNDER POPULATION OF ST. MARY BAY

Detailed records of catch and effort have been collected for the newly developed winter flounder fishery since its inception. In St. Mary Bay, one of the centers of the fishery, tagging was carried out in the fall of 1949 and the spring and fall of 1950. Along with these data, samples of the commercial catch to determine size and age composition have been taken since 1948. A preliminary analysis of the data leads to the following tentative conclusions.

Average recruitment into the population appears to be of the order of 1,300,000 flounders per year, weighing about three quarters of a million pounds. Considerable fluctuation around this mean value is, of course, apparent. Natural mortality is estimated to be about 30% per year, while the average growth by weight is slightly in excess of natural mortality, nearer 32 or 33% per year.

With a recruitment of three quarters of a million pounds per year, natural mortality of 30% and growth rate of 33% by weight, a fishing mortality of 10% should yield an average yearly total catch of about one and one quarter million pounds. Fishing mortality of 20% would give a lower average yearly yield of about 950,000 pounds according to calculations. If fluctuations produced a smaller population equivalent to a recruitment of 600,000 pounds per year, catches at 10% and 20% fishing mortality would be about 1,000,000 or 600,000 pounds, respectively. Calculations show that under present biological and environmental conditions the yield would not be lower than 600,000 pounds per year with fishing mortalities higher than 20% but the catch would contain few fish of the size now considered desirable by the industry.

There seems to be an essentially simple relationship between fishing effort and fishing mortality for seasonal fishing mortality rates of less than 40%. Change in fishing effort equivalent to 1,000 fishing hours by a 40-ft. flounder drag produces a change in seasonal fishing mortality of 4%. Since the inception of the fishery in St. Mary Bay the stock of winter flounders here has been subject to fishing mortalities of 6% (1948), 21% (1949), 39% (1950) and 21% (1951), suggesting that a higher long-term yield would be obtained with less intensive fishing than in the last three years.

All calculations are based on data for St. Mary Bay proper and do not include data for a recently developed fishery off Cape St. Mary at the extreme mouth of the bay. This population appears not to mix with the St. Mary Bay population to

any extent. Tagging is being carried out in 1952 to check this assumption.

The above estimates of yield are based on somewhat unreliable estimates of natural mortality and calculations indicate that small errors in estimating natural mortality may lead to large errors in estimating catches over the range of fishing mortalities which are of greatest interest.

Tagging will be carried out in the fall of 1952 and in the summer of 1953 to provide a further check on some of the assumptions used in the above calculations.

L. M. Dickie

Appendix No. 44

SAVINGS GEARS FOR WINTER FLOUNDERS

Experiments with cod-ends having a larger mesh size than that now used show that by selecting a suitable mesh small flounders can be released without markedly affecting the number of commercial-sized flounders taken.

These trials were carried out in Passamaquoddy Bay in the fall of 1950 and the data analyzed during the winter of 1952. The M/V "J. J. Cowie" was used for the otter-trawling and K. G. Sollows acted as observer. Both fifteen-minute and half-hour tows were used, a particular effort being made to give each mesh size the same towing time. Trawls and cod-ends were of single cotton twine as is usual for the standard flounder drag on the Canadian Atlantic coast.

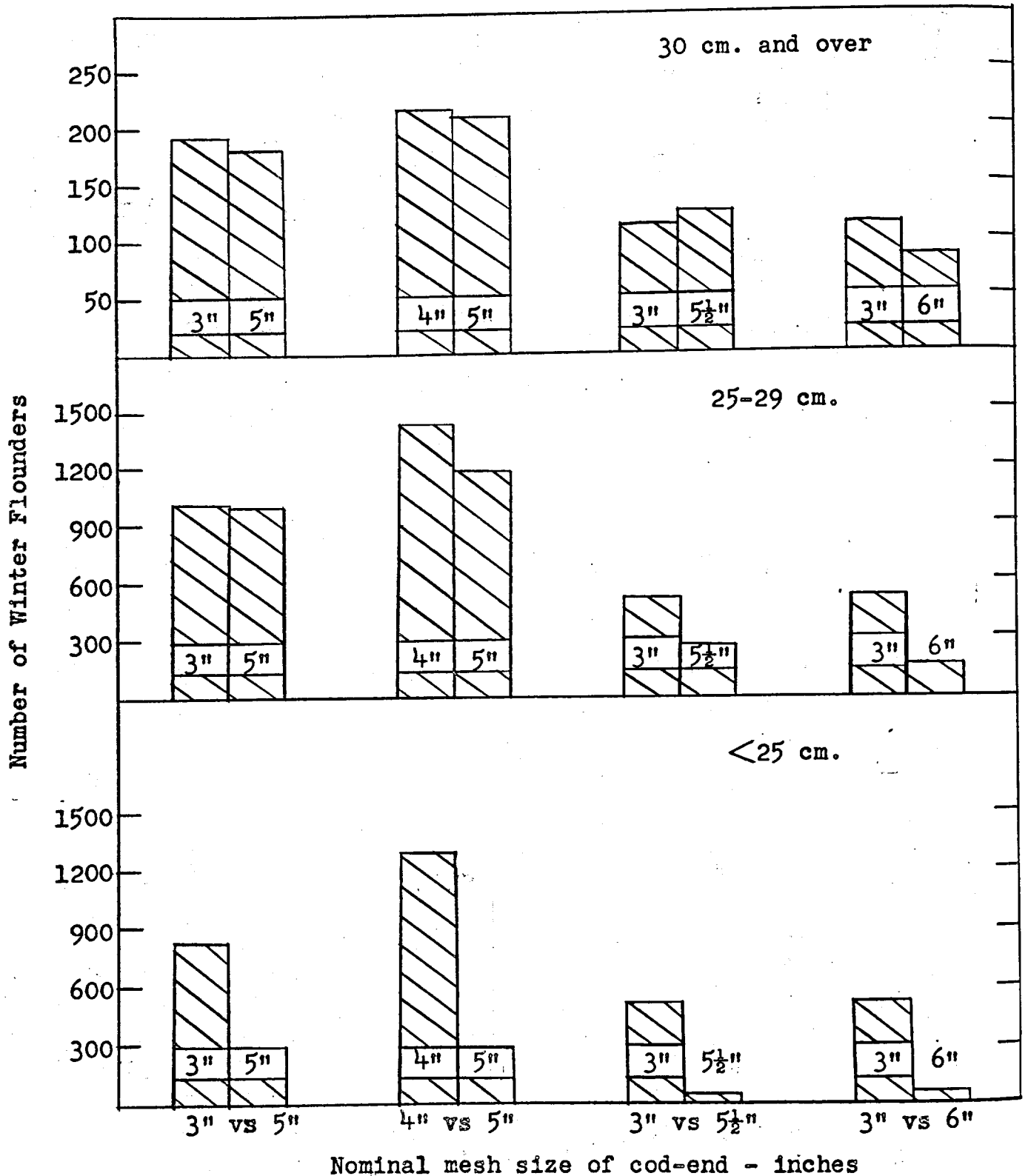
The first column of Table I shows the mesh measurement in the manner commonly used by fishermen and net manufacturers. The second column gives a measurement of mesh similar to that suggested for a proposed George's Bank haddock regulation; i.e. the average of ten mesh measurements using a flat, wedge-shaped gauge inserted into the mesh when the mesh had been stretched by, in this particular experiment, a weight of 15 pounds. Variation in shrinking, stretching, tightness of knots, etc., makes some such precise measurement essential.

Table I

The measurements in inches of cod-end meshes tested

<u>"Nominal size"</u>	
<u>New, dry, stretched,</u>	<u>Used, wet, stretched,</u>
<u>knot-center measurement</u>	<u>inside-knot measurement</u>

3	2.88 - 2.96
5	4.51 - 4.61
5½	5.45 - 5.6
6	5.73 - 5.85



The total number of winter flounders caught, in comparative tows with various cod-end mesh sizes, shown according to the following size categories:

- 30 cm. and over = the common minimum commercial size
- 25-29 cm. = expected acceptable commercial size
- <25 cm. = below expected commercial size

The total numbers of winter flounders caught in the size categories 30 cm. and over, 25-29 cm., and less than 25 cm., by the various meshes for all comparable tows are shown in the accompanying figure. These size categories were selected on the basis of present commercial practice, 30 cm. being the most commonly used minimum commercial size at the present time with a trend toward accepting flounders down to 25 cm.

It is apparent that little change in the catch of sizes over 30 cm. resulted from increasing the mesh size even up to six inches. Within the 25-29 cm. size category a reduction of catch is apparent with the 5½" but not with the 5" mesh. Of haddock below 25 cm. all three larger mesh sizes (5", 5½" and 6") caused a marked reduction in catch as compared with the standard of 3" mesh.

With a lower size limit set at 30 cm. by the trade, a nominal mesh size of 5.45"-5.6" would release most of the small flounders now discarded without seriously affecting the catch of the sizes used. If the present trend to reduce the minimum acceptable length to 25 cm. continues, then a nominal mesh size of 5" would seem most satisfactory.

F. D. McCracken

#### Appendix No. 45

#### DRIFT-NET FISHING FOR HERRING IN THE GULF OF ST. LAWRENCE

Exploratory drift-net fishing for herring in the Gulf of St. Lawrence was started in the summer of 1950 and good catches of large, fat herring were made regularly throughout the season in most of the areas where the fishing was done. The average catch per night per net (37½ yards long and 150 meshes deep) was 136 pounds and this compares very favourably with commercial fishing in the North Sea, where average catches vary between 50 and 100 pounds per night per net of the same length but more than twice as deep.

This exploration was continued in 1951, with most of the fishing in the areas where the best catches had been made in 1950, and it was expected that catches would be improved, partly because of selection of promising areas fished but chiefly because of several changes in the gear and in the method of handling. The total catch for the whole season was actually less than one tenth of the catch in 1950 for the same number of fishing days. Attempts to improve catches were unsuccessful until late in September when it was found that by doubling the depth of the nets good catches were again made. By this time, however, the season was too far advanced to give these double-depth nets a thorough trial and further experiments were deferred until 1952.

In 1952 gear was purchased from a supply house in Scotland and consisted of drift-nets, canvas floats, ropes and fittings of a type regularly used in Western European areas.

The main difference between this gear and that which had been used in 1950 and 1951 was that the nets were 360 meshes deep instead of 150 meshes, which is a standard depth in Canada.

A fleet of gill-nets varying in length from 375 to 780 yards and approximately 16 yards deep was fished in the vicinity of Magdalen Islands from May 20 to July 16 and in the vicinity of Gaspé from July 31 to September 15. All of the nets used in the Magdalen Islands area were of 2½-inch stretched mesh and in the Gaspé area 2-inch stretched mesh. All of the fishing was done from the M/V "J. J. Cowie". Fishing was done at night as in the two previous seasons, nets being set before sunset and hauled back immediately after daybreak. Plankton hauls and bathythermograph recordings were made before each set. A detailed record of atmospheric conditions was made every hour while the nets were in the water and the sonic sounder was operated for at least five minutes each hour. Fishing was done in areas where the presence of herring was indicated by echo-sounder recordings, presence of birds, whales, etc., or from previous experience.

The catches throughout the season were generally good. A total of 33 sets was made and from 21 of these more than 50 pounds of herring and mackerel per net were boarded. On one occasion the nets were lost in a sudden storm and no measure of the catch was possible, and on another occasion, when the nets sank with the weight of fish, only a minimum estimate could be made. The total catch for the season was 98,129 pounds of herring and 4,078 pounds of mackerel. A summary of the catches by dates and areas is given in the accompanying table. The accompanying chart shows the areas where fishing was done in 1952 and the areas where good catches were made both in 1950 and in 1952.

Drift-net catches of herring and mackerel in 1952

<u>Date</u>	<u>Area</u>	<u>No. of sets</u>	<u>Net-nights*</u>		<u>Total catches (pounds)</u>		<u>Av. catch per net-night</u>
			<u>Total</u>	<u>Effective</u>	<u>Herring</u>	<u>Mackerel</u>	
May 20-June 26	F	6	60	41	16,800	145	413.3
June 3-July 16	G	10	103	80	6,397	3,678	125.9
July 31-Sept. 9	N	13	160	160	74,485	90	466.1
Aug. 7&Sept. 15	M	2	21	21	425	15	20.2
Sept. 21&Sept. 25	G	2	20	20	22	150	8.6
Totals		33	364	322	98,129	4,078	317.4

\* A "net-night" is the use of one net for one night. In "effective" net-nights, nets which were lost or prevented from fishing at all by serious entanglement are not included.

The program for 1952 was designed chiefly to test the commercial possibilities of drift-net fishing in the Gulf and because of this very little exploratory work was done. When an area where fish were plentiful was found the boat continued to fish there to determine how many herring could be caught and during what part of the season.

The amount of gear that could be handled depended chiefly on the total quantity of fish caught, since the removal of fish from the nets was a serious limiting factor. For example, on June 11 it took four men 12 hours to remove 8,250 pounds of herring from ten nets, while on August 19 the same men removed 4,875 pounds of herring from 21 nets in less than six hours. It is believed that the efficiency of handling gear and catches could be greatly increased, perhaps even doubled, by using a boat which could be more easily manoeuvred than the "J. J. Cowie", and which had less freeboard and more deck room. On several occasions, under poor weather conditions,

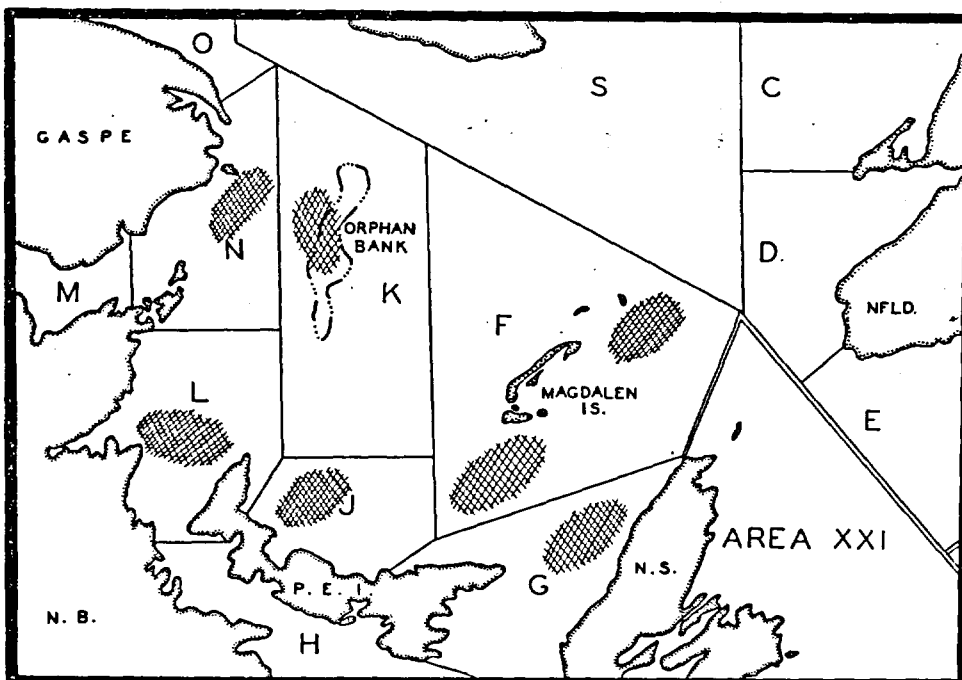
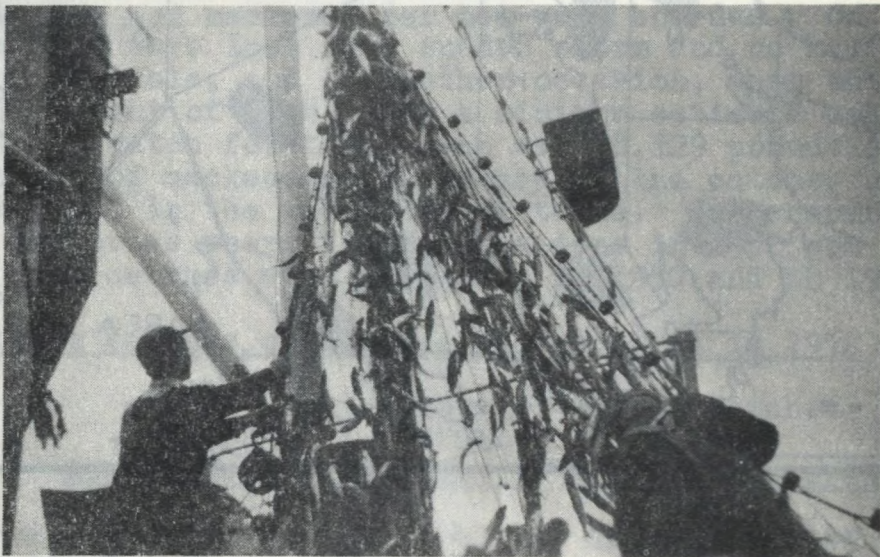


Chart showing areas fished (lettered) and areas where good catches of herring and mackerel were made in 1950 and 1952. (cross-hatched).

it was necessary to take the whole fleet of nets on board without removing the fish. An example of a large catch which was handled in this manner is shown in the accompanying photograph.

Since with this season's operations experimental drift-net fishing in the Gulf of St. Lawrence has been concluded, the following observations on the commercial possibilities of this method of fishing can be noted.

Commercial quantities of high-quality herring (see Appendix 47) can be taken in most of the southwestern Gulf areas throughout the period May to September. An average of three fishing days per week can be expected and catches should average from 6,000 to 10,000 pounds for a crew of four using a minimum of 750 yards of net. A Cape Island or similar type of boat 45 to 55 feet long would be satisfactory. European nets are from two to three times as efficient as Canadian nets, chiefly because of their greater depth. The success of the operation will, of



A large drift-net catch of herring in the Gulf of St. Lawrence, 1952.

course, depend on the value of the catches and it is apparent that this would have to be three cents per pound or more.

S. N. Tibbo  
E. G. Sollows

Appendix No. 46

RELATION OF DRIFT-NET CATCHES TO TEMPERATURE, LIGHT AND PLANKTON

In conjunction with experimental drift-net fishing for herring in the Gulf of St. Lawrence, records were made, as in 1950 and 1951, of (a) surface temperatures and the depth of the warm surface layer; (b) light conditions while the nets were in the water; (c) the abundance and distribution of the planktonic forms upon which herring feed; and (d) the abundance of pelagic fishes as indicated by sonic sounder recordings.

Temperature. Surface temperatures recorded at the fishing stations were generally lower in 1952 than they were in 1951 but were similar to those recorded in 1950. The average temperature from June 1 to September 30 was 14.4°C. in 1952, 15.9°C. in 1951, and 14.1°C. in 1950. These temperatures do not necessarily reflect general temperature conditions in the Gulf during the three seasons, since observations were not made in the same localities at the same time, but show the temperature conditions under which fishing was done. It was suggested earlier (Appendix 44 of Annual Report for 1951) that the small catches in 1951 may have been due, at least in part, to relatively high water temperatures. Good catches were made in both 1950 and 1952 under lower temperature conditions.

Light. A pilot-house record of light conditions was made for every hour while the nets were in the water. Using these data fishing nights were classified into three groups, viz. moonlight, clear starlight and dark overcast nights depending on the condition prevailing for more than 50 per cent of the period. The results show that the largest catches were made on clear starlight nights and the smallest ones on bright moonlight nights. The average catch per net per night was 82.9 lb. on moonlight nights, 236.7 lb. on dark overcast nights and 540.9 lb. on clear starlight nights. Most of the fishing was done in selected areas under all three light conditions and it is apparent that light is an extremely important factor in the success or failure of this method of fishing.

It was also recorded that the fish were well distributed from top to bottom in the nets on dark overcast nights and on starlight nights, but on moonlight nights the fish were largely in the lower half of the nets. This indicates that a greater flexibility is desirable in the depth at which the nets can be set.

Plankton. Plankton hauls were taken immediately before setting the nets at each station. These consisted of 10-minute horizontal tows made about 3 metres below the surface with a net 30 inches in diameter and of #0 mesh. No detailed examination of the plankton samples has yet been made but a cursory inspection has revealed that the copepod Calanus was the principal constituent, with smaller and varying amounts of fish eggs and fish larvae, Ctenophores, Chaetognaths, Amphipods and Decapod larvae also present in most of the tows. An examination of the stomach contents of herring in the Gulf area indicates that Calanus is the principal food item.

Plankton tows were separated into groups classified as rich, medium and poor on the basis of the quantities of Calanus in them. A comparison between the quantities of herring caught and the abundance of Calanus shows that in all cases where small quantities of plankton were found the catches were also small (50 pounds per net or less) whereas the best catches (200 pounds per net or more) were invariably associated with large quantities of plankton. It was further shown that in 12 out of 21 sets, or in more than 50 per cent of the cases, large catches were made in areas having a better than average abundance of plankton. It is evident, therefore, that the abundance of plankton can be used as a guide for setting drift-nets to catch herring.

Sonic Sounder Recordings of Pelagic Fish. The M/V "J. J. Cowie" is equipped with a DRI model Bendix echo-sounder and this instrument was operated while the boat was cruising and also for a period of at least five minutes every hour while the nets were in the water. The results show that this instrument is not an infallible guide for actual fishing operations. Most of the good catches were associated with good recordings but some good catches were made without any indication of fish on the recorder and, conversely, very poor catches were made in some areas where the sounder indicated that large schools of pelagic fish were present.

S. N. Tibbo  
E. G. Soliows

Appendix No. 47

THE CONDITION (FATNESS) OF HERRING IN THE GULF OF ST. LAWRENCE  
DURING THE SUMMER MONTHS

As in 1950 and 1951, weekly samples of herring for fat determinations were taken from drift-net catches during the 1952 season. The procedure was to grind from two to six fish in a food chopper, mix thoroughly, and measure a small sample in duplicate into containers with known amounts of  $\text{Na}_2\text{SO}_4$ . Fat determinations were made in the laboratory by the ether<sup>2</sup> extraction method and values are expressed as a percentage of the wet weight of the whole fish. A summary of the results is given in the following table:

Percentage fat content of herring (May 15 to September 30)

Period	No. of Samples	Size (cm.)	Fat Content	
			Range %	Average %
May 16 - 31	4	29 - 34	2.9 - 4.0	3.5
June 1 - 15	4	28 - 37	9.2 - 13.8	11.5
June 16 - 30	8	27 - 38	10.2 - 17.1	14.6
July 1 - 15	6	36 - 39	15.7 - 17.5	16.4
Aug. 1 - 15	4	28 - 32	11.7 - 15.5	13.5
Aug. 16 - 31	4	29 - 32	13.3 - 14.6	14.2
Sept. 1 - 15	4	27 - 37	13.2 - 13.8	13.6
Sept. 16 - 30	2	30 - 35	10.3 - 11.7	11.0

The results show that herring recover rapidly from the effects of spawning and low water temperatures. Fat contents increased from 3.5 per cent in mid-May to 11.5 per cent in mid-June. The best condition was reached early in July and was reasonably well maintained until September when there was a decrease which is believed to be associated with the development of the gonads.

It has been shown earlier that the largest fish have the highest fat content but it was impossible to check this during the past season as only a small size-range of fish was taken. However, the results over a three-year period show that both immature and adult herring of excellent quality and suitable for high-grade food products can be taken in the Gulf of St. Lawrence throughout the period June to September.

Mr. E. G. Sollows collected the samples in the field and Miss Phyllis Gibson made the fat determinations in the laboratory.

S. N. Tibbo

#### Appendix No. 48

#### EXPLORATIONS FOR HERRING IN NOVA SCOTIA WATERS

Disappointing catches by the summer herring fishery on the outer coast of Nova Scotia in some recent years have led the industry to request explorations in that area in the hope that a reliable source of raw material for the established kipper and bait trade may be found. Preliminary work was done in 1952 in preparation for a more intensive search in the future. The M/V "Harengus" and the M/B "Mallotus" were both employed for a period of six weeks during the summer of 1952 in searching for herring off the coast of Nova Scotia. The "Harengus" was equipped with bottom trawls and operated as far off shore as Sable Island bank. The "Mallotus" was equipped with a fleet of drift-nets which were used from close inshore to about 20 miles off shore between Halifax and Cape Sable.

Bottom trawling with M/V "Harengus". The M/V "Harengus", an 84-foot dragger, was made available for herring investigations during the period August 15 to September 30. Two types of trawls were used: a #4 Gourock trawl with a small-mesh cod-end, and a Dutch herring trawl designed and manufactured by Mr. L. Van der Zwan, of the Canadian Fishing Supply Company at Lunenburg, who has had a great deal of experience in the construction and operation of this type of gear in Holland and very kindly offered to assist in the experiment by instructing the crew of the "Harengus" in the proper method of using the trawl.

The Dutch herring trawl differs from an ordinary otter trawl in that it is of very light construction and is designed to be towed so that it skips lightly over the bottom with the head-rope raised by means of kites and floats to a height of from 12 to 15 feet off the bottom.

After some preliminary trials in the vicinity of Lunenburg the vessel was dispatched to Sable Island bank where five drags were made and quantities of haddock, hake, cod and flounder were taken, but only 16 herring. During the last drag the trawl was torn badly and it was necessary to return to Lunenburg for repairs. Following this, dragging was done with both the Dutch and the Gourock trawls at Jordan Bay, Roseway Bank, Sambro Bank, St. Margaret Bay, Rose Bay and Halifax Harbour but no herring were taken in any of the drags. Much time was lost because of damage to the trawls, due chiefly to lack of familiarity with the nature of the bottom, which was very rough in some of the areas fished. It is planned to continue this exploration in 1953, starting operations earlier in the season when herring have been reported plentiful on Sable Island bank and Banquereau.

Drift-netting with M/V "Mallotus". The "Mallotus" made three cruises along the Nova Scotia coast from Halifax to Cape Sable in July, August and September searching for herring with drift-nets. A string of gill-nets 262 yards long and about 14 yards deep was set at six established stations within the area. The stations were occupied in rotation, one night being spent at each station during each cruise. Four sizes of gill-nets were used, viz.  $1\frac{1}{2}$ ",  $2\frac{1}{4}$ ",  $2\frac{1}{2}$ " and  $2\frac{3}{4}$ " stretched mesh (inside knots). The nets were set in the late afternoon or evening and hauled back in the early morning. Provision was made for varying the depth at which the nets were set by lowering them as much as 18 feet below the surface. A DR1 model Bendix echo-sounder was operated while cruising and at intervals while the boat was drifting. Surface temperatures, bathythermograph observations, and plankton hauls were made regularly in conjunction with the exploration for herring and a record was kept of light conditions while the nets were in the water.

The quantity of herring taken during these operations was very small. Some fish were caught in eight out of fifteen sets but the total amount for all sets was only 620 pounds. Since the gear was almost exactly the same, except for mesh sizes, as that which was used successfully in the Gulf of St. Lawrence, it has been concluded that herring were very scarce in these areas during the past summer. This conclusion is supported by the failure of the commercial fishermen to catch normal quantities of herring this year. Further drift-net explorations are planned for next season with more attention to the depth distribution of herring.

S. N. Tibbo

Appendix No. 49

#### TRAWLING FOR SARDINES IN THE BAY OF FUNDY

During February, 1952, mid-water and bottom trawls were tested on sardines in the vicinity of Lepreau Harbour, N. B. The results were so promising as to offer an alternative method to purse-seining which has been carried on during the winter months in the Bay of Fundy for many years. Although

excellent catches are frequently made, there are some disadvantages to purse-seining; the gear is expensive, it requires from six to eight men to operate and fishing is, for the most part, restricted to very short periods of the day -- dawn and dusk.

The first trawling experiments were done at night with a Larsen two-boat mid-water trawl which had been modified by reducing the opening of the mouth from 48 x 48 feet to 25 x 25 feet and by reducing the overall length from 175 feet to approximately 100 feet. The operations were hampered somewhat by the many purse-seine boats in the area and our boats were forced to stay outside the areas where the greatest concentrations of sardines were recorded by the echo-sounder. The best catch was 600 lb. of sardines taken in a 22-minute tow on February 7. The trawl was torn frequently and was finally discarded in favour of a larger net of the same shape but with larger mesh and twine sizes. This trawl was not torn in any of the operations but the towing speed which could be maintained by the 100-horsepower boats "Mallotus" and "Gulf Explorer" was only about  $1\frac{1}{2}$  knots, whereas the smaller trawl could be towed at 3 to 4 knots. The best catch with this trawl was 1,600 lb. in a 9-minute tow on February 8.

Attempts to catch sardines in mid-water during the daytime failed and less than 10 lb. of fish were taken altogether. However, it was shown that catches of from 400 to 600 lb. per tow could be made by using a mid-water trawl on the bottom and also by using a single-boat shrimp trawl or flounder drag.

The most encouraging aspect of these experiments was the adoption of the bottom trawling method of fishing by some commercial fishermen with excellent results. The M/B "Li'l Abner", with a crew of two, used a  $\frac{3}{4}$  No. 35 Yankee trawl with a small-mesh cod-end and made catches during the daytime of from 500 to 8,000 lb. in tows which were usually of 60-minute duration. For the five-week period for which reports were received the average catch was 50,000 lb. per week with an average of three fishing days per week. Before the season was over two other commercial boats were fitted for this method of fishing and operated with similar success.

S. N. Tibbo

Appendix No. 50

#### HERRING POPULATION STUDIES

A long-term study of the biological characteristics of herring on the east coast of Canada was carried on from 1946 to 1949 by the Atlantic Herring Investigation Committee and showed a segregation of the stock into at least six separate and distinct populations. Although reduced considerably in scope, this study is being continued each year to follow any changes that may occur in the populations, particularly with regard to length and age composition and the relative strength of the various year-classes.

During 1952 samples of the commercial catches at Matane, P. Q., Caraquet, N. B., and North Rustico, P. E. I., were obtained 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 as yet since most of the effort along these lines was directed towards the preparation for publication of the results of the 1946-49 investigations.

However, enough has been done to show that there is no significant change in the length composition and mean vertebral counts of the various herring populations. The wide range of sizes found in all of the commercial fisheries indicates that a large number of year-classes are represented and that the total mortality rate is low. Age determinations must be made to verify this conclusion. Two samples of herring from Woods Hole, Mass., were received through the courtesy of Dr. H. W. Graham. These will be examined and the results compared with data from Canadian areas.

The drift-net catches of herring in offshore areas of the Gulf of St. Lawrence were sampled regularly and it is apparent that there is also a segregation of populations on the summer feeding grounds. The herring taken on American Bank from July to September are very similar to those taken in the Chaleur Bay area in May, whereas in the southeastern part of the Gulf the summer herring are indistinguishable from the spring spawning herring from Magdalen Islands and the north side of Prince Edward Island.

S. N. Tibbo

#### Appendix No. 51

#### DISEASE AND FAT CONTENT IN BAY OF FUNDY SARDINES

Sampling of commercial sardine catches has been done annually to provide a comparative record of the incidence of the fungus disease which often affects herring in this area, as well as of the size composition and fat content.

Herring disease. The herring disease which is due to infection by the fungus Ichthyosporidium hoferi was far more prevalent this year than it was in 1950 and 1951 when most of the samples showed no evidence whatsoever of the disease and the maximum proportion in any sample was 2.5 per cent.

All but one of the sixteen samples examined in 1952 had some diseased fish. In a sample from Mace's Bay on February 25, 27.0 per cent of the herring were affected. During June and July the numbers ranged up to 11.1 per cent and in September, when the disease is normally either absent or at a very low ebb, 6.2 per cent of the fish were affected.

Fat contents. Seventeen samples of sardines were taken for fat determinations and showed a variation of from 4.2 to 10.8 per cent of the wet weight of the whole fish. These values are

somewhat lower than usual, particularly during the summer months when values as high as 16 per cent are not uncommon. In most cases the larger herring were fatter than the smaller ones in the same sample.

Some attention was given to the fat contents of diseased fish. In three out of four cases the values were slightly (1.0 to 1.9 per cent) lower than for non-diseased fish of the same size.

S. N. Tibbo  
P. J. Gibson

## Appendix No. 52

### BILLFISH IN THE ST. MARGARET BAY AREA, 1952

Further to explorations conducted in 1950, varied attempts were made during the summer of 1952 in the St. Margaret Bay, N. S., area to determine whether billfish could be taken consistently and in commercial quantities.

Gill-net fishing. Gill-nets of  $1\frac{1}{2}$ -inch mesh were used from the M/V "Mallotus" during three drift-net cruises off the Atlantic coast between Halifax and Cape Sable during July, August and September. No billfish were taken.

Surface gill nets of 1,  $1\frac{1}{2}$  and 2-inch mesh, 55 feet long and 40 feet deep were fished in St. Margaret Bay during the last two weeks of both August and September. One billfish measuring  $37\frac{1}{2}$  cm. was taken from the net of  $1\frac{1}{2}$ -inch mesh. Observations on this fish and on those taken from a trap-net catch of August 21 indicate that the soft body meat of the billfish, combined with its characteristic and violent struggles when meshed, lead to such a degree of self-mutilation as to make much of the gill-net catch useless for commercial purposes.

Trapping. Despite gill-net failures, it is known that billfish were in Canadian Atlantic waters in considerable numbers during the summer of 1952. One large school estimated at 14,000 pounds was trapped at South-West Island at the mouth of St. Margaret Bay. All but 4,000 pounds, of the larger size-group, escaped through the meshes during seining operations.

Lift-net fishing with the aid of lights. Pursuing the promising lead given in 1950 by brief trials with lift-net and lights (Appendix 44 of Annual Report for 1950), organized trials with better equipment were conducted in the St. Margaret Bay area during the last two weeks of August and September from the M/V "Mallotus".

The lift-net was of  $\frac{1}{2}$ -inch mesh and measured 20 feet square. Two white-painted light reflectors each with a 5-outlet base were constructed to give, with the electric light bulbs available, variations in light intensity ranging from 1,000 to 5 watts at 32 volts. White light was produced by frosted bulbs in the uncovered reflector, while red, yellow, green, tan and blue colours were produced by coloured plexiglass sheets which

could be quickly and easily attached to cover the reflector mouth.

The following observations are recorded as indicators for future work:

- (a) Billfish were readily attracted by light but not in commercial quantities. Lots of only 100 to 150 were seen at any one time even though a large school of 14,000 pounds was taken in a nearby trap net.
- (b) The smaller and immature billfish were more readily attracted by light than larger and mature fish, which were always seen deeper or at the periphery of the area affected by the lights.
- (c) Lights of 100 watts and over tended to keep the fish, both large and small, at the periphery of the lighted area, where they darted back and forth highly excited, while a 5-watt light caused the smaller fish to swim regularly back and forth right across the lighted area.
- (d) Varying the colours through blue, green, tan, orange and red produced no appreciable change in the reaction of the fish.
- (e) No billfish were taken by means of the lift-net, apparently because of their wary, excitable nature and the fact that the lift-net, which had been treated with cuprinol, was too conspicuous in the water.

Further experiments with lift-net and lights are planned for 1953.

Biological observations. Seven hundred and sixty-four fish from the trap-net catch of August 21 were measured and a large random sample of these were sexed. Bimodality of the length frequency and the existence of two age-groups were again confirmed. Fish of the younger of the two age-groups were found to be sexually immature and as yet it has been impossible to recognize the sexes in the immature state. Examination of a sample of 100 from the older age-group showed that the ratio of males to females was 2.33, and that the average length of males was about 37.5 cm., while that of the females was about 39 cm. Under the lights large squid were observed chasing and biting chunks out of large-sized billfish.

L. R. Day

Appendix No. 53

#### OBSERVATIONS ON THE EFFECT OF LIGHT ON MARINE FISHES IN THEIR NATURAL HABITAT

Although much research has been carried out in the laboratory on the reactions of captive marine fishes to various stimuli, very little has been done in nature. During the last

two weeks of both August and September of 1952 our efforts to catch billfish in the St. Margaret Bay area with a lift-net and lights (see Appendix 52) gave an opportunity to observe, and to record with the aid of a Bendix Depth Recorder, some of the reactions of schools of gaspereau, herring and squid as well as billfish to artificial light of different intensities and colours. The observations were made from the M/B "Mallotus" during the "dark of the moon" of August and September and with very calm, clear water.

### Gaspereau

During the night of August 13 to 14 a white 500-watt light attracted and held a large school of gaspereau which averaged 8 cm. in length. The closely knit school milled in a clockwise direction directly under the light and could not be re-directed. At 0445 hours Atlantic Standard Time the school appeared agitated, spiralling up and down in the water until 0451 hours when it spiralled downward and was not seen or recorded again. At this time the light of day was as strong as the 500-watt light, and at 0517 hours the sun rose into a clear, cloudless sky.

During the night of September 22 to 23 the white 200-watt light attracted and held a school of about 50 gaspereau which averaged about 15 cm. in length. The school milled slowly and loosely under the white 5-watt light in a clockwise direction.

### Herring

At dusk on August 14 a large school of small herring was attracted and held with white lights of 500 to 200 watts. The school was lost at 0200 hours on the 15th when the boat was set in motion in attempts to lead the fish with light.

At dusk on August 19 a large school of small herring averaging 10 cm. in length was attracted by means of lights and held until dawn.

Variations in artificial light intensity. White light of 1,000 to 5 watts, held from 1 foot to 15 feet above the surface of the water, attracted and held small herring. Responses of the fish to alternate light and dark were almost instantaneous. This is illustrated in the echograms, in figure 1 for white light and in figures 2 to 5 for the colours. White light of 100 watts and over caused violent vertical agitation of the school. This is indicated by the strong vertical densities in the echograms of figures 1 and 5 and was confirmed by direct observation. The change from 100 watts to 5 watts as shown in figure 5 caused the fish to concentrate nearer the surface with no vertical agitation evidenced.

Variations in natural light intensity. No fish were recorded despite extensive cruising during the daylight hours of August 19. While cruising slowly just at sunset (2015 hours)

ECHOGRAMS OF REACTIONS OF SMALL HERRING, BILLFISH AND SQUID TO ARTIFICIAL LIGHTS

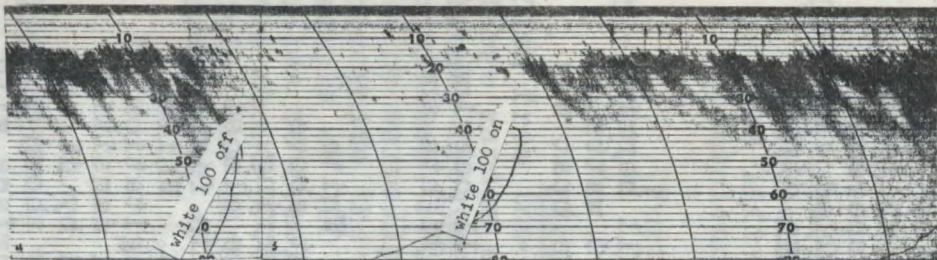


Fig. 1 Small herring - white light 100 watts

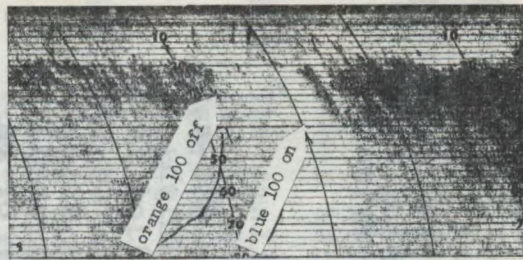


Fig. 2 Small herring - orange to blue light 100 watts

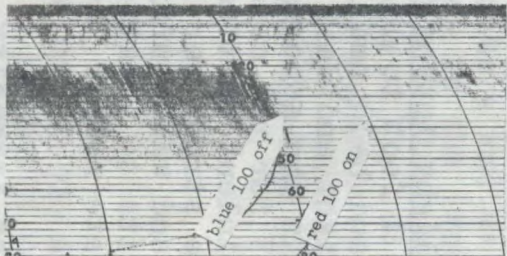


Fig. 3 Small herring - blue to red light 100 watts

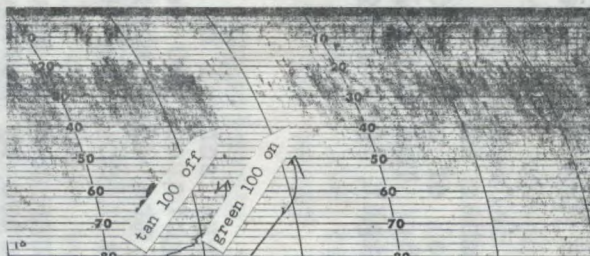


Fig. 4 Small herring - tan to green light 100 watts



Fig. 5 Small herring - white light 100 to 5 watts

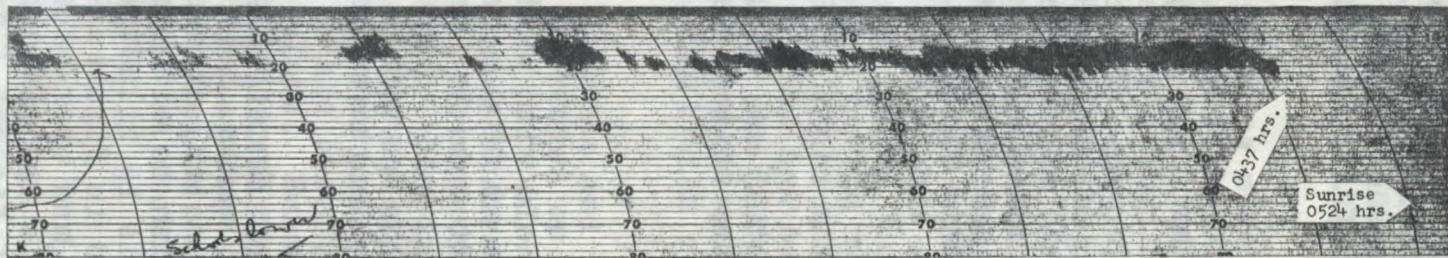


Fig. 6 Small herring - Dawn vs 5 watts

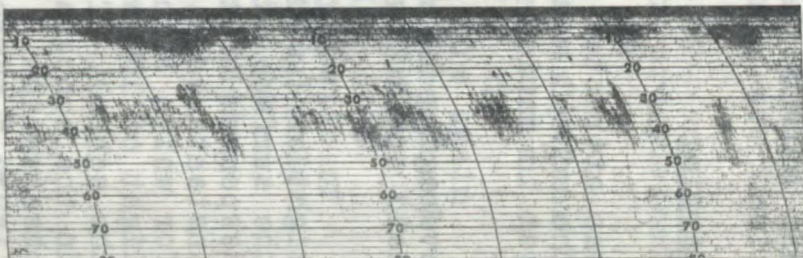


Fig. 7 Typical billfish schooling - white light

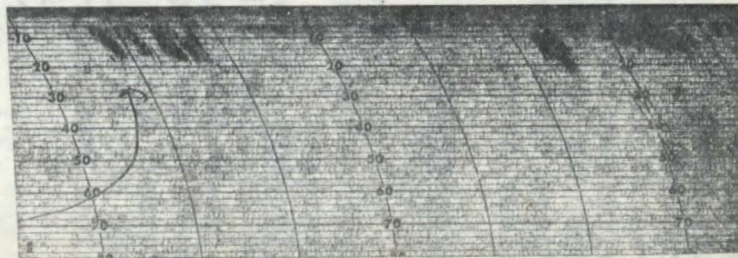


Fig. 8 Typical squid schooling - white light

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the water around the boat suddenly became "alive" with small herring. The fish were highly agitated and were appearing over a considerable area of the bay. As the red glow of sunset left the sky the fish became less agitated and could be seen and recorded lower in the water. At 20<sup>40</sup> hours the white 100-watt light was turned on. It attracted great quantities of small herring which were observed until dawn (see figures 1 to 6).

In contrast, the reaction of the herring to the increasing light of dawn is shown clearly in figure 6. From schooling as typified in figures 1 and 5, signs of agitation and bunching became apparent at 04<sup>00</sup> hours and became more exaggerated until 04<sup>37</sup> hours when the school disappeared. Natural light was then as strong as 5-watt light and the sun rose at 05<sup>17</sup> hours in a clear sky. All attempts to re-discover the schools during the ensuing day failed.

Variations in colour and intensity of the artificial light. All 100-watt colours, except red, attracted herring in quantity. From the results shown in figures 1 to 5, colours may be arranged in the following order from the best to the poorest: white, blue, green, tan, orange and red. With the 5-watt light attraction was poor and similar by all colours except white. Presumably the intensity of the 5-watt light was cut to an ineffective value with the use of the colour filters.

Schooling behaviour under the lights. The small herring milled directly underneath in a counterclockwise direction in contrast to gaspereau which milled clockwise. Attempts to disorganize and re-direct the fish by turning the lights off for 3 minutes and then on, and by splashing among them had no effect on the direction of milling. They were not disturbed by the operation of the lift-net, dip-net or the presence of numbers of hake and pollack which were continually preying on them. One 12-inch pollack which was jigged had 30 small undigested herring in its stomach.

### Billfish

Reactions of billfish to artificial light have already been reported upon in Appendix 52. Figure 7 shows a typical trace of billfish in quantity under the white 5-watt light. Vertical agitation is readily seen and also the tendency for the fish to separate into the two size groups under artificial light.

### Squid

The characteristic box-shaped schooling of squid under white 5-watt light is well shown in the echogram in figure 8.

The above and still other observations are all indicative of the part light might play as an accessory to the fixed and in some cases the mobile fishing engines in our pelagic fisheries. Further work is planned.

L. R. Day

Appendix No. 54

NOTES ON STOMACH CONTENTS OF SWORDFISH (XIPHIAS GLADIUS)

Through the interest and generosity of Captain Jules LeBlanc, a former employee of this station, 11 swordfish stomachs taken at random from fish harpooned in the area of Brown's and George's Banks during the summer of 1952 were made available for examination.

The drained volume of contents varied from 800 to 6280 c.c. for each stomach, the average being 2518 c.c. Contents were in various stages of digestion, presumably because the fish bask at the surface after feeding.

Most of the food consisted of large adult herring (Clupea harengus). As many as 28-30 whole fish were taken from each of 3 stomachs. Nine out of 11 fish had eaten herring. Squid (Ommastrephes illecebrosus) was next in importance from the standpoint of numbers consumed with large specimens appearing in 6 out of 11 stomachs. Hake (Urophycis ?) ranked third in importance, being found in 4 out of 11 stomachs.

In all cases where it was possible to recognize the orientation of the fish eaten, they had been ingested head first.

Two stomachs contained Argentine (Argentina silus) 14 to 15 inches in length. One stomach contained two fishes about 6 inches long, which have been tentatively identified as belonging to the genus Lampadena of the Lantern Fish family Myctophidae. Both Argentina and Lampadena are deep-water forms and their presence in swordfish stomachs would lead one to believe that this pelagic fish descends to considerable depths in feeding forays.

Unidentified nematodes of all sizes were in considerable numbers in 10 of the stomachs but were entirely lacking in the largest stomach. Giant trematodes of the genus Hirudinella were found in 4 of the 11 stomachs.

L. R. Day  
W. C. Carson

Appendix No. 55

RELATIONSHIP OF NUMBER OF SPAWNING SMELT  
TO NUMBER OF LARVAE PRODUCED

The accompanying table shows (a) the numbers of larvae collected in various parts of the Miramichi river system using plankton nets in the same manner from year to year, and (b) the sizes of the spawning runs as estimated by visual inspection and as indicated by systematic fishing in typical brooks.

The irregularity in the catches of larvae in various streams or even within the same stream makes quantitative sampling difficult and limits the significance of the results. The

table shows that peaks occurred at different places in different years. Nevertheless it is clear that 1950 (in which 10 of the 13 collections were the best recorded) was one of generally high larval production and that 1952 was a very poor year.

Numbers of larvae taken in the same way from year to year

		<u>1948</u>	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>
<b>(a) <u>Numbers of larvae collected</u></b>						
Main branches						
Renous	1.	9223	1429	2469	6498	632
	2.			4349	3791	1567
Sou'west	1.	699	9358	5086	1120	308
	2.			1906	1162	328
Nor'west and Little Sou'west	1.	332		1233	246	589
	2.			2796	113	159
	3.			1028	168	368
	4.	59		886	388	288
Total				5943	915	1404
Three small tributaries	1.	257	4110	4368	1482	407
	2.	1102	1000	34	339	67
	3.			4499	5494	2602
Newcastle bridge						
Bottom		8240	25483	68793	7385	2557
Oblique hauls		5233	17997	51024	6073	1373
<b>(b) <u>Abundance of spawners</u></b>						
i. By visual inspection						
Renous	v.good	poor	fair	poor	v.v.good	
Sou'west	v.good	fair	fair	v.good	v.v.good	
Nor'west	v.good	good	good	v.good	v.good	
Little Sou'west	v.good	good	good	v.good	v.good	
ii. Catch by systematic fishing of ten typical brooks						
		652	1028	1118	1145	778

The data on the sizes of the spawning runs suggest that years with good runs in the main branches of the river (e.g. 1948 and 1952) had poor runs in the brooks, and vice versa. In 1952 the run in the Renous and Sou'west branches was considered the best in years and twice as good as in 1951; in the brooks the numbers caught by systematic fishing were 778 and 1145 respectively. This tendency, if true, combined with the difficulty of sampling numerous brooks and branches, makes it very difficult indeed to get any precise relationship between numbers of spawners and number of larvae produced.

The data presented are sufficient to show that the degree of correlation between numbers of spawners and of larvae is low. Of the three better known years, 1950, which had a

generally very good larval production, had only fair to good spawning runs in the main branch; 1952, with low larval production in main branches and brooks alike, had exceptionally good spawning runs in the latter.

That other factors than number of spawners are involved is exemplified by conditions in 1952 which offer an explanation of the poor larval production. There were no great freshets in May or June but rain fell on 34 of the 61 days and totalled more than in any year since 1945. The water, therefore, remained high enough to make it difficult for the smelt to get far up into fresh water. In the main river branches large schools of smelt remained fairly close to the head of tide during most of the spawning season; in the brooks the high water made small obstructions, as well as the usual difficult places, impassable. As a result, spawning both in the main branches and in the brooks occurred in much more restricted areas than usual. Such conditions have been shown to reduce production of larvae.

#### Appendix No. 56

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

Determination of the degree of correlation between the relative abundance of successive year-classes as larvae and the total catches taken from the same year-classes in all the years when they are fished will indicate the value of increasing the production of larvae by such means as stream clearance, and might make possible the prediction of the abundance of smelt in the fishery by sampling the larvae.

Regular samples of the smelt catch in the Miramichi area have been taken for the past four seasons and the ages and weights of the individual fish determined. Using these data, together with the monthly catch statistics, it has been possible to calculate the commercial take from each year-class season by season. Such information over a period of years will give the total yield from each year-class that passes through the fishery.

Four fishing seasons have now been treated in the above manner and the results summarized in the table. Fish approaching two, three and four years of age usually make up almost all the commercial catch, with a few younger and some older smelt present. Some year-classes make substantial contributions to the fishery during only one year (1949), others during two years (1948), and still others during three succeeding years (1947).

As yet fairly complete comparisons of total yield can be made for the 1947 and 1948 year-classes only and it is seen that the former was slightly the larger. As 1948 was the first year in which quantitative assessment of the abundance of larvae was attempted (see Appendix 55) this work will have

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
	<u>1948-49</u>	<u>1949-50</u>	<u>1950-51</u>	<u>1951-52</u>	
1944	0	0	0	0	
1945	845(4-)	43(5-)	47(6-)	0	935
1946	11,466(3-)	578(4-)	112(5-)	8(6-)	12,164
1947	7,812(2-)	4,760(3-)	2,368(4-)	148(5-)	15,088
1948	10(1-)	6,374(2-)	7,299(3-)	419(4-)	14,102
1949		20(1-)	11,887(2-)	1,750(3-)	13,657
1950			67(1-)	6,200(2-)	6,267
1951				10(1-)	10
Totals	20,133	11,775	21,780	8,535	
Catch per net (lb.)	616	382	775	385	

to proceed for a number of years before relative abundance of larvae and total catch can be compared for a number of year-classes.

R. A. McKenzie

Appendix No. 57

COMMERCIAL SMELT CATCH PER UNIT OF EFFORT

During the 1951-52 fishing season it was possible to organize the collection of records which will permit the determination of catch per unit effort from year to year in a much better way than heretofore.

Record books adequate for a number of years with daily columns for date, number of nets hauled, number of net days fished, total catch, etc., were provided to ten fishermen located in different districts of the Miramichi smelt fishing area. For various reasons, present recorders will have to be replaced from time to time, but it is hoped that records will be obtained from all districts for a period of years from now on.

The table indicates the character of the records obtained before this program was inaugurated. In the lower section the total Miramichi smelt catch for the last four seasons is shown, together with the licensed nets fished and the catch per net per season. It is seen that the landings in 1948-49 were almost as great as those in 1950-51 but those in 1949-50 were only 54% and those in 1951-52 were only 39% as great. This drop in the total catch caused alarm. However, when we use the catch per net as a measure of relative abundance we see that, while 1949-50 and 1951-52 were very poor years in comparison with 1950-51 and 1948-49, the 1951-52 catch per net was actually slightly

larger than that in 1949-50. This change in the picture is, of course, brought about by the fact that there was a great decline in the number of licensed nets in 1951-52 compared with the earlier years -- only 68% as many as in 1948-49.

Miramichi Smelt Catches (lb.)

<u>District</u>	<u>Catch</u>	<u>Seasons</u>			
		<u>1948-49</u>	<u>1949-50</u>	<u>1950-51</u>	<u>1951-52</u>
Neguac	per net haul	17	?	15	8
	per net day	12	?	?	4
Rocky Pt.	per net haul	90	?	57	29
	per net day	36	?	35	11
Oak Pt.	per net haul	17	12	44	10
	per net day	5	4	31	4
Whole Mira- michi area (all districts)	per net haul	?	?	?	11
	per net day	?	?	?	5
Total Miramichi catch (cwt.)		20133	11775	21780	8535
Total licences issued		3266	3085	2811	2218
Av. catch per net per season (or licence)		616	382	775	385

Thus, on this basis, there was actually not as great a decline in the abundance of the fish as there seemed to be from a comparison of the total landings. In fact the smelt were slightly less abundant in 1949-50 when the total landings were some three thousand hundredweight greater, and yet from this low point the catch rose a year later in 1950-51 to one of the largest catches in the last ten years.

R. A. McKenzie

Appendix No. 58

EARLY SPAWNING SMELT DIFFER IN VERTEBRAL COUNT  
FROM LATE SPAWNERS

In 1949 it was found that the early-spawning Miramichi smelt had a lower vertebral number than the late spawners. It increased progressively as the spawning season advanced. During the past four years the spawning runs have been sampled for vertebral number in order to determine the possibility of using this characteristic in separating different groups of smelt.

The accompanying table shows the average vertebral count of spawning smelt in each quarter of each

Average Vertebral Counts in Spawning Smelt  
(Numbers in samples in brackets)

<u>Year-class</u>	<u>Divisions of spawning season</u>				<u>Year-class average</u>
	<u>First quarter</u>	<u>Second quarter</u>	<u>Third quarter</u>	<u>Fourth quarter</u>	
<u>In 1949</u>					
1947	61.57(387)	61.71(506)	61.93(467)	62.02(734)	61.81
1946	61.74(141)	61.82(84)	62.07(188)	62.05(220)	61.92
1945	61.58(19)	61.56(18)	62.25(24)	62.16(51)	61.98
<u>In 1950</u>					
1948	61.84(515)	61.81(360)	62.23(245)	62.11(155)	62.00
1947	61.42(271)	61.86(349)	62.04(366)	62.16(180)	61.87
1946	61.76(33)	62.15(20)	62.26(19)	62.27(11)	62.04
<u>In 1951</u>					
1949	61.68(360)	61.78(292)	61.79(193)	62.05(384)	61.83
1948	61.78(175)	61.79(47)	61.79(38)	62.23(131)	61.93
1947	61.60(35)	61.71(14)	61.79(33)	62.24(55)	61.91
<u>In 1952</u>					
1950	61.75(517)	61.67(102)	61.69(110)	61.96(257)	61.79
1949	61.74(91)	61.70(69)	61.83(83)	62.02(190)	61.88
1948	62.05(22)	61.88(17)	61.88(17)	62.26(38)	62.07

spawning season and also the average for each year-class for each season. The sexes are not separated in the table as they have been found to have the same average vertebral count.

Of the four seasons, the 1949 two-year-old fish show the most orderly progression from low early in the season to high later. However, notwithstanding the irregularities during the season from one quarter to another, it is seen that in every case, especially when the year-classes were two years old, the average vertebral count was significantly higher in the last quarter of the season than in the first quarter.

During the past four years the 1948 year-class, entering the spawning stock as two-year-olds, had a higher average vertebral count than either 1947, 1949 or 1950, thus indicating that there can be differences in average vertebral numbers between year-classes.

Comparing the total average count of the year-classes as they grow older, it is seen that as a rule this increases with age.

Whether or not early-spawning smelt with low average vertebral numbers produce young of the same character or the opposite is not definitely determined as yet, but the evidence at hand indicates that they do and in view of this vertebral samples from the fishery for comparison with those from the spawning run are to be obtained.

The increase in the average vertebral number of the spawning smelt as the season progresses occurs at a time of year when the water temperature is increasing. This is contrary to what would be expected (according to the beliefs of a few years ago) if the spawners themselves are hatched in the same order. Early spawners do show more growth on their scales in their first year than the late spawners, indicating that they themselves are probably hatched in the order in which they are found at spawning.

This finding of increasing vertebral numbers with increasing spawning temperatures accords with some of the experimental work done by Tåning in the last ten years, but conclusive proof can be obtained only by experiment or by making vertebral counts on larvae produced naturally under such conditions. Both early- and late-hatched Miramichi smelt larvae are all carried in the yolk-sac stage into the estuary where they are mixed long before they reach the length (20-30 mm.) at which their vertebrae can first be stained and counted. However, collections of larvae in the estuary as they first reach this countable stage may be possible within the next few years.

R. A. McKenzie

#### Appendix No. 59

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

A creel census has been conducted annually since 1943 at a 23-acre artificial pond on the North Montague River, P. E. I. Valuable data are accumulating not only upon seasonal and annual variations in yield and size of trout but also upon the extent to which trout populations in such areas may be cropped and yet continue to provide good angling. The creel-census taker is resident at the pond and has for hire the boats from which almost all of the fishing on the pond is done. Through a misunderstanding the census was not started in 1952 until after the angling season had opened.

A summary of the data is provided in the accompanying table. Certain features of the data are briefly discussed.

1. The high yields to the anglers reflect the favourable conditions for the production of trout to be found in Prince Edward Island streams and ponds generally. These data result, however, from one of the few factual assessments that have been made for the area.
2. There is little, if any, evidence that one season's yield has affected that of the next. Consistently good catches of trout have been made each September near the close of the angling season. These observations do not indicate over-fishing, but rather that a greater cropping could be made without harming the fishery.
3. Considerable annual variation in the number and weight of trout taken and in the rate of their capture has been manifest.

There has been a trend exhibited during the ten years of observations from high to low and again toward higher levels, hinting at a cyclic character in production and yield.

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>
Number caught	3731	3801	3533	3819	3061	2403	3097	3622	3730	4720
Number of rod-hours	-	1516	1632	1634	1723	1351	2144	1868	2054	2026½
Number per rod-hour	2.5	2.5	2.2	2.3	1.8	1.8	1.4	1.9	1.8	2.3
Av. total length (in.)	-	8.2	8.5	8.1	8.4	8.0	8.1	8.2	8.1	8.0
Av. weight (oz.)	-	3.8	4.5	3.6	4.1	3.4	3.6	3.7	3.6	3.5
Pounds per acre	-	40.7	44.0	37.2	34.1	22.4	30.1	36.7	36.2	44.8

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

4. The high yields of trout cannot be ascribed alone to the productivity of the pond but also to the tributary stream from which the pond population is recruited. For instance, seven seine hauls in as many pools about two miles above the pond on September 11, 1944, yielded 1237 trout, the majority of which were in their first and second year of age. The value of the pond as an area for making a large stock of trout of suitable size available for angling is, however, apparent.

M. W. Smith

Appendix No. 60

TROUT PRODUCTION IN ARTIFICIAL PONDS IN PRINCE EDWARD ISLAND

Because of an abundance of streams which provide excellent spawning grounds and cool, fertile waters, Prince Edward Island provides unusually good conditions for the production of young trout. However, the small size of the streams often prevents the realization of the productive potentiality of the waters, and the formation of ponds on the streams is a means of permitting better growth of trout and availability to anglers.

Investigations are being conducted to determine the maximum number of trout of suitable angling size which can be produced in a minimum of time in artificial ponds. The procedure involves stocking of the ponds with various densities of yearling trout and subsequent determination of their rates of

growth and survival. During 1952 three experimental ponds have been available for study: Kelly's, Simpson's, and Stephenson's ponds ranging in age from three to 80 years. An additional pond, Andrews', has been available in past years, but the dam at that site went out in May, 1952, and the pond will not be in use until 1953.

Kelly's pond (80 years; 2.6 acres) has been stocked at rates closely approximating 400 and 800 yearling trout per acre during the past six years, and the yield of trout flesh during 9 and 12-month periods has been determined. No agreement between density of stocking and yield has been found. As dictated by availability of stock during the last two years, the trout were planted at a larger size in September rather than in early July as previously. Although survival was comparatively good, growth of these larger trout during a 9-month period was not sufficient to provide an increase in total weight when harvested over their total weight when planted. In this and the other ponds, assessment of trout production is made by draining to original stream levels.

<u>Year</u>	<u>Rate of stocking per acre</u>	<u>% Survival</u>	<u>Yield per acre*</u>
1946-47 (12 mos.)	400	25	22.8 lb.
1947-48 "	800	25	47.3
1948-49 "	400	54	36.5
1949-50 "	800	30	28.4
1950-51 (9 mos.)	400	52	-
1951-52 "	800	52	-

\*Determined from final total weight less total weight when planted.

Data on growth and survival of trout in Simpson's pond (6 years; 2.3 acres), Stephenson's pond (3 years; 3 acres), and Andrews' pond (4 years; 3.0 acres) is presented in the following table. The yield of trout flesh (final less initial weight) over approximately 70-day periods in the summer are also given.

The yield of trout flesh has varied markedly within and between ponds without much relationship to the initial density of stock. Some of the variation may be attributed to differences in the size of the trout when planted, in seasons and in the character of the ponds, all affecting growth and survival. Predation by fish-eating birds may well be a more prominent factor, however, and will receive increasing attention. The entrance of native trout into the ponds from tributary streams during the period of the experiments is also a factor which has not yet been subject to reasonable control. Proper screening of these fish from the ponds during freshets presents a difficult physical problem.

<u>Pond and Year</u>	<u>Number planted</u>	<u>Days in pond</u>	<u>Number recovered</u>	<u>Increase in av. weight (oz.)</u>	<u>Av. increase per week (oz.)</u>	<u>Av. length when recovered (in.)</u>	<u>Yield lb. per acre</u>	<u>No. of small native trout in pond when drained</u>
<b>Simpson's</b>								
1948	920	76	871	1.4	0.10	7.2	29.0	104
1949	920	95	643	1.7	0.10	7.3	21.1	996
1950	925	71	663	1.1	0.11	7.5	9.2	686
1951	1838	76	1504	1.4	0.12	7.1	48.1	1073
1952	1800	79	1015	1.4	0.12	7.3	10.3	375
<b>Stephenson's</b>								
1950	1201	73	988	1.0	0.10	7.7	13.9	677
1951	1100	69	650	1.5	0.15	8.0	0.0	197
1952	1150	82	666	2.0	0.18	7.2	20.7	397
<b>Andrews'</b>								
1949	1311	84	939	2.0	0.16	7.4	27.0	636
1950	863	72	602	0.6	0.06	6.7	0.0	331
1951	1219	67	1021	0.5	0.04	6.6	4.7	508

Although the variations have been considerable, the data indicate the high production of trout that is possible in pounds formed on Prince Edward Island streams. With such measures as bird control, planned in 1953 for one of the ponds at least, more consistent results may be realized.

R. M. Spence  
M. W. Smith

Appendix No. 61

RESULTS OF ANGLING AND AN ESTIMATE OF POPULATION OF TROUT  
IN A PRINCE EDWARD ISLAND POND

Studies on the production of trout in Kelly's pond, P. E. I., involve an annual draining of the pond for assessment of population. In 1952 the opportunity was taken (1) to determine the extent to which a known angling effort would reduce the stock of trout and (2) to evaluate estimates of population based upon proportions of unmarked to marked trout in the anglers' catches (Petersen method).

The population of trout in the pond consisted of (a) the survivors from 2050 yearling trout planted in the pond in September, 1951, at which time the adipose fins were removed, and (b) native trout which had entered the pond from the feeder stream. Approximately ten days before angling was permitted in the pond in July, 1952, 140 of the planted trout were captured by angling with flies on barbless hooks, additionally marked by removal of the right ventral fins, and released again into the pond after having been held for 24 hours in wire cages to assure that handling had had no apparent harmful effect.

The pond was opened to angling on July 14, 1952. After five days, however, angling ceased because in the estimation of the local fishermen the catches were too poor. On July 23 and 24 the pond was drained and the surviving trout removed. Data from the creel census, the draining of the pond, and upon estimates of population are given in the accompanying table.

(1) The anglers removed only 54 per cent of the introduced and 10 per cent of the native trout. Catch per unit effort provided an index of the catchable rather than the total number of trout in the pond.

(2) The native trout were less catchable than those introduced into the pond. The native fish were smaller, however, averaging 18.6 cm. in length as against 20.6 cm. for the introduced stock.

(3) Data obtained upon the first and second days of angling provided the best estimates of population. A progressive decline in the proportion of marked to native fish in the anglers' catches, because the former become less vulnerable or

Population of Trout in Kelly's Pond

<u>Removed by angling</u>	<u>July 14</u>	<u>July 15</u>	<u>July 16</u>	<u>July 17</u>	<u>July 18</u>
<u>Number caught</u>					
<u>Introduced stock:</u>					
adipose removed	257	156	71	16	6
adipose and ventral removed	34	15	4	2	0
Native	12	8	1	1	1
Total	303	179	76	19	7
<u>Rod-hours</u>	112	113	68	53	48
<u>Number per rod-hour</u>	2.7	1.6	1.1	0.4	0.1
<u>Estimates of population*</u>					
Introduced	1198	1320	1418	1413	1428
Introduced and native	1248	1377	1474	1469	1487

\*Estimates based upon data accumulated to given date

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Total removed by angling and examined (see above)	584
Introduced stock angled but not examined	16
Removed by draining July 23 and 24:	
Introduced: adipose removed	417
adipose and ventral removed	73
Native	226
Not examined	40±5
Total removed by draining	<u>756±5</u>
Total removed by angling and draining	<u>1356±5</u>

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for other reasons, resulted in a rise in the estimated numbers. However, the discrepancy between the determined and the final estimate of total population amounted to only 9 per cent.

R. M. Spence  
M. W. Smith

Appendix No. 62

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

Large numbers of young speckled trout run to salt water from Prince Edward Island streams. Subsequently in the estuaries and upon their return to fresh water, these fish make an important contribution to the sport fishery. However, ponds which are formed on the streams also provide excellent fishing areas for this species, and pond formation is being adopted as

one method of managing the populations of small trout in the streams for improved angling. The building of dams obviously restricts the movements of those trout that may run to sea, but to what detriment, if any, to the fishery in a stream system as a whole has not been evaluated. The principal objective of the investigations on Ellerslie Brook is to assess the seeming benefits derived from pond formation when balanced against possible harmful effects arising from restrictions imposed by a dam upon the movements of the sea-run trout.

Since June, 1946, a two-way fish trap has been in operation at the mouth of Ellerslie Brook throughout the year. The trout are enumerated and measured as they enter and leave the brook, and a numbered tag is attached to the lower jaw of each fish when it moves through the trap for the first time. In the fall of 1950 a second two-way fish trap was installed immediately above the pond site to provide information upon the movement of trout between two sections of the stream and, with the pond formed, between stream and pond. A creel census has been maintained upon the stream and estuary during each angling season since 1947. Efforts are also made to obtain records of any tagged trout taken by anglers in other streams of the area.

A dam was completed across Ellerslie Brook near the head of tide in October, 1952. A pond of approximately five acres in area will be formed. The dam is of wooden construction and has four stop-log gates, each about four feet in width, which may be removed to drain the pond to the original stream level. Provision has been made in the construction of the dam for the installation of non-flooding screens to prevent escape of trout from the pond whenever such action is desired during the course of the investigations. Provision has also been made for a fish ladder of which the utility in permitting trout to pass upstream past a dam will be studied at a later date.

The numbers of trout that have been counted through the trap at the mouth of the brook are given in table I. These numbers are impressive in view of the fact that Ellerslie Brook has an effective length for the production and harbouring of trout of only four to five miles. Certain prominent movements of trout into and out of the brook recurred during approximately the same period of each year: inward during (1) April, (2) late June and early July, and (3) October through December, and outward during the fall season. Other appreciable but erratic movements have been noted, especially in May. For the most part few trout move during the winter months, March, late summer and early fall. Most, if not all, trout movements can be correlated with changing water levels, spawning activities and water temperatures of the stream and estuary.

Table I. Numbers of trout counted through the fish trap at the mouth of Ellerslie Brook

	<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	1110	2049
1947	629	197	879	81	1100	1038
1948	78	88	563	15	491	1706
1949	952	1463	876	153	447	1315
1950	920	465	460	39	126	1136
1951	131	186	316	55	263	389
1952	657	108	321	10		

The yields of trout to the anglers during the years 1947 to 1952 inclusive are given in table II. The catch per unit effort has shown a gradual upward trend, while the total number caught has fluctuated considerably. Little variation in the average length of the angled trout has been noted from year to year until 1952 when a significant increase occurred, the reason for which is at present unknown. The majority of the trout taken by the anglers are young, until 1952 about 80 per cent being in their third year of age.

Table II. Results of the Ellerslie Brook creel census

	<u>Number caught</u>	<u>Number per rod-hour</u>	<u>Average total length (inches)</u>
1947	1141	1.5	6.9
1948	1086	1.5	7.0
1949	1942	1.8	6.9
1950	1608	1.9	7.0
1951	1461	2.1	7.0
1952	1628	2.3	7.6

The tagged trout may be (1) recaptured in two traps as they move up- or downstream, (2) accounted for by the creel census on the stream, (3) taken by anglers in neighbouring streams and reported, or (4) encountered during estimates of population which are made each summer in the stream. Notwithstanding this rather close surveillance of the tagged trout, a very considerable part of them disappear without further record (table III). As a whole, the trout of the Ellerslie stream system are short-lived. There is evidence, however, that fish-eating birds may account for a good number of the tagged trout, as witness the finding of 16 tags in two great blue herons killed near Ellerslie Brook. Efforts will be made in 1953 to obtain comprehensive data upon the status of at least the great blue heron as a trout predator in the Ellerslie area, although a program of bird control on the brook itself is not contemplated at this time.

Table III. Numbers and percentages of marked trout without recorded recapture

<u>Year marked</u>	<u>Number marked</u>	<u>Number not recaptured</u>	<u>Percentage not recaptured</u>
1947	2696	1168	43.3
1948	1831	500	27.3
1949	2894	988	34.2

The program of operating the traps, maintaining creel censuses, etc., will be continued after the pond is formed. At first the trout entering the lower trap from salt water will be liberated in the pond in order to study the effects of the latter upon their growth, movements and availability to anglers. Later in the investigation they will be barred from the pond and then at a still later date permitted to enter under their own volition by way of a fish ladder.

Messrs. C. R. Hayes, J. W. Saunders and Cyril Williams have been associated with the writer in this investigation.

M. W. Smith

Appendix No. 63

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 stock of fingerling trout and salmon and are imperfect for the yearling fish. Studies on the summer population of trout and salmon in Ellerslie Brook were begun in 1948 and continued through the summer of 1952. The object is to determine ultimately the effect of pond formation upon the population of a stream.

Nineteen areas (usually 50-yard sections), representing 20% of the effective stream length, were studied in 1952. Population estimates were based on the total capture of trout and salmon in each area. A 120-volt electrofishing 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.

Population estimates for 1952 were based on an effective stream length, for trout production, of 7,450 yards. These estimates, compared with those of previous years, are presented below:

Table I.

<u>Year</u>	<u>Fingerling trout</u>	<u>Older trout</u>	<u>Salmon fry</u>	<u>Salmon parr</u>
1948*	15500	5350	-	-
1949*	10500	9600	5050	3450
1950*	6450	5670	410	2680
1950**	8700	9220	1620	10680
1951**	4362	5536	505	1976
1952**	10016	6172	-	1469

\* seining

\*\*electrofishing

The increase in fingerling trout, as shown in the above table, may be the result of high water during the fall of 1951 which resulted in better spawning conditions. Since no adult salmon entered the brook during the fall of 1951 there were no salmon fry in the brook this past summer.

Salmon fry are so difficult to catch, especially by seining, that estimates of their numbers are unreliable. This accounts for the disparities between their estimated abundances and those of parr one year later.

For the sixth consecutive year the same 450-yard area of the tributary Hayes Brook has been subjected to study. As in 1951 the whole 450-yard area was electrofished and an attempt was made to capture all the fish in the area. The results, compared with previous years, are presented below:

Table II.

<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

\* seining

\*\*electrofishing

The fingerling population in the 450-yard section followed the trend in the main brook and an increase was had over the previous year. The fact that there have been no significant changes in the numbers of older trout in Hayes Brook suggests that the section has a constant carrying capacity for older trout regardless of seeding and this capacity is determined by factors in the habitat.

J. W. Saunders

Appendix No. 64

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

The low yield of speckled trout to the anglers from Charlotte County lakes has been found to be associated with a poor supply of nutrient salts in the waters. Commercial fertilizers in moderate quantities were added to two of these lakes to determine if their level of production, particularly that of trout, could thereby be substantially increased.

In June, 1946, Crecy Lake (50 acres; 7.8 ft. mean depth) received one ton of ammonium phosphate and 500 lb. of potassium chloride. This amounted to an application of 6.5 lb. per acre-foot, sufficient to provide 0.39 mg. of phosphorus, 0.21 mg. of nitrogen and 0.27 mg. of potassium per litre of water. The average per-fertilization phosphorus content approximated 0.015 mg. per litre.

An important effect of the fertilization was to improve the growth rate of introduced fingerling trout to the point where they entered the anglers' catches the year after planting, a situation not previously found in Crecy or neighbouring lakes. There resulted in 1947 a definite improvement in the yield of trout to the anglers. The improvement was short-lived, however, for in 1948 and 1949, notwithstanding that the growth of fingerling and older trout continued to be as good and even better, the catches of planted and native trout declined to pre-fertilization levels. Coincident with this decline was an increase in the number of predatory birds and mammals frequenting Crecy Lake, likely attracted by the consistent annual introduction of fingerling and yearling trout. Attempts to control these predators were initiated in 1949 and became more fully effective in 1950 and later. A program of trapping eels in the lake was also undertaken in 1950. Eels are the only predatory fish in Crecy Lake aside possibly from the trout themselves, but because of difficulties attendant upon their capture in the lake to anything approaching exhaustion of their numbers, eel control has been less effective than in the case of the birds and mammals. To provide better control ultimately, a barrier dam was erected in the outlet of Crecy Lake in 1951 to prevent the entrance of elvers, which constitute the recruits to the limnetic population of older eels.

The growth rate of the fingerling trout declined in 1950 when a greater survival to the anglers was experienced. A second comparable fertilization of Crecy Lake was made in 1951 to establish whether both growth and survival could be improved by concurrent application of fertilization and predator control; the number of introduced trout was also doubled in 1951 to insure adequate stock of trout to capitalize fully upon any increased production level occasioned by the second fertilization. The results of these and previous actions are summarized in tables 1 and 2 and are shown to be very favourable. Particularly noteworthy was the survival to the anglers in 1951 and 1952 of 19.7 per cent of the fingerlings planted in 1950. Previous investigations have consistently shown that less than one

Table 1. Growth and Survival of Planted Trout

Stock	<u>Average total length (in.)</u>			% survival to anglers a year later	
	<u>When planted (year)</u>	<u>When angled a year later</u>	<u>In-crease</u>		
<u>Greycy Lake</u>					
1946	yearlings	7.5 (1945)	10.1	2.6	10.2
1947*	yearlings	8.4 (1946)	11.4	3.0	16.7
	fingerlings	3.2 (1946)	8.5	5.3	3.6
1948	yearlings	8.4 (1947)	12.2	3.8	3.9
	fingerlings	2.9 (1947)	9.3	6.4	0.5
1949	yearlings	6.4 (1948)	11.9	5.5	1.8
	fingerlings	2.4 (1948)	8.4	6.0	0.3
1950**	yearlings	7.3 (1949)	10.5	3.2	28.6
	fingerlings	2.6 (1949)	7.5	4.9	0.9
1951***	yearlings	7.3 (1950)	9.8	2.5	45.0
	fingerlings	3.3 (1950)	6.7	3.4	14.8
1952****	yearlings	10.05 (1951)	10.3	0.25	81.6
	yearlings	7.0 (1951)	8.7	1.7	35.6
	fingerlings	3.2 (1951)	6.8	3.6	9.3
<u>Gibson Lake</u>					
1947	yearlings	8.4 (1946)	10.4	2.0	12.0
	fingerlings	3.2 (1946)	4.5	1.7	0.2
1948*	yearlings	8.4 (1947)	10.5	2.1	3.8
	fingerlings	2.9 (1947)	5.5 (only two recaptures)		
1949	yearlings	6.7 (1948)	10.5	3.8	2.1
	fingerlings	2.4 (1948)	(no recaptures)		
1950	yearlings	7.1 (1949)	8.5	1.4	2.7
	fingerlings	2.6 (1949)	(no recaptures)		
1951	yearlings	7.3 (1950)	9.8	2.5	2.2
	fingerlings	2.6 (1950)	(no recaptures)		
1952****	yearlings	10.05 (1951)	11.5	1.45	10.2
	fingerlings	3.2 (1951)	6.0	2.8	0.1

\* First year after initial fertilization; \*\* first year after beginning bird and mammal control; \*\*\* first year after beginning eel control; \*\*\*\* first year after second fertilization and doubling of number planted.

Table 2. 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>Crecy Lake</u>										
No. caught	167	148	-	143	425	110	39	264	1441	2418
No. per rod-hour	0.4	0.5	-	0.6	1.0	0.3	0.15	0.6	1.4	1.6
Lb. per acre	2.1	1.3	-	1.5	3.6	1.6	0.8	2.7	6.4	12.5
<u>Gibson Lake</u>										
No. caught - trout		20	5	8	82	50	30	27	27	174
- salmon		44	47	57	21	17	5	3	0	0
No. per rod-hour (trout and salmon)		0.3	0.4	0.5	0.3	0.2	0.1	0.1	0.1	0.3
Lb. per acre (trout and salmon)		0.7	0.5	0.8	1.1	0.8	0.35	0.3	0.3	1.3

\* Crecy Lake closed to angling.

\*\* First year after doubling of number planted.

per cent of planted fingerlings is subsequently captured by fishermen from unfertilized Charlotte County lakes.

In 1947 Gibson Lake (59 acres; 13.2 mean depth) received fertilizer in amounts to provide one half of the concentration of nutrient materials employed at Crecy Lake. A second comparable fertilization was made in 1951 and the number of trout introduced into the lake was doubled. However, predator control was not exercised at Gibson Lake. These actions have resulted in little or no improvement in the trout angling. Data upon the growth and catches of trout (and land-locked salmon which have almost disappeared in recent years when their upward migration from lakes below was barred by beaver dams) are summarized in tables 1 and 2. The somewhat higher catches in 1952 resulted principally from yearlings planted in 1951 which were larger than those previously planted; yet only 10.2 per cent of the number of these introduced trout were taken by the anglers as compared to a return of 81.6 per cent from the same stock in Crecy Lake. Much of the disparity in results between Gibson and Crecy Lakes has been attributed to two conditions, the difference in degree of fertilization and the control of trout predators, although dissimilar reactions to fertilization that might arise from habitat differences inherent in the morphometry of the two lakes cannot be overlooked.

The hydrography, plankton and bottom fauna of Crecy and Gibson Lakes have also been studied in detail during this

investigation. A state of at least temporary eutrophy developed in the lakes following fertilization, as demonstrated by the occurrence of prominent algal blooms. These consisted almost entirely of blue-green algae which are normally minor constituents of the flora of the lakes. Their persistence until the lakes froze over, and their subsequent decay, caused greater than usual deficits in the dissolved oxygen content of the water during the winter, but there has been no evidence that a winter-kill of trout because of low oxygen values has occurred in either lake. Oxygen depletion to the point of killing fish is perhaps the most serious adverse condition that may result from fertilization, and the most difficult to predict and control, while at the same time it produces a maximum yet favourable algal crop.

Spawning facilities for trout in such head-water lakes as Crecy are often limited. The introduction of hatchery-reared or other stock is accordingly an essential part of any program designed to maintain the fishery. The fertilization and predator control at Crecy Lake created conditions whereby hatchery fish made a much greater contribution to the anglers' catches than is usually experienced. There has been sufficient improvement in the angling to warrant further application of the procedures in similar Maritime lakes.

M. W. Smith

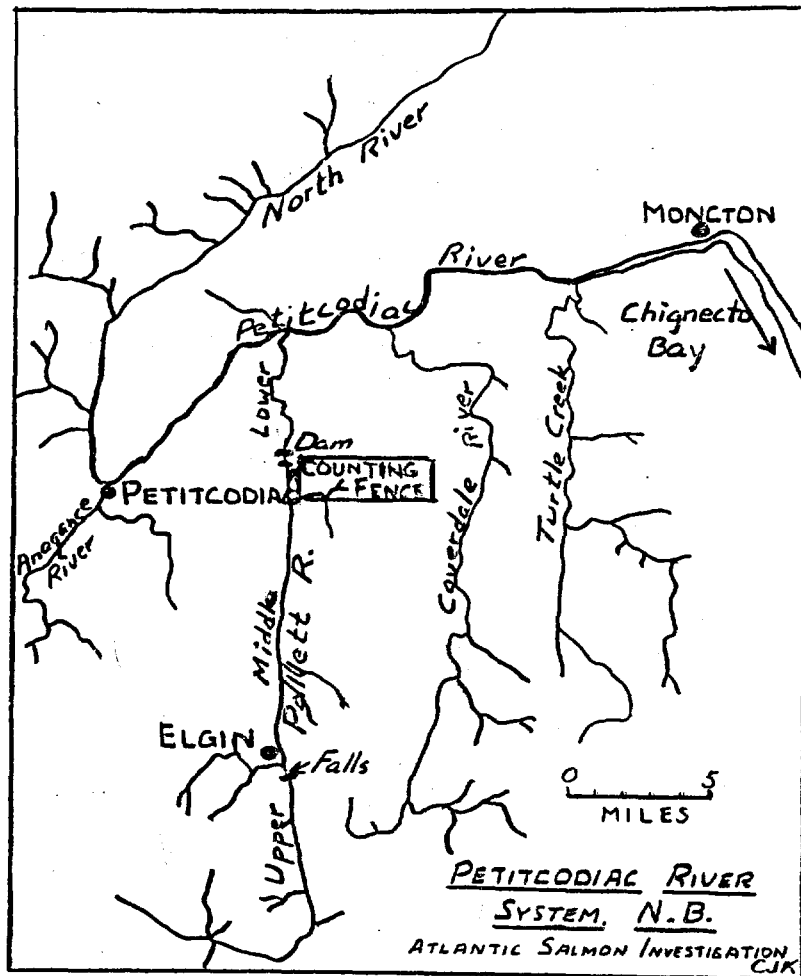
Salmon Investigations on the Petitcodiac River, N. B.

The Pollett River is a tributary to the Petitcodiac River, which flows through Moncton and enters Chignecto Bay, an arm of the Bay of Fundy. In 1942 it was selected for smolt production studies and by 1946 five varied plantings of hatchery stock had been made in the 11-mile stretch from a barrier dam at the Jordan Memorial Sanatorium and up to barrier falls at Elgin. Beginning in 1947 heavy plantings of hatchery-produced fingerlings were made annually on this experimental stretch of stream with predatory birds, namely kingfishers and mergansers, removed systematically. These plantings were continued until 1950, when an experiment was started involving the planting of fingerlings in different densities from year to year on the same section of the river. A Denil-

type fishway has just been completed in the dam at the lower end of the section and in future information will be available on the salmon returning to the Pollett River, and on the effectiveness of natural spawning as compared to artificial seeding. In the following appendices this section of the river is usually referred to as the "middle Pollett".

The "lower Pollett" is about 6 miles in length and extends from the Sanatorium dam to the junction of the Pollett with the main Petitcodiac River; no experimental work has been done on it.

The "upper Pollett" comprises the remainder of the stream from the barrier falls at Elgin to the head-



waters. It has been used since 1948 for tests of the effects on smolt production of planting fingerlings at various densities using different dispersal techniques. They have been marked by distinctive fin-clipping so that the results can be assessed when the annual smolt runs are checked through a complete counting fence at the lower end of the middle Pollett.

Appendix No. 65

ASSESSMENT OF YOUNG SALMON PRODUCTION IN THE POLLETT RIVER

1. Measuring smolt runs

The most direct measurement of salmon smolt production is the counting of all descending migrants. Counting weirs have been developed which permit complete enumeration on relatively small rivers (maximum discharge under about 4,000 cubic feet per second in most years. Experience has shown, however, that these weirs frequently cannot be installed early enough, nor operated effectively, on larger rivers.

During the last three years a method for estimating smolt production, through the use of pairs of more easily operated sampling weirs or traps which occlude only part of a stream, has been under study on the middle Pollett. This method is being tried out a short distance upstream from a weir which bars the entire stream and thus permits complete counting as a check on the estimates. The sampling battery itself includes two traps, about one mile apart. Fish taken in the upper trap are marked, counted and liberated each day. Those taken in the lower trap are examined for marks and the proportion of marked to unmarked, as well as the total catch, recorded. The estimate of total smolt descent is derived from the relation:

$$\text{Total run} = \frac{\text{Smolts caught below} \times \text{Marked smolts liberated above}}{\text{Marked smolts caught below}}$$

Estimates and counts of total runs accumulated to a given date show much better conformity than day-by-day estimates and counts. Presumably the best estimate for any year is the final one, which includes all available data.

Table 1. Measuring salmon smolt production from the middle Pollett River

Year	Total	<u>Complete count</u> In period of sampling battery operation	Estimate from sampling battery	Difference of estimate from count		Clopper and Pearson 99% limits of confidence
				<u>No.</u>	<u>%</u>	
1950	15,862	14,370	10,365	-4,005	39% low	8,000 to 14,000
1951	25,164	18,842	21,255	+2,413	11% high	17,000 to 28,000
1952	26,297	25,899	40,500	+14,601	36% high	30,000 to 54,000

Even these rough estimates would have value for showing large changes in production such as, for example, occurred on the Pollett when, following bird control, average smolt runs increased from about 2,200 per year to about 19,000.

2. Measuring populations of salmon parr and associated fish

(a) Seining for a total count. The starting and ending points of studies of Pollett River salmon production have been plantings of known numbers of salmon and counts of the resulting smolts. It has, however, been possible to get information on salmon survivals and growth at intermediate stages, and on the numerical importance of other species of fish in the river. The first studies of fish populations in the stream were made by attempting to remove all, or nearly all, of the fish in representative sample areas. In table 2 are given the numbers of fish caught in each of the last five years in the same sampling areas using the same methods each year.

Table 2. Fish caught in seven sections (total length, 392 yd.) of the middle Pollett River

<u>Year</u>	<u>Catos- tomus</u>	<u>Coue- sius</u>	<u>Rhin- ichthys</u>	<u>Eels</u>	<u>Salmon parr</u>	<u>Salmon smolts following year</u>
1948	568	2,639	486		396	19,925
1949	391	2,645	1,117	1,678	550	13,190
1950	629	1,633	935	1,043	633	20,348
1951	326	1,270	1,335	-	933	22,852
1952	604	1,704	783	1,759	105	(in 1953)

No trend towards increase or reduction of numbers is shown for any of the species of "coarse" fish, although most species were approximately twice as abundant in some years as in others. The large eel populations, for the three years given, were found by electrofishing. Of these species, eels alone appear likely to be predators on young salmon, the others being at most competitors for food or space. The apparent upward trend for parr is of questionable significance. Some of it reflects accumulating experience of the seining crew. The extremes, except in 1952 when the low catch resulted from absence of planting in 1951, are almost contained within the same limits of variation as for most other species. As indicates in the table the apparent upward trend has not carried through to following smolt runs.

(b) Seining for an estimate. Assessment of fish populations by attempting to remove all individuals depends on such factors as experience of the operators, type of stream bottom, depth and temperature of the water and other variables, some of which cannot readily be subjected to evaluation. To circumvent some of these unknowns a method of estimating populations within an area by recovery of a proportion of a known number of marked fish has also been used. This method appears to work very well on salmon parr and fish of similar size and habits, but is less satisfactory than "total seining" for eels and very small fish.

In order to develop an idea of total fish populations within a long section of stream this method of assessment has been tried on a series of areas selected as representative of general stream conditions and on a series of areas selected by

chance. In table 3 these results, for parr, are compared with the estimate for the whole stream resulting from the method of "total seining".

Table 3. Estimation of salmon parr in the middle Pollett River

	Approximate stream length (yards)	Estimated number of parr***		
		1950	1951	1952
In sampling areas:				
Total seining				
7 selected areas	390	633	933	105
Sample seining				
6 selected areas	see below**	226	631	52
10 chance areas	300	-	1,059	75
In entire middle Pollett:				
Total seining*	19,000	35,000	55,000	5,000
Sample seining				
In selected areas	19,000	30,000	70,000	4,000
In chance areas	19,000	-	65,000	4,000

\* Assuming 80% catch in sample area

\*\* 150 yd. in 1950; 175 yd. in 1951; 230 yd. in 1952.

\*\*\*To nearest 5,000 in 1950 and 1951, and nearest 1,000 in 1952.

Although each of the three methods of estimating total parr in the river was carried out on quite independent sample areas, there was relatively good agreement between the resulting estimates.

If "total seining" could be done with a consistent degree of effectiveness it, in some modification, would be the preferred method since, with present techniques, it is best adapted to handling all kinds of fish. With "sample seining" it is possible to arrive at an estimate for which the reliability can be gauged; moreover, when fish are very scarce, a satisfactory estimate can be reached more quickly than by total seining, hence it is the more generally satisfactory method for such fish as parr.

P. F. Elson

Appendix No. 66

EXPERIMENTAL PLANTING OF FINGERLINGS FOR BEST SMOLT PRODUCTION

Effect of dispersal at planting. In 1949 an experiment was set up on the upper Pollett River to determine whether any worthwhile advantage would accrue from giving planted fingerlings a large degree of dispersal at liberation. Three similar stretches of river were seeded in three successive years with 4,000 fingerlings each. Planting was at rates of 5, 50 and 500 per yard of stream length in any one year and at different rates at each place in each of the three years. The fish for each section were given the same distinctive fin-clip throughout the

experiment. In 1952 the final crop of two-year-old smolts from this experiment was counted. The experiment will be completed with the counting of three-year smolts from the last planting in 1953, and with analysis of scale samples to determine the numbers of two and three-year smolts from each of the nine plantings.

The magnitude of the three principal smolt runs from each section is given in the table.

Smolt production and degree of dispersal at planting

<u>Number per yard</u>	<u>Number of smolts from section</u>			<u>Totals</u>
	<u>Upper</u>	<u>Middle</u>	<u>Lower</u>	
5	947	841	1,475	3,263
50	1,194	1,129	1,097	3,420
500	<u>1,410</u>	<u>628</u>	<u>1,380</u>	<u>3,418</u>
	3,551	2,598	3,952	10,101

Analysis of the data shows that the principal causes of variation in the nine smolt crops are those associated with good and bad years (1948 - 2672; 1949 - 4014; 1950 - 3415) and with the particular section planted. In respect to the latter, it is to be noted that the middle section gave consistently low returns; this may be associated with the distinguishing mark used (both pelvic fins removed) being sometimes obliterated by regeneration of one or other of the fins.

The fact does emerge from this experiment that there is only a little over one chance in 100 that the different degrees of dispersal have had any effect whatsoever on the resulting smolt yields.

An interesting by-product is the high rate of production of smolts from planted fingerlings. For all plantings together, this rate (about 28%) is more than three times the rate of survival from the middle Pollett River for the same years. It is thought to be associated, in part, with a relative scarcity of eels in the upper reaches. Control of merganser broods only was used on the dispersal experiment.

Best smolt production from the middle Pollett. The attempt to learn the best production obtainable from the middle Pollett by planting fingerlings was begun in 1942, suspended when five different trials resulted in uniformly low production, and resumed in 1950 when increased fish populations resulting from bird control appeared to have reached approximate stability. Results from the above dispersal experiment then indicated that wide dispersal gave no particular advantage over intermediate dispersal. The intermediate dispersal, which involved little more effort than the small amount of dispersal, was therefore used for the attempts to get the best production from the middle Pollett. The experiment will involve at least three separate plantings: a very heavy planting, which should indicate the maximum productive capacity of the area; a very light planting, which should indicate the maximum survival rate likely to occur; and an intermediate planting to indicate the relation between

maximum production of fish and maximum survival rate.

Plantings to give best smolt production from the middle Pollett  
(with bird control)

<u>Planting</u>	<u>Year of planting</u>	<u>Approx. ratio of plantings</u>	<u>No. of fingerlings</u>	<u>Parr in 1 year</u>	<u>Smolt in 2 years</u>	<u>Survival rate: fingerlings to smolts</u>
Heavy	1952	16	925,000	in 1953	in 1954	-
Intermediate	1950	4	246,000	55,000	23,000	9%
Light	1953	1	65,000	in 1954	in 1955	-

Comparison with natural spawning. The relative merits of (1) planting hatchery-reared young above barriers which prevent access to spawning grounds, and (2) providing access for adults above such barriers have nowhere been critically evaluated. Experiments involving adult salmon will be undertaken on the middle and upper reaches of the Pollett following completion of the present experiments using hatchery fingerlings.

In 1950 a Denil-type fish ladder was installed by the Department of Fisheries at the dam barring the middle Pollett to salmon. A trap at the upper end of the ladder facilitates examination and counting of ascending fish.

Salmon using Denil ladder at lower end of the middle Pollett

<u>Year</u>	<u>Total salmon</u>	<u>Unmarked salmon</u>	<u>Marked as Pollett smolts</u>
1950	15	14	1
1951	5	5	0
1952 (to Nov. 6)	<u>22</u>	<u>19</u>	<u>3</u>
Totals	42	38	4

That some of the marked smolts survive the descent through trap and estuary is shown by their capture (in 1952, about 200 or 1% of the smolt run) in eight weirs operated for herring and salmon on the south shore of the head of the Bay of Fundy two to three months later. There these Pollett-marked post-smolts constituted about one fifth of the post-smolts caught. Why do the Pollett smolts not contribute more to local fisheries and to Pollett spawning stocks? The continuation of the experiments outlined above should provide answers to this and other questions.

Appendix No. 67

VARIATION IN INCREASED PRODUCTION OF SALMON PARR AND SMOLTS  
WITH BIRD CONTROL

The notable increases of young salmon in the Pollett River, which accompanied control of mergansers and kingfishers, have been mentioned in earlier Annual Reports. In 1952 data have accumulated from an additional year with control. The crop measured this year was planted in 1950 and part of the object was to measure the effect of different planting procedures. However, information presented elsewhere (Appendix 66) has indicated that the procedure used in 1950 does not give a materially different result from that used earlier; hence this 1952 data can be incorporated into the general comparison of production with and without bird control. The average yearly smolt production was about nine times as good with control as without.

	<u>With bird control</u>	<u>With no control</u>
Smolt crop years	1949 - 1952	1944 - 1948
Mean annual crop	19,000 smolts	2,200 smolts
Standard error	±2,000	± 600

Actually, there was considerable variation among the four smolt crops given the benefit of bird control, although the poorest crop with protection was still three times as good as the best without. Production in the four years with control was as follows:

	<u>Year of planting</u>				<u>Mean</u>	<u>Standard error</u>
	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>		
Fingerlings	273,000	235,000	243,000	246,000	249,000	±8,000
Parr 1 yr. later						
In sample areas						
Seined	396	550	633	933		
Estimated	500	694	704	1,169		
In total area (to nearest 5,000)						
Total parr	25,000	35,000	35,000	55,000	38,000	±6,000
Parr over 10 cm.	20,000	30,000	30,000	45,000	31,000	±5,000
Smolt counted 2nd yr. after planting	19,925	13,190	20,348	22,852	19,000	±2,000
% Production						
Parr from						
Fingerlings	9	15	14	22	15	±3
Smolts from						
Fingerlings	7	6	8	9	8	±0.6
Total parr	80	38	58	42	55	± 10
Parr over 10 cm.	100	46	68	51	66	± 12

The above table shows the relation between numbers of fingerlings planted, resulting parr populations as found by studies in sample areas, and the smolt crops counted as they migrated from the

experimental area. About 85% of the young salmon from the Pollett migrate as two-year old smolts, and nearly all the remainder as three-year-olds. Survival rates between different stages would doubtless be different for salmon having different life histories (e.g. Miramichi with predominantly three-year smolts). The 1947 Pollett planting with birds controlled was not immediately preceded by a similar planting, which has some bearing on the resulting parr population being smaller than in succeeding years.

Some tentative conclusions are drawn from the data thus far available.

1. The survival from fingerlings to yearling parr from these plantings was about 15%. This survival rate varies between about 10% and 20% (by twice its standard error) so that in some years nearly twice as many parr may survive as in others.

2. The survival from parr over 10 cm. long (which are likely to transform to smolts in the following spring) to smolts nine months later was 66%. The variability of this rate (standard error  $\pm 12\%$ ) was such that smolt production from a parr population of given numbers may be twice as large in one year as in another.

3. The variability in survival rates from fingerling to parr and parr to smolt could result in giving four times as many smolts from one planting as from another. No definite connection is indicated between survival rates for these two stages.

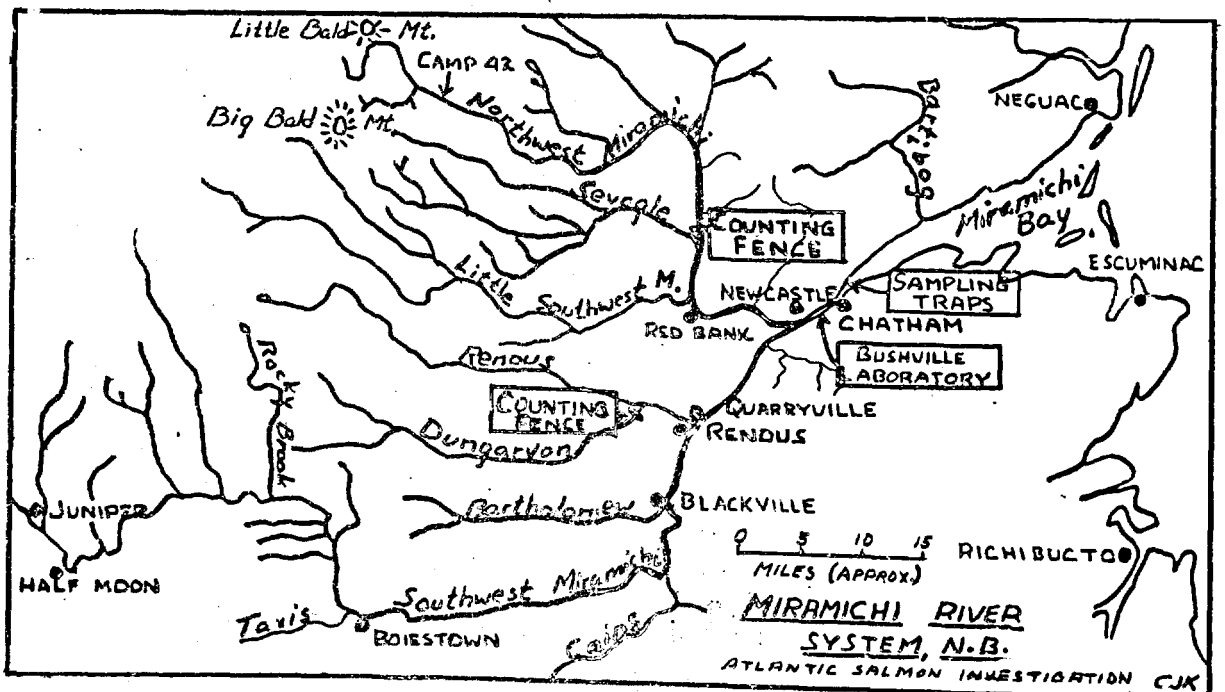
For the Pollett plantings, the overall rate of survival from fingerlings to smolts was about  $8\% = 0.6\%$  and the general standard of smolt production with a planting of one quarter million fingerlings was about 19,000 smolts ( $\pm 2,000$  for standard error).

P. F. Elson

Salmon Investigations on the Miramichi River, N. B.

Since 1950 a new investigation of Atlantic salmon has been carried on in the Miramichi River area. The objective is to determine: (1) the annual production of young salmon over a long period, (2) their whereabouts after leaving the river as smolts, (3) the proportions of the Miramichi stock which are taken by the various commercial and sport fisheries around the coast, (4) the improvement in salmon production that may result from removal of predatory birds during the pre-smolt period, and (5) information on such topics as the times of various runs of fish into the river, the size and age composition of the runs, and other matters relating to proper regulation of the salmon fishery.

The accompanying map shows the geography of the area. The two main branches of the river, the Northwest Miramichi and the Southwest Miramichi, join just above Newcastle. On these branches the head of tide is in the vicinity of Red Bank and Quarryville. Angling for salmon occurs almost everywhere above head of tide. The commercial fishery is carried on (1) with set-nets along the shores in the tidal sections of the river and in Miramichi Bay, and (2) with drift-nets outside of a line between Neguac and Escuminac. Our research is carried on chiefly at two counting fences located on the Northwest Miramichi just above the mouth of the Sevogle River, and near the mouth of the Dungarvon River, a tributary to the Southwest Miramichi. Considerable work is also done in the estuary just below Chatham, where gear is operated to obtain samples of descending smolts and ascending salmon.



Appendix No. 68

INCREASED PRODUCTION OF NATIVE YOUNG SALMON  
ACCOMPANYING CONTROL OF MERGANSERS

The large increases in crops of salmon parr and smolt which accompanied control of kingfishers and mergansers on the Pollett are summarized in Appendix 67. The control on the Pollett involved an average of two days per week for two men throughout the year. Here the first consideration was to obtain scientific information on the effects of these predators but the resulting ninefold increase in the average smolt run justifies efforts to develop practical procedures for control of mergansers. By 1950 investigations had indicated that predation by kingfishers was of minor importance. That year it was decided to begin an investigation of salmon on the Miramichi River, and to include an experiment which might lead to development of a technique of merganser control for waters supporting important sport and commercial fisheries.

The Northwest Miramichi River was selected for the experimental control and another tributary, the Dungarvon River, for study and comparison of conditions without it. The two streams are similar in size, in environmental conditions for salmon, and in the numbers of mature salmon entering from the sea each year. Both appeared to have been subjected to heavy merganser predation up to 1950.

The project has been a co-operative one involving three organizations. The Canadian Wildlife Service has conducted an annual mid-summer census of mergansers on the Dungarvon and studied the distribution and habits of the birds on other streams through counting and banding young birds. The Fisheries Research Board has made annual inventories of young salmon stocks, starting on the Northwest Miramichi in 1950 and in the Dungarvon in 1952. The Conservation and Development Service of the Department of Fisheries has supplied the senior officer for actual control operations, as well as equipment. The Board has supplied assistants and travelling expenses for the project, and some advice and supervision.

Merganser populations on the Northwest Miramichi and Dungarvon. The annual inventories of mergansers on the Dungarvon were made in 1951 by canoe and in 1952 by low-altitude aeroplane flight. The merganser populations found on the two streams, and the bird-control operations on the Northwest Miramichi, are shown in table 1.

Year	<u>Dungarvon</u> (50 mi. of stream)		<u>Northwest Miramichi</u> (70 mi. of stream)			
	<u>Ducks counted</u>		<u>Ducks counted</u>		<u>Left after summer control</u>	
	<u>Total</u>	<u>Per 10 mi.</u>	<u>Total</u>	<u>Per 10 mi.</u>	<u>Total</u>	<u>Per 10 mi.</u>
1950	No census made		132	19	51	7
1951	71	14	87	12	29	4
1952	45	9	57	8	15	2
Av. per yr. per 10 mi. of stream	12		13		5	

The intensity of potential merganser depredations during summer is indicated by the finding of about 12 birds per 10 miles on the Dungarvon and 13 birds on the Northwest. Brood-control operations alone reduced the Northwest ducks by somewhat more than half, and on this stream subsequent autumn control further reduced the resident birds as well as invading autumn migrants.

Native salmon parr populations on the Northwest Miramichi and Dungarvon. Comparison of the young salmon populations found in these two rivers, by seining in sample areas for an estimate of numbers, is made in table 2.

Table 2. Density of native populations of young salmon in streams with and without merganser control - 1952

	<u>Dungarvon</u>		<u>Northwest Miramichi</u>	
No. of sampling areas	6		10	
Total stream length in sample	300 yd.		508 yd.	
Estimated no. of salmon				
Fingerlings	1,480		2,500*	
Total parr	1,141		4,098	
Percentage of parr over 10 cm.	18%		33%	
Salmon per 100 yd. of stream	<u>Number</u>	<u>Ratio</u>	<u>Number</u>	<u>Ratio</u>
Fingerlings	493	100	714*	100
Parr under 10 cm.	312	63	541	76
Parr over 10 cm.	68	14	266	37
Large parr (over 10 cm.) per mile of stream	1,202		4,682	

\*From seven areas (where fingerlings were large enough to be caught).

Parr over 10 cm. long are those likely to transform into smolts in the following spring. The majority of smolts from these two streams descend as three-year-olds. From stomach analysis it has been found that mergansers prey mostly on yearling and older parr. The apparent survival rate of small and large parr from fingerlings is noticeably better for the Northwest than for the Dungarvon.

Increases in native parr on the Northwest Miramichi. The improvement in parr populations which has accompanied merganser control begun in 1950 is indicated in table 3.

Table 3. Northwest Miramichi: Approximate number of parr per 100 yd. of stream length, found by repeated seining for proportion of marked fish recaptured from sample areas.

Year	Total parr	Parr under 10 cm.	Parr over 10 cm.	Probable smolts (60% survival from large parr)	
				Number	Ratios for years
1950	460	400	60	36	1.0
1951	660	430	230	138	3.8
1952	810	540	270	162*	4.5*

\* Survival rate for large parr found in 1952 to smolts in 1953 is expected to be better than indicated in table because of extension of merganser control throughout autumn.

The initial density of large parr in the Northwest (60 per 100 yd.) was very similar to that now obtaining in the Dungarvon (68 per 100 yd.) (table 2), but the density in the Northwest has increased by more than four times.

The survival rate from small to large parr, approximately equivalent to survival from yearling to two-year-old stages, has been about 60%. A good part of the 40% loss between these two stages is probably attributable to merganser predations during seasons of the year when control was not attempted.

Development of methods for merganser control on the Northwest Miramichi. Control was begun in the summer of 1950. In the first two years chief emphasis was placed on removal of broods, and patrol crews of four men were employed over a three-week period in mid-summer. In the second year (1951) spring control, involving two men for May and June was added, both to give protection during the early part of the season and to simplify brood removal during the summer. Frequent reports on these control operations by Mr. Neil MacEachern of the Conservation and Development Service, when considered in relation to information on salmon populations from seining parr and counting migrants, indicate how effective the control has been in reducing mergansers and increasing salmon stocks. By the end of 1951 it was evident that parr populations, although somewhat improved (about four times the pre-control level) were still subject to a 40% mortality in the pre-smolt year; this was seen as resulting to a considerable degree from autumn and spring predations by migrating mergansers.

By late 1951 experience had indicated that Mr. MacEachern and one competent assistant could accomplish the necessary removal of birds by spending most of the open-water season (last of April to late November) on the job. This has been the plan followed in 1952. A summary of control operations to date is given in table 4.

Table 4. Mergansers encountered during three years of control on the Northwest Miramichi

	1950			1951			1952		
	Sight records	Estimated number	Killed or wounded	Sight records	Estimated number	Killed or wounded	Sight records	Estimated number	Killed or wounded
Spring	No control			187	-	13	97	-	28
Summer	263			112			82		
ducks without broods		9			22			14	
females with broods		12			9			5	
young in broods		111	81		56	58		38	42
Autumn	29*	-	29	24*	-	24	182**	-	54
Total sight records	292			323			361		
Total killed and wounded			110			95			124**

\* Collected by F.R.B. personnel for food analysis, etc.

\*\* November 1, 1952.

The results suggest that spring control has definite value both for reducing predation at that time and for simplifying control of broods, but it has not removed the need for summer control. The results of this year's autumn patrol show that predation at this season can be extensive and that some degree of control is apparently feasible. It is expected that comparison of parr populations in 1953 as compared with those of 1951 and 1952 will indicate the real value of autumn control for increasing young salmon stocks, by showing whether there is any large increase in the rate of survival from yearlings to two-year-olds.

General conclusion. The information accumulated to date from this work on the Miramichi is interpreted as indicating that control of mergansers to increase stocks of parr and smolt by four or more times is feasible. It still remains to be demonstrated, however, that such increases in young stocks will be followed by commensurate increases in harvestable salmon.

P. F. Elson  
C. J. Kerswill

Appendix No. 69

STOMACH ANALYSES OF MERGANSERS

Merganser-control experiments on salmon streams have indicated that predation by mergansers is a limiting factor in the production of salmon smolts. It has thus become desirable to have thorough knowledge of the feeding habits of these ducks.

In 1951 collections were made on various streams of the Maritimes. Size, age and sex of each duck were recorded. The "stomach", including the gullet, proventriculus and gizzard, was preserved in dry salt. Since we determine species, numbers and approximate sizes of food fishes from the bones of ingested fishes, it is necessary to get rid of the flesh. When retained in salt solution digestion continues, so that generally when the stomach contents are removed the digested or partly digested food flesh can be separated from the bones by washing, screening and decanting. During such operations offensive odours can be controlled by the use of commercial chlorine solution.

From streams, estuaries and lakes in the Maritimes we now have detailed records of the stomach contents of 662 American Mergansers and 58 Red-Breasted Mergansers. The largest collections from individual streams have been made on the Pollett River and the Northwest Miramichi (122 and 90 respectively) where merganser control is being carried out. To complete the collection more late-fall and winter collections from both fresh and salt-water habitats are desired. The data from these analyses have not been organized but the following facts are obvious already:

1. Salmon parr are a major food of mergansers taken on salmon streams.
2. In the upper waters of the Northwest Miramichi and the Margaree the food of mergansers consists almost entirely of salmon and trout.
3. In most areas the sucker is a staple food item.
4. Existing species of minnows are taken by mergansers of all ages.
5. When smelt are present mergansers may feed entirely upon them.
6. Eels are rarely eaten except in the winter or early spring, and then mostly by male ducks.
7. Mergansers will eat such spiny fishes as yellow perch and bullheads.

H. C. White

Appendix No. 70

SURVEY OF THE ST. MARY RIVER, N. S., FOR BIRD CONTROL

Experimental control of fish-eating birds, especially mergansers, is to be instituted in 1953 on the St. Mary River, N. S. - suitable because most of the better salmon-rearing areas are accessible by good roads. In order to follow its effects a preliminary survey was made in 1952 to estimate the population of fish on the various branches and the number of mergansers present.

During late August and early September, with H. W. Coates and local help, quantitative seinings were carried out on three sections of both of the two main branches, West River and East River. A count of mergansers was attempted on the entire river system and a few mergansers were collected for stomach analyses.

Seining. On each branch three sections of the better parr-rearing area were measured and marked for future reference. Seining was done without using barrier nets or marking fish for re-capture, but twice for each section it was repeated until no more fish were caught. The sections were long enough so that barrier nets would have made no appreciable difference to the number of fish taken. Estimates of relative abundance are to be based on seining the same sections in succeeding years at comparable times and in the same manner. If after bird control the seinings do not show great increases in young salmon, perhaps in the order of tenfold, bird control can be considered as only partially effective.

The following table shows the number of young salmon taken:

	<u>West River St. Mary</u>				<u>East River St. Mary</u>		
	<u>Length</u>	<u>Fry</u>	<u>Parr</u>	<u>Minnows</u>	<u>Length</u>	<u>Fry</u>	<u>Parr</u>
Upper section	110 yd.	58	4		129 yd.	8	1
Middle section	140 "	86	1	3	75 "	21	3
Lower section	70 "	11	4		145 "	32	1

We believe that most of the parr and larger minnows such as would be taken by the nearly full-grown mergansers were caught in this seining; the seining for the fry of the year in water only a few inches deep was not very effective. Note that the parr and larger minnows were extremely scarce, as in the Pollett River before bird control. That the mergansers were responsible for the small number of fishes of the sizes which they ordinarily take was confirmed by seining with a small one-man hand seine in the occasional small side runs, heads of weedy backwaters and small tributaries. These are places where mergansers do not feed and they were well populated with merganser food. Large minnows and parr were seen in the main stream at highway bridges and along a part which bordered the highway, places where mergansers would be frightened away. Lone large minnows occasionally found in hiding places along the stream

could not be easily frightened into deep water. They kept along the shore and tried to find other hiding places in water only two or three inches deep. During our duck collections on various streams we have repeatedly observed this behaviour of both parr and minnows in areas where mergansers were actively feeding.

Merganser survey. At the time of the survey, August 23 to September 2, the river was unusually low and progress by canoe was slow. On the West River the survey was started at the South branch about 45 miles above its junction with the East branch and took two and one half days.

In the upper part seven well-grown but non-flying young birds were found singly along the stream. Two flying birds went up-stream. Single faecal splashes on rocks indicated that these were the only ducks using this area. These may have been strays or survivors of flocks depleted by natural enemies. A Barred Owl followed a single duck ahead of the canoe for about half a mile. The duck travelled much of the distance under water, an unusual behaviour. In the lower two miles we found a flock of 19 young ducks, some of which were able to fly; 12 were shot for food analyses. Four days later a flock of 22 was found in the same area.

The main stream as far as Sherbrooke was run by canoe but only three young ducks were found. In this area guides and anglers had repeatedly reported a flock of about 60.

Owing to low water the main East River could not be navigated by canoe and walking the entire length was impracticable. It was examined at all accessible places. Three ducklings were seen at Garden of Eden Lake and faecal splashes indicated a flock of 7 or 8 along the mid-section of the stream. On the smaller branch below Lochaber Lakes a flock of 20 was encountered and 12 from this flock were collected for stomach analyses.

Apparently the young ducks at the time of this survey had depleted the better sections of the stream and were moving quickly through the lake systems and even to the estuary, probably in search of good feeding grounds. Certain areas of the stream frequented by anglers or bathers had not been fished by the broods when they were accompanied by the more wary female parent. Now, unaccompanied by the parent females and with people absent, they were making blitz attacks on these good fishing places.

On the Moose River, tributary to the East River above Garden of Eden Lake in the deep woods, we found plentiful fresh merganser splashes. This was an area where mergansers, other than downy ducklings, would not ordinarily be found.

From the areas examined and the evidence obtained we have estimated a population of about 200 mergansers for the entire system.

Stomach analyses of mergansers. Four analyses of 24 mergansers collected at the time of this survey and 16 taken on the upper West River on May 10, 1951, are shown in the following table:

Stomach analyses of mergansers collected  
from St. Mary River, N. S.

Food items	West R.St.Mary Cameron Settlement Aug. 10, 1951 In 16 specimens (10♀, 6♂)		West R.St.Mary lower 2 mi. Aug. 24, 1952 In 12 specimens (6♀, 6♂)		East R.St.Mary on Lochaber Branch 1 mi. below Two Mile Lake, Aug. 28, 1952 In 12 specimens (5♀, 7♂)	
	No.	% by no.	No.	% by no.	No.	% by no.
Salmon	95	38	21	17.4	9	6.5
Suckers	55	22	31	25.6	25	18.1
Shad	-	-	-	-	19	13.8
Minnows*	88	35.2	52	42.9	51	36.9
Eels	6	2.4	2	1.7	-	-
Bullheads	-	-	3	2.5	3	2.2
Killifish	4	1.6	11	9.1	19	13.8
Perch	-	-	-	-	5	3.6
Sticklebacks	-	-	1	0.8	7	5.1
Insects	2	0.8	-	-	-	-
Total items	250	100.0%	121	100.0%	138	100.0%

\* Five species present: Semotilus atromaculatus, Couesius plumbeus, Notropis cornutus, Chrosomus eos, Notemigonus crysoleucas.

The food taken varies with both the time of the year and the part of the river system. On the upper part of the West River salmon constituted numerically 38% on August 10, 1951; on August 24 on the lower part of the West River salmon constituted 17%; on the Lochaber branch of the East River salmon formed only 6.5%. Although the latter collection was taken in the stream their food shows the influence of the lake habitat with Golden Shiners (most of the minnows) as the dominant food.

The significant fact regarding the salmon taken is not what percentage of the food they constitute but the actual numbers taken. The 40 ducks killed for these analyses contained the remains of 125 young salmon.

H. C. White

Appendix No. 71

THE EEL AS A PREDATOR ON NATURAL STOCKS OF YOUNG SALMON

In July and August, 1952, at twelve sites on four streams in New Brunswick the numbers of different species of fish in closed-off sections of the streams were estimated, the eels removed after a night's feeding and their stomach contents analysed to determine what proportion of fish, particularly salmon fry, a known number of eels had removed during the preceding

hours of darkness. Three sites were on the Becaguimic River and five on the Shiktehawk, both tributaries to the Saint John and important salmon spawning streams. Two were on a tributary to the Becaguimic, Cold Stream, on which a small number of salmon spawn. Two were on the Digdeguash River, which flows into Passamaquoddy Bay about ten miles east of St. Andrews; an unknown but probably small number of salmon ascend this river. The sections were from 60 to 93 feet long and 10 to 41 feet wide, the mean depth was from  $\frac{1}{2}$  to 2 feet and the estimated velocity of flow was 0.3 to 3.0 feet per second.

The collections were made with electrofishing gear using a new 1000-watt generator with speed adjusted to give a potential difference of 750 volts under no load. The voltage and current under load varied in the different waters and were recorded for each site, as well as water temperatures, type of bottom and other pertinent data. In operation the voltage was usually between 600 and 700 volts and the current between 1.0 and 1.7 amperes.

Barrier nets were set in the evening at the upper and lower ends of the section. Fishing began at dawn as soon as light permitted and the same procedure was followed consistently. The operator began at one upper corner of a section and moved slowly back and forth from bank to bank, each time overlapping the last strip, and probed thoroughly among rocks and under banks, while two assistants with dip-nets and a bucket to hold the fish stood a little below him. The electrode was swept from as far as it would reach up-stream to as far as it would reach down-stream, then lifted from the water and the process repeated. One complete fishing of the section in this manner has been termed a "sweep", and at most sites three sweeps reduced the last catch of each species to a very small fraction of the catch of the first sweep, although on three occasions four were needed. The whole process at each site usually took from dawn to noon.

Eels, salmon fry, salmon parr, trout fry, adult trout, sculpins, ling, sticklebacks, black-nosed dace and other minnows were taken. Eels were immediately dropped into a bucket of strong formalin to preserve the stomach contents; the other fishes were placed in a live-box and released later below the fishing site. The total number of fish taken from the twelve sites was 2,958.

A tabulation has been made of the catches per sweep of eels and other fishes at all the sites where they occurred. A total of 315 was taken at nine sites and of these 260 (85%) were taken during the first sweep, 35 (11%) during the second, 18 (6%) during the third, and 2 during the fourth. Eels were electrofished more readily than the other species. For example, 777 black-nosed dace were caught at nine sites: 435 (only 61%) in the first sweep, 228 (25%) in the second, 100 (11%) in the third and 14 in the fourth.

The average densities of eels in areas sampled in this survey, and previously sampled on five tributaries to the Petitcodiac River, are given in the following table:

The density of eels in small sections of  
nine New Brunswick streams

<u>River system</u>	<u>Stream</u>	<u>Width of stream (yd.)</u>	<u>No. per 100 yd.</u>	<u>No. per sq. yd.</u>	<u>Relative mid-summer temperatures</u>
Petitcodiac	Bennett	1	204	2.04 )	Warm
	Nigus	2	220	1.10 )	
	Turtle	10	275	0.262)	
	Coverdale	17	201	0.121)	
	Pollett	23	294	0.133)	
Saint John	Becaguimic	12	243	0.305	Medium
	Cold Stream	10	36	0.039	Cold
	Shiktehawk	12	142	0.121	Medium
Digdeguash	Digdeguash	10	60	0.057	Warm

Stomach contents of eels. The stomach contents of 382 eels collected during the above electrofishing operations have been examined. The stomachs of 82 were empty. The bulk of the food comprised insects, principally nymphs of the order of Ephemera. Thirty eels contained small fish comprising 10 salmon fry, and 65 specimens of other species, mostly black-nosed dace; this amounted to about 3% of the estimated total population of small fish, including salmon fry, present in the twelve sections of streams. The 10 salmon fry had been eaten by 6 eels; this constituted an approximate reduction by eels of 1.4% of the estimated fry population. Of the 382 eels examined, only between 150 and 200 were big enough to take salmon fry, and an average of one salmon fry per night was removed by every 15 to 20 of these eels. The 10 salmon fry were taken by eels on only two sites, from an approximate total of 122 fry, where from 61 to 71 eels of sufficient size were present.

There is insufficient data at present to judge whether or not such predation can be considered to be a serious factor in reducing populations of young salmon. The information applies only to a small total area of water and to a limited number of environmental conditions; the figures are in terms of a single night's predation only, at one brief season of the year. New evidence is provided, however, of predation by eels among populations of native fry of known sizes. The usefulness of the electrofishing apparatus in carrying out such studies has been demonstrated.

Condensed from a report by H. Godfrey

Appendix No. 72

EELS AND PLANTED SALMON FRY

This year a heavy planting of salmon fry was made in the experimental area of the Pollett River, about half a million being distributed along some four miles of the stream below the Forest Glen dam. The planting started earlier than in former years and the fry were much smaller than usual. In other years it was found that eels took a very high percentage of the larger fry during and shortly after planting. This summer, beginning on August 8 while planting was in progress, observations were made to learn the fate of the fry and whether or not they might survive better if planted in selected areas, perhaps close to shore.

Immediately after planting, the fry were clustered along the edge mostly within three feet of the shore and bunches crowded beneath every loose stone - the very places where one would expect to find eels. I observed numerous eels but catching them was difficult. An electric shocker could not be used as it would probably have killed large numbers of the fry; seining proved ineffective. One  $4\frac{1}{2}$ -inch eel was killed with a sharp knife blade and five others ( $11\frac{3}{4}$  to 16 inches) were taken on small baited hooks. The smallest eel contained one fry but all the others were empty.

On August 9, the first night after planting had been completed, we fished with number 12 hooks baited with small pieces of minnow. Small eels took the bait repeatedly and six were caught. Observations and fishing were carried out again on the fifth and sixth nights after planting. The following table gives the results:

Stomach contents of eels collected after planting salmon fry in Pollett River, N. B., August, 1952

<u>Time of collection</u>	<u>Eels</u>		<u>Salmon fry</u>	<u>Other fish</u>	<u>Insects</u>
	<u>No.</u>	<u>Lengths</u>			
Mid-day, Aug. 8 (date of planting)	1	$4\frac{1}{2}$	1	-	
	4	25 to 40	-	-	
1st night					
10 p.m. to	2	13, $13\frac{1}{2}$	12	-	
1 a.m.	4	25, 22, $17\frac{1}{2}$ , 17	-	-	
5th night	1	$12\frac{1}{2}$	-	-	Trichoptera larva
10 p.m. to	1	14	-	1 minnow	
2 a.m.	1	22	-	1 sucker	
	3	16, 17, 20	-	-	
6th night	2	$11\frac{1}{2}$ , 12	-	-	Trichoptera larva
10 p.m. to	2	$14\frac{1}{2}$ , 15	2	-	
1:30 a.m.	3	16, 16, 20	-	-	

By the fifth and sixth night the fry were becoming very scarce and the only survivors that we could find were those in very shallow water, some resting in water one quarter to one half inch in depth. A few were resting on stones which came near the surface. Numerous small eels were observed in water so shallow that they splashed when a flashlight was turned on them. In other years we found that the larger eels were taking large numbers of the fry, but from the scanty evidence obtained this year it appears that the smaller eels were getting them more readily than the larger. Some protection against eels was apparently afforded fry close to shore by the shallowness of the water.

H. C. White

### Appendix No. 73

#### OPERATION OF SALMON COUNTING FENCES IN THE MIRAMICHI RIVER AREA

Starting in 1950 fences have been operated on the Northwest Miramichi and Dungarvon Rivers to count descending smolts and ascending and descending salmon, and to mark smolts for study of their movements in the sea and their contribution to various fisheries. By fishing smolts in the estuary throughout the entire smolt run it is possible to estimate the total production of the Miramichi River system using the proportions of marked to unmarked smolts which are taken.

In 1950, the first year, both counting fences were completed too late to take any but the latter part of the smolt run. In 1951 the fences were completed much earlier and reasonably good quantities of smolts were captured and marked at both sites. In 1952 a combination of heavy timber drives and freshet conditions during May and early June prevented completion of either fence until the smolt run was nearly over, so that only 848 were taken on the Northwest Miramichi and 461 on the Dungarvon. Many of these were taken while only the short leg of the fence, the trap, and part of the long leg were in position. These were protected at both sites by a fin-boom which diverted most of the logs and pulpwood. It was suspected, however, that descending smolts also tended to lead along the boom, and to avoid the trap. Various devices will be tried next spring for leading the smolts into the trap itself.

New lumbering roads are being built this year which will enable the local companies to cut extensively in the vicinity of the headwaters of the Northwest Miramichi River, and timber drives may possibly interfere with our counting fences on this tributary for some time. Consideration is being given to the installation of a fence about thirty-five miles up-river from the present site, perhaps near Camp Forty-two. This area is now readily accessible on the new road, and it might be possible to mark here a sufficient quantity of smolts produced in the upper reaches. The river has a width of only about one hundred feet here, as compared to over three hundred feet at the present White Rapids site. Probably installation of the fence could be completed quite early owing to its moderate size, the reported early disappearance of

ice in this vicinity, and through being above several large tributaries on which lumber is cut.

During the period of operation of both counting fences a close watch is kept for salmon and grilse bearing marks applied at the counting fences in previous years. The results are given in a later summary (Appendix 75).

Daily records of weather conditions, water temperatures and water heights are made at both counting fences. This year, following an unusually heavy spring freshet, the waters of the Miramichi system fell to a very low level and had higher temperatures than usual from July to mid-September. This adversely affected angling in some areas. A few fishing camp operators on the Southwest Miramichi took their guests to the upper reaches of the Northwest Miramichi where water temperatures remained lower and angling was good. Residents of the Southwest Miramichi area reported that the water was the lowest within memory.

In 1950 and 1951 on the Dungarvon River, spent salmon descended to the fence during the first part of November and were allowed to go through after some counts were made. It is believed that most, if not all, of the salmon which ascended the Dungarvon throughout the summer descend at this time owing to lack of suitable up-river wintering pools. In 1951 the descent of some spent salmon was observed at the counting fence on the Northwest Miramichi River, but here most of the salmon appear to remain up-river over the winter.

To determine the distribution of the fish above the fences about 10% of the adults taken each day at the fence on the Northwest Miramichi and about 21% of those on the Dungarvon were tagged before being released on the up-stream side. Recaptures are discussed in Appendix 76.

Northwest Miramichi River. The following table gives the details of the handling of smolts and larger salmon at the White Rapids counting fence over the past three years.

	<u>Smolt marked</u>			<u>Salmon checked</u>			<u>Grilse checked</u>		
	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>
May*	7,124	32,286	?	0	53	?	1	28	?
June*	840	1,121	792	229	253	53	731	994	716
July**	5	0	56	55	51	45	1,297	1,017	1,013
Aug.	0	0	0	7	7	0	69	79	19
Sept.	0	0	0	0	82	10	42	78	35
Oct.	0	0	0	528	316	521(a)	318	139	265(a)
Nov.***	0	0	0	10	54	?	1	3	?
Total	7,969	33,407	848	829	816	629+	2,459	2,338	2,048+

\* Fence installed completely May 31, 1950, May 16, 1951, June 18, 1952.

\*\* Fence not operating July 13-21, 1951 - washout.

\*\*\* Fence removal began Nov. 4, 1950, Nov. 3, 1951.

(a) Figures in 1952 include only to Oct. 15, 1952

In 1952 the upward run of adult fish began earlier than usual. "Bright" salmon were taken well up-river by anglers before the commercial set-nets captured any in tidal waters where fishing commenced in the third week of May. During early summer there was unusually good angling throughout the river above the counting fence, indicating that many early-run fish ascended before the fence was completed on June 18. Following this date the run of grilse increased to a peak on June 24 and 25 and again on July 8, and the July run of grilse compares almost exactly to that of July, 1951.

From late July through August and September the water was extremely low and warm, the daily maximum being consistently over 20°C. from mid-July to mid-September, and occasionally going as high as 28°C.

Dungarvon River. The following table shows, by months for the period May to November, the handling of smolts and older salmon at this counting fence over the past three years.

	<u>Smolt marked</u>			<u>Salmon checked</u>			<u>Grilse checked</u>		
	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>
May*	?	14,868	357	?	3	?	?	0	?
June*	253	98	104	29	73	49	167	167	307
July**	9	0	0	89	50	16	971	296	128
Aug.	0	0	0	60	10	2	24	5	8
Sept.	0	0	0	92	37	6	64	91	9
Oct.***	0	0	0	743	818	749(a)	340	255	365(a)
Nov.****	0	0	0	15	?	?	2	?	?
	<u>253</u>	<u>14,966</u>	<u>461</u>	<u>1,028</u>	<u>991</u>	<u>822+</u>	<u>1,568</u>	<u>814</u>	<u>817+</u>

\* Fence installed completely June 10, 1950, May 20, 1951, June 12, 1952 (partial fence from May 19, 1952).

\*\* Fence washed out July 14-21, 1951.

\*\*\* Fish so numerous traps catching but not holding them all, Oct., 1951.

\*\*\*\* Fence removed early November each year, fished only a few days.

(a) To Oct. 15, 1952, only.

It is seen that fewer salmon passed through the fence before October 15, 1952, than in the previous two years. In June, 1952, almost twice as many grilse were taken as in June, 1950 or 1951, but considerably fewer were taken in July this year than previously. These grilse must have moved on quickly to the headwaters because good angling was reported there, while relatively few were taken in the remainder of the river.

It is believed that very few salmon or grilse were missed through the fence being incomplete until June 12, because in the past two years there was little movement of fish before this date and very few were taken by anglers before June 12 this year. Once installed the fence operated without interruption until October 4 when a very sharp rise in water level caused several holes to be washed out beneath the fence which could not

be plugged for thirty-six hours. Fish, which had been resting in a large pool down-stream owing to extremely low water prior to the freshet, moved through the fence but the number was estimated by counting continuously the fish passing through one hole.

During the past two years a large gravel bar was former along one side of the Dungarvon River at the fence site. This narrowed the channel and made the stream quite deep and rapid at one section of the fence during freshets. This September, by means of a bulldozer, most of this bar was pushed ashore and a channel was made through an island below the fence. Good results were observed during the freshet in October when the water spread out over the full width of the stream at the fence and ran away from below much more quickly than formerly.

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C. J. Kerswill

Appendix No. 74

EXPERIMENTAL FISHING FOR SMOLTS AND LARGER SALMON  
IN THE MIRAMICHI RIVER ESTUARY

For smolts. As mentioned in the previous Appendix an effort is made annually to obtain good samples of descending smolts in the estuary several miles below the junction of the Northwest Miramichi and Southwest Miramichi tributaries throughout the smolt run. In previous years various types of gear have been tried, including box-nets, trawls, drift-nets and seines. The most effective gear has proved to be double-end box-nets provided with long leaders running out from the shore and with special compartments at the ends of the boxes to separate the smolts from gaspereau which commonly ascend the Miramichi in great numbers at this time. This year four box-nets were operated, two on either side of the river just below Chatham. The catches of smolts are given in the following table showing that most of the catch was made at sites No. 2 and No. 3 which are on the south side of the river. Only two sites, No. 2 and No. 4, were used last year when No. 4 was also the poorer.

Smolt Catches Miramichi River Estuary, 1952

Weeks ending	MacHardy Cove box-net (1)	Canada Dock box-net (2)	Middle Is. box-net (3)	Millbank box-net (4)	Total
May 10	0				0
May 17	2				2
May 24	1	37			38
May 31	8	345	39		392
June 7	92	760	1,113		1,965
June 14	33	366	175	12	586
June 21	35	230	583	38	886
June 28	9	44	75	1	129
	0	0	0	0	0
Total:	180	1,782	1,985	51	3,998

- (1) Operated first at 100% efficiency, May 3
- (2) Operated first at 100% efficiency, May 19
- (3) Operated first at 100% efficiency, May 29
- (4) Operated first at 100% efficiency, June 10

As in previous years small experimental fyke-nets set for smelts during the first half of May in tidal portions of brooks tributary to the Northwest, Southwest and main Miramichi Rivers took a few small salmon having the appearance of smolts. This indicates that smolts are moving, at least to some extent, in these areas fairly early. In the sampling for smolts in the estuary, however, very few were taken before mid-May.

Since so few smolts (1,309) were caught and marked at the two counting fences in 1952 it is not surprising that none were retaken in the estuary among the 3,998 smolts captured, examined and released. As in 1951, no smolts were taken twice in any of the estuarial nets, indicating that once released they moved directly out of the netting area -- no doubt on down to sea. Although the gaspereaux were well separated from the smolts by the special partitions in the box-nets, smaller fish such as smelts mixed with the smolts in very large quantities at times, necessitating much sorting.

For larger salmon. Some salmon ascending early were caught in the smolt box-nets and these were tagged and released to provide information on their distribution among commercial set-nets and anglers in the river above. When this gear was taken ashore in early July one 3½"-mesh salmon trap-net was set in 22 feet of water just above site No. 2 and operated continuously into October, so that the tagging operations could be continued. The following table summarizes the tagging of grilse and salmon by months.

	<u>: Grilse</u>	<u>Salmon</u>	<u>Total</u>
June	20	5	25
July	97	19	116
August	43	17	60
September	279	504	783
October (to 15th)	39	97	136
Total	478	642	1,120

Very few grilse or salmon were caught during the period of operation of the smolt box-nets because of the hordes of gaspereaux in the nets, and in July and August when the larger-mesh net was first operated the water was quite warm (17° to 24° C.) and few fish were moving in the river. In September the catches increased considerably in spite of depredations by seals. By mid-October the ascent of fish had declined considerably and those caught were in many cases ripe -- the males with running milt.

At certain times of tide both grilse and salmon were seen over sand and gravel bottom in very shoal water along the shores of the river near the trap site. Reports by older fishermen in the district indicate that salmon have spawned in other years along these shores. One tagged female was recaptured several times at intervals of only a few days at the trap and when last handled appeared to be partially spawned out. Some evidence thus exists for the belief that late-running salmon may do some spawning along the open shores of the main Miramichi River twenty miles or more below the head of tide.

Appendix No. 75

RECAPTURES OF SALMON MARKED AS SMOLTS IN THE MIRAMICHI RIVER AREA

Each spring since 1950 an effort has been made to capture and mark by fin-clipping as many as possible of the smolts descending the Northwest Miramichi River above the mouth of the Sevogle tributary, and the Dungarvon River. In 1950 only 7,969 and 262 were marked at the two counting fences but 33,407 and 14,966 were marked in 1951. These represented only fractions of the runs owing to difficulties with high water and lumber drives.

In 1951 no special effort was made to find marked fish returning as grilse after one year in the sea, except to look carefully for them as they passed through the up-traps at the counting fences. In 1952 the marking program was publicized and rewards (\$1.00) were offered for returns of fin-scars and data on the time and place of capture plus scale samples. A technician, Mr. R. J. Wiley, was engaged to visit a large group (75) of angling camps in the Miramichi area at monthly intervals to stimulate interest and see that record books, distributed in the spring, were completed properly. At Escuminac, where most of the Miramichi drift-net catch is landed, another assistant saw that most of the fish were examined and the marked ones reported. Commercial fishermen in the Baie Chaleur area were interviewed and some recaptures were reported by them. During the commercial season in the Chatham-Millbank area of the Miramichi estuary two set-net fishermen, one on each side of the river, were engaged to record their catches of marked and unmarked fish, including salmon as well as grilse. Since it is illegal for commercial fishermen to retain grilse, this year they were specially authorized to turn over marked grilse to our scientific staff. Our own gear set in the estuary to obtain smolts gave some information on adult fish and one of the nets was modified as a salmon and grilse set-net, and operated until November.

It is planned to make a more intensive effort to look for marked fish next season, particularly in the commercial fisheries around the coast. Many of the rather large number of fish which were marked as smolts in 1951 will enter the fisheries as 2-sea-year salmon in 1953. The most useful information is obtained from records of the ratio of marked to unmarked fish of a particular year-class taken during certain periods in a number of areas. Complete and accurate data can be expected only when our trained staff obtains the records or closely supervises the work.

(a) Fish marked as smolts in 1950

The records available to October 15, 1952, are summarized in the following table:

Recaptures of fish marked as smolts in 1950  
(7969 marked on Northwest Miramichi; 262 on Dungarvon)

<u>How captured</u>	<u>Bearing N.W.M. marks</u>		<u>Bearing Dungarvon marks</u>	
	<u>1951</u> <u>on grilse</u>	<u>1952</u> <u>(to Oct. 15)</u> <u>on salmon</u>	<u>1951</u> <u>on grilse</u>	<u>1952</u> <u>(to Oct. 15)</u> <u>on salmon</u>
<u>Miramichi drift-nets</u>	-	47 (in 9750)	-	1 (in 9750)
<u>Set-nets:</u>				
Main Miramichi	-	24	-	-
N.W. "	-	1	-	-
S.W. "	-	1	-	-
Baie Chaleur	-	3	-	1
<u>Anglers:</u>				
N.W. Miramichi	-	4	-	-
S.W. "	-	1	-	1
Total	<u>0</u>	<u>81</u>	<u>0</u>	<u>3</u>

N.W. Miramichi counting fence	36 (in 1900*)	29 (in 629)	0 (in 814)	0 (in 822)
Dungarvon counting fence	-	-	-	-

\* Careful examination for marks commenced in mid-June after start of grilse run.

The total of 84 marked salmon reported by the commercial and sport fishermen represents a return of about 1% of the fish marked as smolts on both tributaries in 1950. Information on the proportion of marked to unmarked salmon taken by the fishermen is available as yet on only the Miramichi drift-net fishery where it is known that about 9,750 salmon were taken during the whole season; thus about 0.5% of this catch bore marks. If all the fish entering this drift-net fishery could be assumed to have developed from smolts produced in the Miramichi system, and if only the one year-class of salmon (1950) was present so that the catch comprised a representative sample of Miramichi stock, it would be possible to estimate the 1950 production of smolts by the whole river from the product:

$$8,231 \text{ (the total number of smolts marked)} \times \frac{100}{0.5} = 1,640,000$$

This figure is of the same order as that obtained through estuarial fishing for a sample of the smolt run in the following year (1951) when it was estimated that 1,650,000 were produced by the whole river. The earlier work of Belding and Prefontaine indicated, however, that some fish from the Miramichi drift-net area are caught elsewhere, and until further information is obtained on this point the proportions of some Miramichi stock in the

drift-net catches are only interesting speculations.

Seventy-seven of the 84 recaptures were either weighed or had their weight estimated. The average weight was slightly over 9 pounds and the largest fish weighed 14 pounds 3 ounces. Sex records were obtained from 21 of the recaptured fish in late May and June, giving a ratio of 12 females to 9 males.

It is interesting that four of the recaptures of Miramichi stock were made in the Baie Chaleur area and that one Northwest Miramichi salmon was taken by an angler in the Southwest Miramichi. The percentages of marked to unmarked grilse and salmon (1.9% and 4.6%) taken at the counting fences provides little information, since only small and unknown fractions of the smolt runs were marked in 1950. The returns do indicate, however, the successful survival of a fair number of marked fish for one- and two-year periods in the sea.

(b) Fish marked as smolts in 1951

The following table summarizes the records which were available up to October 15, 1952:

1952 recaptures of grilse marked as smolts in 1951 (to Oct. 15/52)  
(33,407 marked on Northwest Miramichi; 14,966 on Dungarvon)

<u>How captured</u>	<u>N.W. Miramichi marks</u>	<u>Dungarvon marks</u>
<u>Miramichi drift-nets</u>	-	-
<u>Set-nets:</u> Main Miramichi	14	5
N.W. Miramichi	-	-
S.W. Miramichi	-	-
Baie Chaleur	1	-
<u>Anglers:</u> N.W. Miramichi	88	1
S.W. Miramichi	21	29
Total	<u>124</u>	<u>35</u>
<hr/>		
N.W. Miramichi counting fence	225 (in 2048)	0 (in 2048)
Dungarvon counting fence	3 (in 817)	91 (in 817)

Noteworthy were the recapture of a Northwest Miramichi grilse in a Baie Chaleur set-net, and the exchange of grilse between the Northwest Miramichi and Southwest Miramichi tributaries as shown by the anglers' catches -- 21 Northwest Miramichi fish taken on the Southwest Miramichi, and one Dungarvon fish taken on the Northwest Miramichi.

Records of the total number of fish taken by commercial fishermen and anglers during the season in the various areas have not yet been analysed to obtain the proportions of marked to

unmarked grilse. At the counting fences, however, only 10% to 11% of the ascending grilse bore marks -- a surprisingly low proportion since it was believed that at least half of the 1951 smolt run was marked on both tributaries. Either the latter estimate was too low or there is a much lower tendency for salmon to return to their "home" stream than is generally believed to be the case.

At the counting fences the percentages of marked to unmarked grilse have been calculated by monthly periods. On the Northwest Miramichi the percentages were as follows: June 8%, July 13%, August 21%, September 9% and October 10%. On the Dungarvon the percentages were: June 14%, July 15%, August 0%, September 0% and October 8%. The values for August and September at the Dungarvon fence were the result of the almost complete lack of fish ascending the river at that time this year.

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#### Appendix No. 76

#### RECAPTURES OF SALMON TAGGED IN THE MIRAMICHI RIVER AREA

Fish tagged near Chatham in 1952. Of 1,120 fish tagged at our traps in the Chatham-Millbank area from June to mid-October, 18 were recaptured by October 15 in the estuary below Newcastle. Most of these were taken within two or three days of tagging, but six were taken 10 to 54 days after tagging. Thus about one third of the fish did not immediately go upriver to enter fresh water, but apparently remained in the estuary for some time. Therefore "early-run" and "late-run" salmon must be defined -- presumably the former as those which enter fresh water early and the latter as those which enter it late but which may have passed through the outer netting area quite early in the season.

Eighteen recaptures were made in the Northwest Miramichi, of which 3 were below the head of tide, 6 in the Northwest system between head of tide and the counting fence and 9 at the counting fence. At the counting fence 5 were taken within 2 to 5 days of tagging near Chatham, 2 were taken after 25 days and 1 after 69 days.

In the Southwest Miramichi 24 recaptures were made, of which 3 were taken below the head of tide shortly after being tagged. Of the remaining 21, 3 were taken in the Renous-Dungarvon system and 18 in the lower half only of the freshwater section of the Southwest Miramichi from June to September. Ten of the latter 18 had been tagged in June and July and, as there was much angling continuously in the upper waters (as shown by the returns of marked grilse), it is rather surprising that some recaptures were not made in the upper half of the river. The time between tagging and recapture was from 4 to 60 days.

Fish tagged at the Northwest Miramichi counting fence in 1952. To October 15, 25 recaptures were recorded from 265 fish tagged from June to October. These were all before late August and were divided about equally between the upper and lower half of the river. Thus at least some of the fish passing up the Northwest Miramichi went on to the head-waters. Their whereabouts at spawning time is not yet known.

Fish tagged at the Dungarvon counting fence in 1952. Of 220 fish tagged from June to October 14 have been recaptured, all before September 6, about half in the lower part of the river and half in the upper reaches.

R. A. McKenzie

Appendix No. 77

#### LATE-RUN VS EARLY-RUN SALMON IN THE MIRAMICHI RIVER

Among those interested in salmon there is much controversy over the comparative values of "early-run" and "late-run" salmon and whether or not they are genetically distinct.

In our study of the "salmon louse", Lepeophtheirus salmonis, at Moser River, where this copepod parasite was responsible for deaths of salmon, we found that the lice dropped off one to three days after the fish entered fresh water, the length of time depending on the water temperature. Early in the season all the fish entering the river carried adult and larval lice. In September and October many fairly dark grilse entered the river with well healed louse scars and a fresh infestation of larvae in various stages of development.

At the Miramichi River many salmon which enter the estuary early in the season apparently remain there until near spawning time. Others move up the Northwest Miramichi and may remain in the deep pool known as the Big Hole where they recover from the wounds caused by the lice, and in late season some of these are taken at the Northwest Miramichi salmon fence, which is just above the Big Hole. Many of these late-running salmon have been tagged and it is hoped that recaptures another year will determine whether or not they have changed from late-run to early-run.

Early in October we visited the Miramichi and examined a considerable number of salmon entering the traps. From the presence and stages of development of the lice and the condition of the scars, the following complicated behaviours were indicated. Some were salmon fresh in from the sea with either fully developed lice or fresh louse scars and were still fairly bright. These could be called "late-run" fish. At the other extreme were very dark fish with completely healed louse scars and no evidence of new scars or lice in any stages. Such fish may well have been in fresh water for three months or more. Between these two extremes there were all gradations including fish with healed louse scars and no adult lice but with a new infestation of small larval lice, indicating that they had been in fresh

water long enough to rid themselves of the lice and had then returned to brackish or salt water and become reinfested. Other similar fish had fairly well developed lice but no fully-grown females.

It appears that there is a great variation in the behaviour of the individual fish. We considered it important that notes on the condition of the scars and the types of infestation should be recorded for each fish tagged at the traps and instructed the trap crews on the classifications which should be recorded.

Our tagging of sea-run trout, which at Moser River become heavily infested, indicated that more than two months are required for the development of the mature lice. Investigations on the development of this parasite and the salinities required might add much to our understanding of the behaviour of the salmon.

H. C. White

#### Appendix No. 78

#### A TECHNIQUE FOR TAGGING EARLY-RUN SALMON IN THE MIRAMICHI RIVER

The tagging of early-run salmon in June and July requires a special technique, since at that time their scales are very loose and any rough handling in fresh water will cause severe injury from which they cannot recover in the stream. In the sea they are able to recover from injuries which would be lethal in fresh water. Salmon caught in the sea in gill-nets and tagged in straight-jackets have later been recovered in good condition.

While carrying on earlier salmon investigations at Moser River, N. S., a tagging technique was developed which caused no injury to the fish. This technique was used in tagging early-run salmon taken in the Miramichi traps.

The scales of the earliest bright salmon are very easily rubbed off and wherever any number of scales are removed an oedemic condition occurs. If grasped by the caudal peduncle enough scales may be removed to cause oedema to such an extent that the peduncle becomes almost rigid and normal swimming is prevented. To demonstrate this on the Northwest Miramichi we tagged a grilse from which the scales had been removed from a small area about one inch in diameter on the caudal peduncle and recorded this fact with the number of the tag. Three days later this fish was back on the trap racks with an almost rigid caudal peduncle and when noticed was beyond recovery. This was the only early-run fish to come down against the racks.

The equipment for handling the salmon is a small fine-meshed hand seine and cones of black cloth mounted on wires for slipping over the head of the salmon as blinders. The tip of the cone is cut off enough to allow the salmon to breathe freely. Several different sizes of cones are required for

different-sized salmon. In use, the salmon is caught in the hand seine but is not taken out of the water. The hood is slipped over the head as quickly as possible. Hooks can be arranged to hold the net in such a position that the salmon's back is out of water. The salmon will immediately stop struggling and if turned so that a flow of water is entering its mouth it will seldom register any nervous reaction even when a wire or pin for attaching the tag is inserted through the skin and bone at the base of the dorsal fin. The salmon may be measured and, if required, a few scales "picked" out without the fish showing any reaction. It may be lifted out of the water for several seconds. When liberating a salmon it immediately becomes normally active when the hood is removed.

For tagging late-run salmon on which the scales are firmly attached, a narrow trough may be arranged for holding the fish while it is being tagged.

H. C. White

Appendix No. 79

#### ARRANGEMENTS FOR 1953 EXPANDED SALMON PROGRAM

On July 15 the Deputy Minister called a special meeting in Ottawa of representatives of the Federal and Provincial Governments to consider the program of research and development work on Atlantic salmon. A recent stimulus for increased attention to salmon had come from publication in October, 1951, by the Atlantic Salmon Association of a report by Mr. W. J. M. Menzies of Scotland on our salmon fishery, with many recommendations for improvement. Most of these recommendations embodied changes in the fishery regulations which would further restrict the commercial fishing effort on the assumption that the spawning escapement is too small. He recommended also that the research program be expanded, particularly in the direction of determining the movements of salmon in the sea. Many of the research projects which he recommended were already under way.

The meeting agreed that final decision on the action to be taken on many of Mr. Menzies' recommendations could not be made until further research had yielded results. More knowledge is needed on such topics as the extent of mixing of stocks from various rivers; the spawning escapement now existing on typical streams and the escapement required for optimum production of smolts; the effects of the various commercial and sport fisheries for salmon on the spawning escapement and the old question of the inheritance of a tendency for salmon to run early or late in the season. It was agreed that the present experiments on the Pollett River, dealing principally with the use of hatchery stock and the effects of bird control, as well as the recently inaugurated research program on the Miramichi River involving large-scale smolt marking, promise valuable results. It was urged, however, that the research program be expanded without delay so that information would be available soon on which to base changes in any of the regulations which have uncertain value. The steady decline in the commercial

catches of salmon since 1930 was considered to be sufficiently serious to justify a special effort to stimulate recovery, although it was realized that this decline has been paralleled in the Atlantic salmon fisheries of Europe and the British Isles and that similar fluctuations have occurred in American waters in the past.

In August the writer visited Newfoundland and discussed plans for an expanded salmon program there. This involved the selection of a river suitable for long-term smolt marking and salmon trapping operations along the lines of the Miramichi program. It is expected that next spring the work will commence under Dr. Blair's immediate supervision on one of three streams which offer possibilities, but which require careful examination before freeze-up in 1952.

At the July meeting an offer to participate in the research program was received from the Province of Quebec, provided that the Board would take the lead in planning the project and in giving supervision. The writer and Dr. Elson visited the Gaspé coast in October when a stream (the Port Daniel) was selected for smolt marking and salmon counting and tagging. Details of a program resembling that on the Miramichi were discussed with Dr. Marcotte, Director of the Marine Biological Station at Grande Rivière. The Quebec program is expected to be under way in time to mark descending smolts next May. It is to be accompanied by a search for marked fish in the commercial and sport fisheries, and a start on bird-control work on the Gaspé coast.

The Conservation and Development Service of the Department is enlarging its field program on salmon also, under Mr. Catt's supervision. The writer is keeping close contact with this work so that there will be a continuous interchange of data and views. A program involving the examination of all the salmon streams throughout the Maritimes has been undertaken. All obstructions, as well as the location and extent of spawning areas and other features which might affect salmon production, are to be mapped. Traps are being installed in several fishways in New Brunswick and Nova Scotia to provide information on the number of ascending salmon. As discussed in a previous Appendix the carrying out of the bird-control program on the Miramichi is now the responsibility of Mr. Neil MacEachern of this Service, and it is expected that he will continue to give similar assistance in the future.

The writer has consulted with the Chief of the Canadian Wildlife Service on plans for the merganser census and banding operations in the Miramichi area and the general bird-control program in relation to the Atlantic salmon investigations. Full co-operation of that organization has been received since the work began, with Mr. George Boyer, Wildlife Management officer, taking part in the program each year. It is expected that next year the Wildlife Service staff participating in the Miramichi work will be increased.

In 1953 it is planned to increase our contacts with the Department's protection officers in all districts where salmon contribute significantly to the local fishery. The co-operation of these men has always been invaluable, and it has

particular significance now when complete and accurate information is needed on the commercial and angling catches and on the recaptures of marked and tagged salmon.

C. J. Kerswill

Appendix No. 80

#### THE BOUNTY KILL OF HARBOUR SEALS

Since the bounty system for the control of harbour seals was revised in 1949 on the recommendation of this Station (see Appendix 72, Annual Report for 1951), lower jaws submitted by bounty claimants have been forwarded to the Station for biological examination after payment of the bounty. The proportion of pups to older seals in the kills in various areas is being determined in order to follow population changes, and especially the effectiveness of having a larger bounty on older seals (\$10) than on pups of the year (\$5).

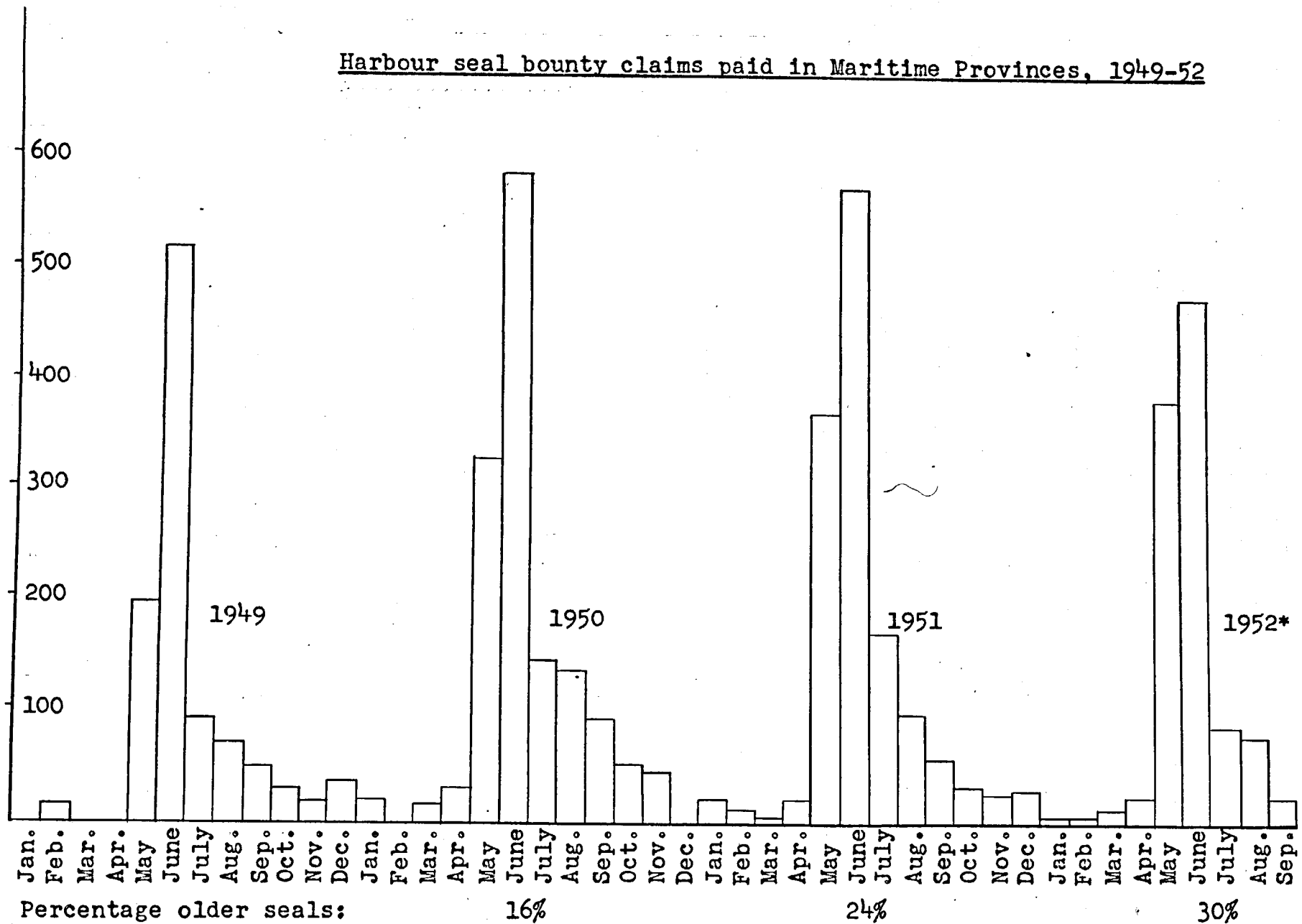
It had been hoped that the age composition of the kill could be determined in detail by reading growth lines in the dentine of the canine teeth as has been done successfully for harp seals. The teeth of harbour seals, unfortunately do not possess clear-cut annuli, probably because they do not experience such a definite seasonal metabolic disturbance. While methods of aging based on the diameter of the pulp cavity in relation to tooth size are being studied, it has not been possible thus far to break down the age composition further than a division between young of the year and older seals.

The accompanying graphs indicate that the bounty kill over the past four years has been roughly the same. It is of interest to note, however, that since the increase of the payment on older seals in the summer of 1949 the proportion of these to young of the year has been increasing. In 1950, 1951 and 1952 (to September) there have been 224, 300 and 362 kills of older seals respectively, an increase in the proportion of this group in the total kill of from 16% to 24% to 30%. Such an increase should reduce the total population if it continues, since before 1949 the bounty kill was accomplishing little more than a "farming" of the crop, possibly keeping the population from increasing but, by killing young of the year almost exclusively, not striking at maturing and adult stock, which has a breeding life of up to 20 years.

A reduction in the population should eventually be reflected in a reduction in the annual bounty kill. It is too early for this to become apparent, but it will be watched for over the next few years.

H. D. Fisher

Harbour seal bounty claims paid in Maritime Provinces, 1949-52



Percentage older seals: 16% 24% 30%  
 \*As of September, and not including P. E. I.

Appendix No. 81

GREY AND HARBOUR SEALS IN THE MIRAMICHI ESTUARY

During the summer of 1952 the study of the inter-relationships between seals, salmon, and salmon fishing in the Miramichi estuary was continued. The work has included direct observation and hunting and extended contacts with hunters and with fishermen during fishing operations.

Occurrence of seals. The 1952 investigations confirmed the information on occurrence of seals obtained in previous years. Seals present in the Miramichi area are of two species: harbour and grey. The harbour seals, not as yet known to migrate much during the year, remain scattered along the coastline. While a few grey seals also stay in the estuary throughout the year, the main body of over 300 is present only from late July or August until October or November. During this time the herd stays close to the Neguac and Tabusintac beaches night and day, except for evasive actions resulting from hunting.

Seal damage to the fishery. Trips and interviews with fishermen indicated that drift-nets did not in 1952 suffer serious damage, possibly because most of their catch is taken before the large herd of grey seals enters the drifting area.

The set-nets are attacked by seals continually, in one place or another, throughout the season, the damage increasing during the summer. It takes the form chiefly of holes in the trap where fish or parts of fish have been torn out by seals. The greatest loss is by trapped fish escaping through these holes, and can only be estimated by comparing the catches of unmolested and of damaged nets. Fishermen estimate that the total set-net catch, at present worth about \$40,000 per year, would be about doubled in the absence of seals.

The seals involved in the set-net fishery are now thought to be distinct from the large migratory herd of grey seals. Thus the set-nets can be protected only by control of the seals in the river during the commercial salmon season.

Some fishermen attribute the decrease in salmon to increasing numbers of seals devouring them clear of the nets. Reports from unbiased residents, long familiar with the estuary, indicate that the seals are, if anything, decreasing in numbers.

Food habits of seals. Three of four grey seal stomachs taken off Neguac in the fall of 1951 were empty except for nematodes and one was filled almost entirely with winter flounder. Of six grey seal stomachs obtained off Neguac and Tabusintac in the summer of 1952, one held about 50% salmon by volume, the remainder being unidentified fish, two contained chiefly small herring, and three were empty save for worms, hard parts of cod, hake, crabs and one piece of mackerel net. More stomachs are sought but this sketchy information does not indicate that the grey seals feed chiefly on salmon. Moreover, the majority of the herd feeds in the Miramichi area only for two to four months of the year.

Of the harbour seals in the area little is known, but they are much fewer and smaller and, judging from food habits generally, unlikely to feed chiefly on salmon either. It thus seems very improbable that seal predation is an important factor limiting the salmon population of the Miramichi.

Control. During the past two years some attempts to kill seals have been made by sporadic hunting with rifles throughout the estuary, with special attention to the times when the large grey seal herd frequents the beaches. Although many have been hit, only ten grey seals have been recovered in this way. For this kill teams from the Station spent about twelve weeks in the area.

The Department's offer of about \$4.00 per day plus bounties to experienced men who would hunt continually and find their own ammunition, gasoline, etc., proved unprofitable. Only one man tried for four days and gave up. Experience unfortunately shows that any persistent or intensive shooting only causes the wary grey seals to leave the area. There seems little prospect of improving very much on the sporadic hunting by local residents encouraged by bounties.

Another possibility is poisoning. Dead grilse containing strychnine capsules have been tied to trap nets by salmon fishermen who believe the technique offers some promise.

Because the trap operated by the Station for salmon tagging (Appendix 74) was the only trap in the river after the season closed, it was subject to greatly increased seal damage, and supplied first-hand experience of the sort of thing with which the fishermen must contend. During all the day-light hours of one week in September the trap was watched by an armed guard, usually in a scow tied to the trap. Attacks on the grilse or salmon in the trap took place under water by several grey seals which would only surface on the opposite side of the river. The attacks continued unabated throughout the week in spite of the guard firing into the water at the seals whenever they hit the net.

An attempt will be made in January and February of 1953 to discover vulnerable pupping groups of grey seals in the Gulf of St. Lawrence and to ascertain the whereabouts of the Miramichi seals at that time of year.

B. A. Mackenzie

Appendix No. 82

MOVEMENTS, FOOD AND COD-WORM INFESTATION OF HARP SEALS  
IN THE GULF OF ST. LAWRENCE

Harp seals are present in large numbers in the Gulf of St. Lawrence each year from about the first week in January until about the first week in June. During the last week in February the pregnant females congregate wherever there is ice suitable for whelping, usually in the mid-Gulf area but during the past

two years near Prince Edward Island, and from then until April are occupied in bearing young, suckling them, and mating. The males apparently haul out on ice near the females shortly after the latter have whelped, and the whereabouts of the immatures at this time is unknown.

Examination of stomachs of adult seals on the ice in the Gulf of St. Lawrence in 1949 and 1952 (about 50 stomachs in all) indicates that in the period between whelping and mating (late February to mid-April) adult harp seals feed little or not at all. Moreover, no cod-worms (Porrocaecum decipiens) were found in their stomachs then. Examination of over 200 stomachs of harp seals of all ages during the southward movement into the Gulf through the Strait of Belle Isle in early January over the past three years indicates both that the seals, though exceedingly fat, are not feeding while moving into the Strait and along the north shore of the Gulf, and that they are not carrying cod-worms.

It seems, therefore, that harp seals are feeding in the Gulf only from about mid-January to late February, and from mid-April until some time in June. Nothing is known about the movements of the seals in the Gulf during these periods except for the following fragments: They stop following the shoreline, on the southward movement through the Strait of Belle Isle, at about Harrington. Presumably they turn southward then and move out into the Gulf of St. Lawrence, but have been reported near shore well up the St. Lawrence River both before the whelping and after the ice has largely moved out of the Gulf in April. They were seen in hundreds off Port Hood, N. S., in early February, 1950, and some, including pregnant females, were taken then by shoremen. They are taken by landsmen again during the month of April off the east coast of Cape Breton Island among loose ice off shore. From about April 20 to May 20 they are caught on set-lines in the Magdalen shallows, usually just before the peak of the herring run there. They have been reported swimming in schools in a northeasterly direction off the northwest shore of Prince Edward Island in early May. During the month of June they move north through the Strait of Belle Isle, being taken in shore nets chiefly at Blanc Sablon.

The finding of mature cod-worms in four stomachs from Port Hood in February, 1950, suggested the importance of harp seals as vectors of cod-worms in the Gulf. As this might be a deciding factor in assessing the prospects for reducing cod-worm incidence by killing off harbour and grey seals, every opportunity has been taken to study the food and cod-worms in harp seals in this region.

The only large sample of stomachs which it has been possible to obtain thus far is a series of 83 from the Magdalen Islands during the seal trawling in April and May, 1952. These were obtained for us through Mr. Paul Montreuil of the Quebec Department of Fisheries, whose assistance and co-operation are gratefully acknowledged.

From the accompanying table it is evident that harp seals at this time of year subsist mainly on herring which concentrate then in spawning schools off the Magdalens. The only

Food items in 81 harp seal stomachs taken off South Beach and Pointe Basse, Magdalen Islands, April 21 - May 16, 1952

<u>Period</u>	<u>Common name</u>	<u>Scientific name</u>	<u>No. of stomachs containing item</u>	<u>% volume</u>	<u>Actual volume</u>
Apr. 21-30 (48 stomachs)	Herring	<u>Clupea harengus</u>	47	76.1	7.1 Imp.gal.
	Flatfish (sp.?)		5	2.7	0.25 " "
	Witch	<u>Glyptocephalus cynoglossus</u>	2	2.7	0.25 " "
	Plaice	<u>Hippoglossoides platessoides</u>	1	1.2	0.125 " "
	Unidentified (not herring)		19	17.3	1.62 " "
	Shrimp	<u>Crago septemspinosus</u>	1*	trace	<u>9.35</u> " "
May 5-16 (33 stomachs)	Herring	<u>Clupea harengus</u>	28	84.7	5.55 " "
	Flatfish (sp.?)		8	7.6	0.5 " "
	Unidentified (not herring)		4	7.7	<u>0.54</u> " " <u>6.59</u> " "

\* from stomach of a pup.

Incidence of round-worms in 81 harp seal stomachs taken off South Beach and Pointe Basse, Magdalen Islands, April 21 - May 16, 1952

<u>Period</u>	<u>Porrocaecum decipiens (%)</u>		<u>Contra-caecum sp. (%)</u>	<u>Total no. worms</u>	<u>Av. no. per stomach</u>	<u>No. examined</u>
	<u>Mature</u>	<u>Immature</u>				
Apr. 21-30 (48 stomachs)	3.7	9.1	87.2	11,370	237	1,632
May 5-16 (33 stomachs)	0.7	11.6	87.7	9,870	300	1,313
Total period (81 stomachs)	2.6	11.0	87.4	21,240	262	2,945

other fishes identified were flatfish, witch and plaice being the only two identifiable species. The stomachs taken in two periods, April 21-30 and May 5-16, are listed separately to show the greater quantities of herring taken in the second period.

Twelve per cent of the round-worms, which averaged 276 per stomach, were Porrocaecum decipiens and only 2.6 per cent were in reproductive condition, the others being immature. The only other round-worm present, Contracecaecum sp., showed a large percentage in the reproductive stage. Infestation with cod-worms, therefore, seems to have been quite recent -- probably within two to three weeks or less of the time of collection of the stomachs.

One would expect that in the second group, collected in May, more cod-worms would have matured than in April but this was not the case. Perhaps the two samples were from schools which had been feeding in different areas.

It is not clear what species of fish contributed the cod-worms, though the worm has been observed in plaice and winter flounder. Presumably the immature cod-worms present eventually mature and produce eggs. It is hoped that stomach collections can be made next June at Blanc Sablon during the northward migration to check on the incidence of mature Porrocaecum at that time, which will be from two to three weeks later than the seals' occurrence at the Magdalens.

It is interesting to note that two stomachs of harbour seals taken at the same time and place as those of harp seals contained no food but herring, but, of 1,230 round-worms contained in the stomachs, 99 per cent were Porrocaecum decipiens, 61 per cent being in the reproductive stage. Assuming, from rough visual estimates and reports, that there are about 5,000 harbour seals in the Gulf of St. Lawrence south of Anticosti Island similarly infested, we can estimate that there are something like 1,800,000 mature cod-worms in these harbour seals at the time in question. Assuming, from aerial photographic estimates, that there are about 300,000 harp seals present in the Gulf in early spring, each carrying about 250 worms of which 2.6 per cent are mature, we can estimate that there are something like 2,000,000 mature cod-worms in harp seals at that time. The effect of harp seals as cod-worm vectors therefore does not appear to be as great in comparison with harbour and grey seals as at first expected when it became known that they carried the worm, especially when it is remembered that the harbour and grey seals are present throughout the year.

It is planned now to obtain as many stomachs as possible from harp seals during their stay in Gulf waters and during the northward movement, to get a clearer picture of food habits and worm incidence throughout the time of their southern sojourn.

H. D. Fisher

Appendix No. 83

AGE DETERMINATION AND SEXUAL MATURITY IN THE HARP SEAL

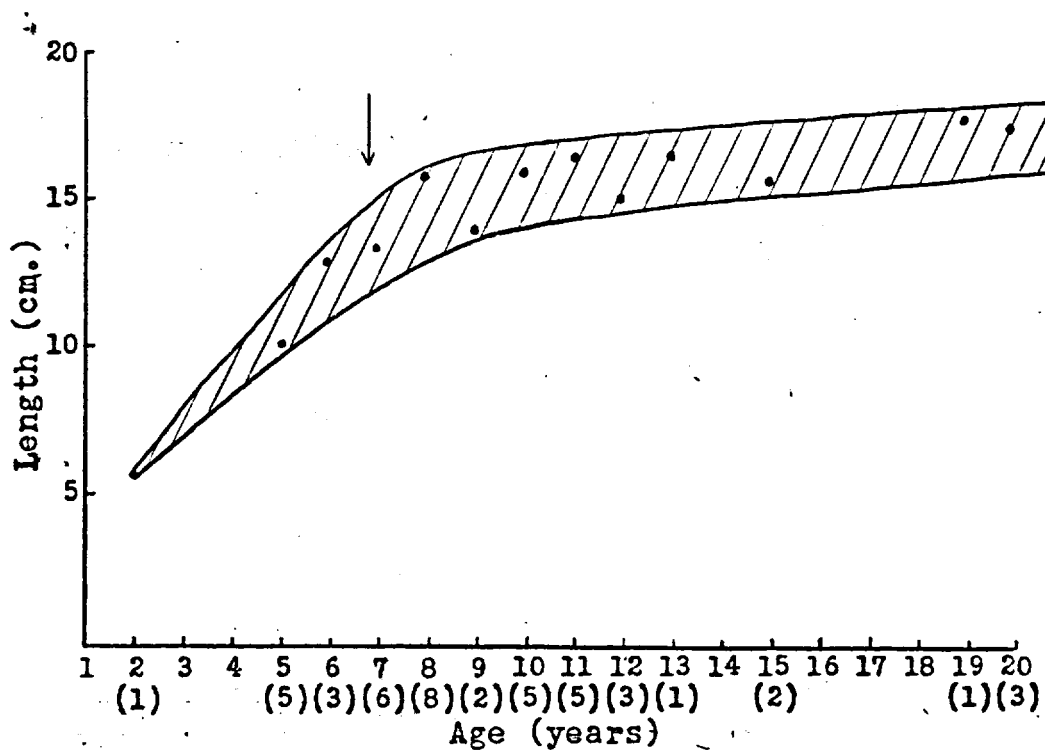
The recent discovery of an accurate method of estimating the age of those mammals which undergo regular seasonal metabolic disturbances (V. B. Scheffer, R. M. Laws), by interpreting rings laid down in the dentine of the teeth, provides the key to detailed knowledge on the reproductive biology, growth and mortality of such mammals. The method has been found to work exceptionally well in the harp seal, through the preparation of ground sections of the root of the canine tooth. Such sections show, on the whole, clear annuli which, from studies of teeth taken at different times of the year, are shown to be annual.

An opportunity of collecting large random samples of teeth and reproductive organs from the population of harp seals exists at shore stations in Quebec Labrador, which net schools of migrating seals chiefly on the way south in winter but to some extent also on the way north in the spring. We have established a sampling station at La Tabatière for the collection of material from approximately 1,000 harp seals taken there each year by netters in late December and early January from schools moving south into the Gulf of St. Lawrence. To date many seals have frozen before the reproductive organs could be taken out, so only the teeth could be collected. This year, through increased assistance and some revision of method, it is hoped to increase the collections of reproductive organs.

Studies of the reproductive organs which have been collected to date, however, do provide some indication of the ages at sexual maturity in both sexes. Male seals possess a baculum, or penis bone, which increases in length and weight with age. The accompanying graph shows the relationship between the age of harp seals and length of the baculum. It reaches almost its full length at about seven to eight years of age, although even after that there apparently is some gradual increase with age. Taking into account also the completeness of formation of the saddle mark on the seal's back and the gross appearance of the testes, sexual maturation appears to take place at six or seven years of age. Histological examination of the testes, now being carried out, should provide a more accurate determination of the age of the male at first maturity.

The corpus luteum (an endocrine gland which forms in the ovary from the ruptured follicle with each pregnancy), while regressing as usual after parturition, persists as a visible scar for a considerable time in the harp seal, as with many other marine mammals. The accompanying table lists corpora lutea counts for 61 pairs of ovaries from harp seals of known age, as determined by tooth sections, and "apparent" ages at sexual maturity calculated by subtracting the number of corpora lutea from the age.

Of a random sample of 70 sexually mature females examined, 20 per cent were not pregnant. This means that the "apparent" age at sexual maturity, which is based on the



Relationship between age and length of baculum. Plotted points are averages for the numbers of bacula in brackets under each age group. Arrow indicates approximate point of sexual maturity.

Corpora lutea counts and deduced ages at sexual maturity from a sample of 61 mature females of known age, La Tabatière, January, 1951-52. Numbers in brackets refer to numbers of specimens examined.

Age	No. c. l.	Apparent*age at sexual maturity	Av. no. c. l.	Average apparent age at sexual maturity
4 (3)	1 1 0**	3 3 4	0.7	3
5 (1)	1	4	1.0	4
6 (6)	3 3 2 1 1 1	3 3 4 5 5 5	1.8	4
7 (7)	4 4 3 3 3 2*** 2	3 3 4 4 4 4 5	3.0	4
8 (9)	5 5 4 4 4 4 3 2 1***	3 3 4 4 4 4 5 6 6	3.6	4
9 (6)	6 6 6 5 5 4	3 3 3 4 4 5	5.3	4
10 (5)	7 6 4 4 3***	3 4 6 6 6	4.8	5

\* Assuming c. l. persist, with pregnancy each year. See text.  
 \*\* Mature ovarian follicles present.  
 \*\*\* Non-pregnant at time of collection.

(continued)

<u>Age</u>	<u>No. c. l.</u>	<u>Apparent* age at sexual maturity</u>	<u>Av. no. c. l.</u>	<u>Average apparent age at sexual maturity</u>
11 (5)	7	4		
	5	6		
	4	7	4.4	6
	3***	7		
	3	8		
12 (8)	9	3		
	7	5		
	5	7	4.8	7
	5	7		
	4	8		
	4	8		
	3	9		
	2	10		
13 (5)	7	6		
	6	7		
	6	7	5.0	8
	3	10		
	3	10		
14 (1)	7	7	7.0	7
15 (1)	7	8	7.0	8
16 (2)	6	10	5.5	10
	5	11		
22 (1)	8***	?	8.0	?
23 (1)	7***	?	7.0	?

\* Assuming c. l. persist, with pregnancy each year. See text.

\*\* mature ovarian follicles present.

\*\*\* Non-pregnant at time of collection.

assumption that each female was pregnant every year, is, on the average, higher than the actual age at maturity.

Theoretically, the number of corpora lutea in the ovaries should increase with age throughout life, but in the table the average number increases to 9 years of age, after which no general increase is evident. Since the oldest scars in ovaries from seals 9 years of age were just barely visible, it seems that they do not usually remain macroscopically visible scars for more than 5 or 6 years, although the records suggest a tendency for them to persist longer as females grow old. This limited life of the scars means that their number in females older than 9 years is of little significance as an indication of age at maturity.

In the sample of 32 pairs of ovaries from animals between 4 and 9 years of age, sexual maturity apparently took place at the following ages:

3 years	-	11	or	34%
4 years	-	12	or	38%
5 years	-	7	or	22%
6 years	-	2	or	6%

A more definite conclusion, however, must await examination of a large series of ovaries from seals which are on the point of maturation.

Pregnant females over 20 years of age were taken east of Newfoundland in 1949 and 1952, so that length of breeding life lasts at least to that age.

The age composition of a sample of 375 harp seals collected at La Tabatière in 1952 has already been reported in Atlantic Biological Station Circular, General Series, No. 20.

Mr. B. A. Mackenzie assisted in the collection and preparation of the material for this report.

H. D. Fisher

Appendix No. 84

#### HARP SEAL MOVEMENTS

The complex seasonal movements of the harp seal, through field observations and tagging of pups on the whelping ice, are gradually revealing the complex seasonal movements of the harp seal (see Appendix No. 82). Since 1949 Norwegian and Canadian workers have tagged over 950 pups on the "Front" (east of Newfoundland) and in the Gulf of St. Lawrence. While many were killed almost immediately by sealers, it is expected that the numbers of tagged seals in the population is being built up, and that returns will contribute information on (1) extent of intermingling between Gulf and Front breeding populations, (2) accuracy of age estimation from dental annuli, and (3) migration routes and speeds.

About 15 returns have been made thus far, from seals taken months after tagging, some after considerable distances had been travelled. All of the returns from the summer range in the Arctic (9 or 10), to the writer's knowledge, have come from Greenland, along whose west coast is much shore-based hunting. Four of the Greenland returns have been of Canadian tags. Three of these, from pups tagged in the Gulf of St. Lawrence, were reported upon in last year's Annual Report. The fourth was tagged in March, 1952, on whelping ice on the Front and was recovered on June 17, 1952, at Narssalik, on the southwest coast of Greenland. On the same date in 1950 a pup tagged in the Gulf was recovered in the same area. It is thus evident that pups born on the ice in March are in Greenland waters by the time they are three months old. They appear to move ahead of the older seals, which lag behind during moulting.

A return from a tagged pup taken on the Arctic Circle in Greenland in January, 1951, suggests that some seals stay in the Arctic in their first winter. The small numbers of yearlings in samples taken in the southern breeding areas for age determination lend weight to this theory, and Dr. Paul Hansen, biologist for the Greenland Administration, reports that young harps are indeed seen in open water in Greenland from time to time throughout the winter, though not usually taken because of difficulty of access.

There have been several returns from Greenland from 95 harp seals tagged as pups on the Front in 1949 with Norwegian tags by Mr. Per Høst. It is thus obvious that a large part of the young of the year swim to Greenland waters on the northward movement. It is also known that many harp seals are in Canadian Eastern Arctic waters in the summer, but no returns of tags have been made from this area, probably because the harp seal is not heavily hunted there. It is hoped that collecting planned by the Board's Eastern Arctic Investigations and by the Danish Greenland Administration will provide knowledge of the age compositions of the herds in these respective areas.

In addition to the Greenland returns there have been half a dozen from pups taken two to six weeks after tagging. These have all shown an initial movement of the pups south into relatively open waters before the northward swim to the Arctic. Pups tagged in the Strait of Belle Isle have been recovered off the Williamsport area, Newfoundland, and pups tagged in the Gulf of St. Lawrence have been recovered on the Cape Breton coast in Cabot Strait.

No seals tagged in the Gulf have yet been recovered on the Front, or vice versa. There is thus no definite evidence as yet of intermingling between the two whelping populations. One tag return, it might be noted, came from off Neil's Harbour, N. S., in April, 1952, from a seal tagged two years previously about 50 miles from this spot, in a Gulf whelping patch.

In our studies of the reproductive biology and age composition of northwest Atlantic harp seals we have been depending largely upon material obtained from the seal netting at La Tabatière, Quebec Labrador, which takes random samples of southward migrating harp seals moving into the Gulf of St. Lawrence.

There is no comparable source of material for those harps forming the population on the Front. It is important to know the degree of distinctness of the stocks in the two areas, and thus whether age compositions obtained in the Gulf are applicable to the Front population. The two areas have been subjected to different hunting intensities, and thus the respective populations may have different age compositions. This problem imparts considerable priority to tagging in the field work, and during the coming sealing season tagging will be continued on as large a scale as is feasible both on the Front and in the Gulf.

H. D. Fisher

Appendix No. 85

STOMACH CONTENTS OF HARBOUR PORPOISES (PHOCAENA PHOCAENA)  
IN THE L'ETETE AREA, BAY OF FUNDY

Each year in June large numbers of harbour porpoises move into the waters just outside of the entrances to Passamaquoddy Bay. Their numbers, and those of several of the larger whales, appear to be at a peak in August and September. During November the porpoises disappear until the following June. Late in June, according to Mr. Vinton Leavitt of Back Bay, N. B., who has hunted porpoises intensively for several years, the calves begin to be born. Calving takes place until early September apparently, being at a peak late in June and early July. Mating takes place mainly during the latter half of August and early September.

While it is not possible to estimate the numbers of porpoises present, on occasions during the past three summers the area from just below Saint John, N. B., to Grand Manan has been populated so thickly that dozens have been visible from a boat at once in any direction.

From August 13 to September 30, 1952, arrangements were made with Mr. Vinton Leavitt to examine porpoises obtained by him in the L'Etete area for mink food. This was done chiefly to determine whether or not these mammals carry the cod-worm, Porrocaecum decipiens, since this parasite has been reported from porpoises in Europe. At the same time, data on their food habits and, since this animal has not been intensively studied, detailed measurements and reproductive data were collected. Thirty-seven specimens were examined.

The accompanying table indicates a considerable variety in the food items contained in these specimens. As in the case of the harbour seals of this general area, herring is the principal item of diet. Squid, hake and pollack were also common. The unidentified fish in the table are considered to be probably pollack, haddock and hake, since no other otoliths, except a few looking like cod otoliths, were found in the stomach contents.

No mature nematodes were found in any of the stomachs. There were only a few dozen unidentifiable larval worms and

Stomach contents of 32 harbour porpoises\*  
from the L'Etete area, N. B., August 13 - September 30, 1952

<u>Common name</u>	<u>Scientific name</u>	<u>No. of stomachs containing item</u>	<u>% of Volume</u>	<u>Actual volume (qts.)</u>
Herring	<u>Clupea harengus</u>	19	31.9	4.25
Squid	<u>Loligo</u>	16	12.0	1.6
Hake	<u>Urophysis tenuis</u>	6	11.9	1.5
Pollack	<u>Polachius virens</u>	7	7.5	1.0
Seaweed		1	3.7	0.5
Haddock	<u>Melanogrammus aeglefinus</u>	4	1.9	0.25
Eggs of hagfish		1	0.9	0.125
Gadidae		1	0.2	trace
Unidentified fishes		14	30.0	4.1

\* Calves not included (contained milk only, or were empty).

three other immature worms, of which two were Porrocaecum deci-  
piens and the third, Anisakis sp. There is thus no evidence that,  
during the summer and fall at any rate, harbour porpoises in this  
area are important vectors of cod-worms. It is hoped that sto-  
machs can be obtained from other areas (e.g. the Miramichi  
estuary) and at other times to get a more complete picture of  
food habits and worm incidence.

H. D. Fisher

Appendix No. 86

THE BIOLOGY AND MORPHOLOGY OF EEL-GRASS

Studies of the growth and density of eel-grass made  
during the previous four seasons were extended over this summer.  
The general condition, health, coverage and density of growth  
of the plants in our area seemed as in previous years. Seedlings  
were particularly abundant this year. Streaked and blackened  
leaves, appearing as the season advanced and the water warmed up,  
indicated that the disease is still present. Towards the end of  
the hot period of the summer most of the plants have shed their  
older leaves. In some areas of lower salinity the leaves had a  
thinner, more fragile and slightly unhealthy appearance, giving  
a general impression of poorer health. A case of "wasting" and  
death of the plants was investigated at Tignish Pond, but it  
appeared to be the normally poorer late summer condition.  
However, the reason why plants seemed to have died in groups at  
an earlier period could not be determined.

Studies of the growth of individual plants were made  
by tagging each at an internode with a celluloid strip marked  
with India Ink and tied on with nylon fishing line. The growth

of individual leaves, internodes and branches was followed by measuring them from that place on from time to time through the summer. The measurements were made under water with a millimetre rule except for the final set which was made with rule and calipers in the laboratory. An "Aqua-Lung" apparatus and a "Frogman Suit" arrived too late for most of the work, but were tested and found useful in the cold water of mid-September.

The growth measurements were made on: (a) plants near the shoreward limit of eel-grass, but never exposed at low tide, (b) plants in an intermediate depth, (c) plants near the deepest extension of the eel-grass, (d) plants from there, transplanted in mud in pots to near the shoreward limit, (e) plants transplanted from the deeper edge into deep water where none grow, (f) plants from the shoreward edge transplanted to the deeper edge, (g) plants under a shade made of tarred laths set at intervals to allow only one-quarter downward penetration of the incident sunlight, and (h) similar plants under a similar shade with the laths set to allow penetration of one-half with incident sunlight.

Most of the plants under one-quarter sunlight died before the end of August as did those transplanted into deep water where normally none are found. The others survived the conditions under which they were growing and were preserved for study to see if there is a variation in their internal anatomy which might be correlated with the variation in environment. Additional plants from these and other environmental areas were also preserved. It was possible to show by these actual measurements that the growth of the plants continued all summer long, in contrast to statements which have been made that they cease to grow in the period when the temperature rises above 20° C. An anatomical study of the development of the plant is being made this winter.

Seedlings were found to be very susceptible to death by exposure at low tide and consequent drying during hot sunny periods. The growth of a number of seedlings being studied was terminated suddenly by their death following exposure during the low "spring" tides of early July when low water coincided with the hours of strongest sunlight and highest temperature. Older plants are more resistant because the initial growing area is protected by older leaves which may die and be shed without much affecting the subsequent life of the plant. Experimental single exposures of older plants showed that some at least could stand exposure to drying in the full midsummer sun for a period of an hour and one half. The susceptibility of seedlings to drying is probably the first factor acting to limit the shoreward extension of this plant. This may be more marked in an area such as Malpeque Bay where a single longer period of low water occurs at "spring" (really apogean) tides.

A. R. A. Taylor

Appendix No. 87

EEL-GRASS AND OYSTER GROWTH

The experiment started in 1949 to find whether oyster growth is affected by eel-grass was continued this year, with the same oysters being distributed in the four groups as in 1951, instead of randomizing them as had been done in the past. They were set out as shown in the table. The mean absolute values are given for this year's increase in weight and length only, but relative mean increase in weight for each group (referred to the year's mean increase in weight for the group on the bottom in eel-grass taken as 1.0) is given for all years.

Position of oysters	Weight incr.* (no.) Spring wt* 1952	Length* incr. 1952	Relative mean increase in weight (Number of individuals)			
			1949	1950	1951	1952
On bottom						
A-in eel-grass	$\frac{8.25 \text{ gm.}}{(71)50.26 \text{ gm.}}$	4.8 mm.	$\frac{1.0}{(91)}$	$\frac{1.0}{(84)}$	$\frac{1.0}{(78)}$	$\frac{1.0}{(71)}$
B-in clear	$\frac{10.57}{(70)55.60}$	7.7	$\frac{1.6}{(79)}$	$\frac{0.94}{(87)}$	$\frac{1.3}{(72)}$	$\frac{1.3}{(70)}$
On stakes (3-4" above the bottom)						
C-in eel-grass	$\frac{13.55}{(73)55.07}$	5.5	$\frac{1.7}{(90)}$	$\frac{0.94}{(79)}$	$\frac{1.6}{(77)}$	$\frac{1.6}{(73)}$
D-in clear	$\frac{15.62}{(69)56.60}$	9.2	$\frac{1.9}{(81)}$	$\frac{1.1}{(80)}$	$\frac{1.5}{(76)}$	$\frac{1.9}{(69)}$
Duration of experiments: start			3.VI	12.VI	22.V	7.VI
finish			10.IX	23.VIII	4.IX	4.IX

\* Weights and lengths are mean values.

In the year 1950 the mean increase in weight was of the same order of magnitude for each group. Nineteen-fifty was widely held to be a bad year for oyster growth. In the three remaining years of the experiment, 1949, 1951 and 1952, the mean increase in weight of those oysters on bottom free from eel-grass was at least 30% greater than that of oysters grown on the bottom in a dense population of eel-grass. Similarly, growth on stakes was better than growth on the bottom in all years except 1950.

These results suggest that, for most years, growth of oysters expressed as weight increase is less amongst eel-grass plants than on bottom clear of eel-grass. This can be important if continued for several years. Growth in length is more variable, and is not dependable for study of small groups of oysters. In view of the better growth clear of eel-grass and above the bottom, it is possible that the effect of eel-grass which retards oyster growth is its reduction of the circulation of

water over the oysters -- possibly providing less food, reducing the oxygen concentration at certain times, and increasing the amount and stability of sediment.

A. R. A. Taylor

Appendix No. 88

THE EFFECTIVENESS OF METHODS USED TO CONTROL EEL-GRASS  
ON OYSTER GROUND

The methods applied and their original effects. One of the basic methods of control of eel-grass on oyster ground which seemed promising was covering the eel-grass by some method to kill the plants and prevent their regrowth through the covering. This was done successfully with concrete slabs, sand on top of tarpaper, gravel, and clam and oyster shells.

Another method was the use of a patented chemical, Benoclor, a mixture of chlorinated benzenes known to kill submersed aquatics. The problem in applying such a chemical in the sea is to prevent excess dilution and dispersion. Our most successful applications were those in which the Benoclor-3 was mixed thoroughly with sand and spread evenly over the area to be treated at a concentration of 1 - 1.1 gallons of Benoclor-3 per 10 pails of sand per 1000 square feet. The Benoclor, oily and denser than water, adheres to the sand and sinks to the bottom with it. In these treatments it came in contact with the growing region at the base of each eel-grass shoot and resulted in the death of this essential part of the plant and thus finally of the whole plant. The treatment was effective only if at least the minimum lethal concentration was maintained consistently, and this involved careful spreading to gain even coverage. It can be used only if there is no strong current over the area, especially at the time of spreading, since mass water movements reduce the amount of Benoclor which can reach the bottom to be treated and cause uneven coverage. Where the above concentration was maintained over an area a complete kill resulted. There was evidence in some cases that enough Benoclor persisted the following year to prevent the colonization by new seedlings at that time.

The third method, which has been used extensively by Mr. S. Andrews at Shippegan, whenever feasible, is the removal of eel-grass by power dragging. He practises this as an improvement measure, cleaning old oyster beds of eel-grass and other unwanted material on the bottom as time permits. It does not remove all of the plants, and therefore does not result in a completely clear bottom, but it does reduce the concentration of plants and completely clears patches, making the subsequent fishing of oysters placed on the lease so treated much easier.

The recolonization of treated areas by eel-grass, and the duration of the control. Since eel-grass reproduces both vegetatively and by seed, invasion and recolonization of denuded areas can be by both methods if there are plants nearby. A

gradual encroachment on the clear area of a foot or more each year will occur through the growth of rhizomes branching from the plants along the edge of the cleared area, or from any left within the area. Each branch produces an upright shoot equivalent to one more plant, and will in turn form additional branches. New seed carried to the area may germinate and produce vigorous young seedlings. In most cases, those seedlings which survive will grow into plants 15 - 25 cm. tall and with two to four branch shoots by the autumn of their first year of growth.

Estimates of the number of new plants colonizing three cleared areas were made by counting all present in representative quadrats. On the tarpaper-and-sand-covered area, set out in 1950, some plants established themselves the season following treatment, and some again this year. All the plants encountered were pulled up over an area 6 metres by 23 metres (approx.) along the east edge of the plot; there were 234 seedlings averaging one branch each, and 112 older plants with a total of 163 branches. This gave an average of approximately 5 upright shoots per square metre (August 7, 1952).

In August of 1950 an area on a private lease was treated with Benoclor as outlined, and became completely clear of eel-grass. A few young plants were noted last year; this August a count was made of plants in 10 one-metre-square quadrats taken at random by dropping a wire square from the surface of the water and then counting the plants where it fell. They averaged about 20 per square metre, the range being from 4 to 34; the lower counts occurred nearer the centre of the plot. The density outside the area was 214 plants per square metre (the average of 32 counts of .04 square-metre plots). The area still appears clear from the surface of the water since the plants are small and relatively insignificant. Fishing the oysters from this plot is still easy. In an area treated similarly with Benoclor in 1951 the number of plants was 9 per square metre determined as above at the beginning of September this year (an average of 8 one-metre-square quadrats; range 0 - 22 per square metre).

It is obvious that over a short period of years a recolonization of the cleared areas with sandy or softer bottoms will occur. Numbers of plants of the order mentioned above in the cleared areas are insignificant as far as fishing for oysters is concerned or for changing the habitat in all except one respect -- they serve as centres for increase in numbers of eel-grass plants. The spread inward from the edges is less noticeable, but is steady and more complete in its coverage of the area involved. The year an area has been successfully treated, it appears clear; the next it may appear clear from the surface of the water but may have some seedlings. In the second year following treatment young plant groups may be noticed but they are not conspicuous. By the fourth or fifth year a light growth will probably have spread over a great part of the area, and in succeeding years full coverage will probably be completed if vigorous cultivation of the bottom, as in yearly fishing, has not gone on removing and loosening the newly established young plants.

In the case of shell or gravel covering, the establishment of seedlings is much more difficult and the areas where this treatment was given show few seedlings. Encroachment from the edges is also slower because of difficulty in rooting. The gravel- and shell-covered areas are lasting well. It is expected that the concrete slabs will remain clear so long as no appreciable layer of silt forms on top of them. The gravel, clamshell and concrete slab plots in Basse Bay at Shippegan are in good condition after four years (five summers) and perhaps half of the oysters placed on them in 1948 will be harvested this year (they are of the 1945, 1946 and 1947 year classes). They have grown well, are of good size and shape and have remained in place in spite of storms and ice.

A. R. A. Taylor

## Appendix No. 89

### NYLON DRIFT-NET

In recent years the extensive use of nylon, as an alternative material to a vegetable fibre twine, has caused some debate as to whether or not the additional cost is repaid by a larger catch and longer life. It is known that nylon rope or twine operates with a minimum of internal friction and surface abrasion. This property, of course, is not an advantage where mesh knots are concerned and unless the net has been specially heat-treated it tends to lose its shape through slippage and distortion of meshes.

Very little experimental work with nylon has been carried out in salt water. According to reports from the Great Lake fishermen, nylon nets yield many more fish than cotton nets of the same size and mesh.

On August 4, 1952, a fully-rigged nylon herring net of 2-inch mesh, 37 yards long and  $6\frac{1}{2}$  fathoms deep, was tied into the centre of a string of ten cotton nets of the same mesh and dimensions. Although the nylon twine was of the same diameter, tests proved that it was about five times stronger, with an average mesh strength of 22 lb. as compared with  $4\frac{1}{2}$  lb. for the cotton. The net was not specially heat-treated.

Seven sets did not show any consistent superiority of the nylon net in catching herring. On August 4 four cotton nets at one end of the string caught 75 to 100 lb. per net, the nylon net in the middle 75 lb., and the six cotton nets at the other end hardly any (1 lb. per net). On August 6 five cotton nets on one end caught 50 lb. per net, the nylon net 35 lb. and five cotton nets on the other end 10 lb. per net. On August 8 five cotton nets on one end caught 13 lb. per net, the nylon net 6 lb. and the five cotton nets on the other end 1 lb. per net. On August 12 five cotton nets on one end averaged 225 lb. per net, the nylon net caught 300 lb. and the five cotton nets on the other end averaged 150 lb. On August 13, 14 and 19 herring catches were evenly distributed throughout the eleven nets and averaged 200 lb., 20 lb. and 375 lb.

respectively.

Observations revealed that during the first set, mesh slippage occurred in the extreme end of the nylon net and this slippage continued to increase with use. The original 2" mesh size was extremely altered, ranging from  $1\frac{1}{2}$ " to more than 3" in some cases.

The herring appeared to mesh more securely and somewhat greater difficulty was experienced in picking or shaking the fish from the nylon net than from the cotton.

This preliminary and inconclusive trial of the use of this net was brought to a close by the loss of the nylon along with 20 cotton nets on August 20. Apparently an excessive catch made the nets sink.

Observations on the boat were made by E. G. Sollows.

C. E. Petite

#### Appendix No. 90

#### AN INSTRUMENT TO MEASURE THE TENSION IN TOWING WARPS

The otter trawl is one of the most important means of catching fish, but little study has been made of the pull involved in towing these nets.

A compression helical spring dynamometer was designed to measure the tension in the towing warps. It consisted of 19 coils of  $\frac{3}{4}$ " spring steel coiled at 3" diameter inside a 4" cast iron pipe. These specifications slightly modified gave an accurate deflection of 1" per 1,000 lb. and would indicate a maximum tensile force of 3,000 lb.

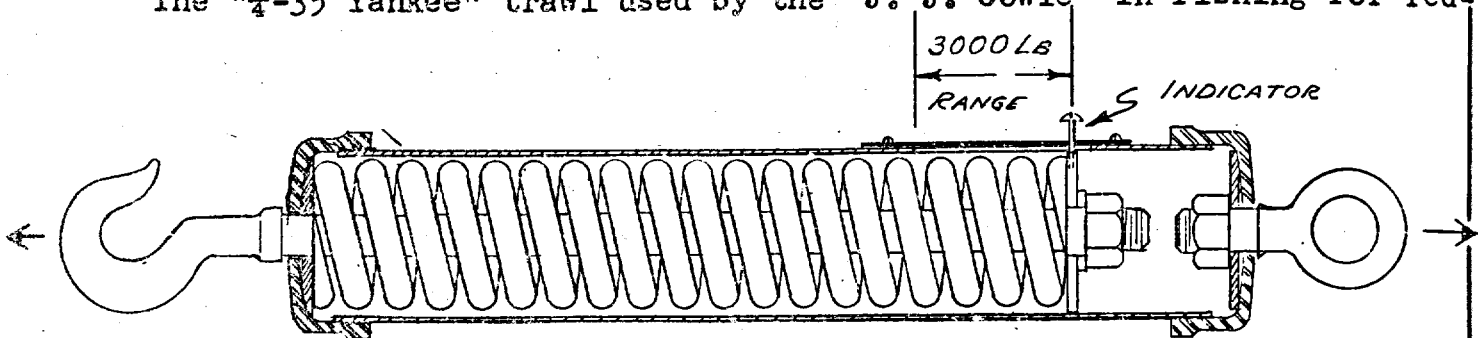
The huge "doors" weighing up to 1,000 lb. each, used to spread open the mouth of the net, along with the weight and resistance of the net itself, create a strong pull. The doors are hung in such a manner as to have a kite-like action and to tend to move apart on being towed. The ground rope of the net between the doors assumes the shape of a catenary curve and the forces involved are in equilibrium. It is common practice to have the towing warp length at a ratio of 3:1 to the depth. This ratio enables the doors to ride and bounce along the bottom.

Tests were made with two trawls -- a 35-foot "flounder drag" towed by M/B "Mallotus" and a " $\frac{3}{4}$ -35 Yankee" trawl towed by the M/V "J. J. Cowie".

The flounder drag had 200-pound doors and 35-foot foot rope. The 55-foot "Mallotus" has a 106 h.p. Cummins high-speed diesel engine. It was found that the tension developed in the towing warps increased noticeably with engine revolutions. At normal towing speed of 2 or  $2\frac{1}{2}$  miles per hour (800 to 900 r.p.m.) there was a tensile force of between 200 lb.-300 lb. per

warp and with the engine at full revolution (1400 r.p.m.) the force was 500 lb. These forces naturally fluctuated because of the rough, uneven sea bottom but it can safely be said that at normal towing speed the average force was about 250 lb. per warp with that particular net and doors. There was no increase in force when the net contained fish.

The "4-35 Yankee" trawl used by the "J. J. Cowie" in fishing for red-



—= COMPRESSION SPRING DYNAMOMETER =—

fish had 425-pound doors and a 51-foot foot rope. The 68-foot "J. J. Cowie" has a 100 h.p. Caterpillar medium-speed diesel engine. At normal towing speed with about 450 r.p.m. there was a tensile force of 700 to 800 lb. per warp, and with the engine at full revolution (about 900 r.p.m.) the maximum force registered was 1,000 lb. ees

It is planned to follow up these preliminary tests with observations on a great variety of nets and other towed gear. It is hoped that this work will throw light on the pulls needed to operate gear properly and on the performance of various boats' engines and propellers in delivering this pull.

C. E. Petite

Appendix No. 91

#### SUCCESSFUL LONG-DISTANCE TRANSPORT OF LIVE STICKLEBACKS

In the spring of 1952 live four-spine sticklebacks (Apeltes quadracus) were shipped successfully via railway express and ocean freighter from this Station to Leiden University in Holland to be used in a comparative behaviour study of the members of the stickleback family including the European species Gasterosteus aculeatus, Pygosteus pungitius and Spinachia vulgaris by Mr. J. van Iersel of the Zoologisch Laboratorium.

Seventy-five Apeltes were seined at the head of Birch Cove near St. Andrews on April 24 and 25 and held in brackish water at 13°C. On April 29, the fish were divided equally among three 5-gallon paraffin-lined wooden tubs each of which contained about 2 gallons of 3 parts fresh to 1 part salt water. A 5" bung in each tub was covered with metal screening to allow for renewal of the oxygen supply and to keep out foreign objects. The fish travelled via express refrigerator car to Montreal where they were held through the kindness of Dr. Dunbar at McGill University at 7°C. until May 7 when they were placed aboard an Orange Line freighter in the care of the First Officer with instructions to keep them in a cool place, remove casualties and change the water every three days.

Four fish died between April 29 and May 7, while only one died during the 14-day voyage from Montreal to Rotterdam.

The freighter arrived at Rotterdam on May 20 and the fish were taken at once to the laboratory at Leiden University. Mr. van Iersel reported that:

"The fishes arrived in a very healthy and lively state. Of course they were thin but after feeding with Daphnias this was straightened out quickly. On the moment (June 25) we keep the fishes partly in fresh, partly in salt water. In both they do very well. The males started very quickly with building behaviour and females became pregnant."

On June 7 there were seven fertilized clutches and by June 26 young were developing rapidly in both fresh and brackish water and gave promise of a good stock for interesting experiments in 1953.

The experiment was a marked success judging from the low mortality and completely normal behaviour of the sticklebacks after long-distance transport over a period of almost a month without food. Such a success, even though made with the tolerant stickleback species, adds to our knowledge of long-distance transport and should encourage further shipments and research of a comparative nature with other and less tolerant species of fishes.

L. R. Day

#### Appendix No. 92

#### UNUSUAL MARINE SPECIES ON THE ATLANTIC COAST IN 1952

Unusual species of fish and other animals which have been identified at the Atlantic Biological Station, or which have been reliably reported, in 1952 include:

#### Invertebrates

#### Nereis succinea (Leuckart).

Specimens were dipped in Miramichi Bay, N. B., on July 29 when a fisherman saw a boiling mass of these worms at the surface. Sent in by Mr. R. A. McKenzie and identified by Mrs. Edith Berkeley.

#### Spissula polynyma Stimpson.

Three specimens were taken in deep water at Grand Manan this summer. Dr. J. C. Medcof reports it as rare.

#### Mya truncata truncata L. Clam

While small numbers of this species have been taken from time to time, as, for example, a single specimen at the Lepreau Ledges in July, it is considered unusual that about 100 specimens should have been found this summer on the clam flats at Grand Manan. Its taste and the tough, sheath-covered siphons make it unpopular as an article of food.

Carcinides maenas (L.). Green Crab.

This animal was reported as new to Canada in 1951. It has been seen again in 1952 in Passamaquoddy Bay but there is no evidence of it having extended farther up the Bay of Fundy. Extensive collecting on the Lepreau Ledges did not locate any specimens there.

Fishes

Cetorhinus maximus Gunner. Basking Shark.

A specimen, approximately 14 feet long, was identified by the Fishery Inspector at Carron Point, East Bathurst, N. B., in late August. Reported by Mr. J. S. MacPhail.

Etrumeus sadina (Mitchill). Round Herring.

This species was frequently seen during late August and early September from a number of points in Passamaquoddy Bay. It was reported as being abundant on the Maine coast. It was last reported in our waters in 1937 when moderate catches were made at Campobello and Grand Manan.

Argentina silus Ascanius. Argentine or Herring Smelt.

Two specimens, about 35 to 37 cm. long, and partially digested pieces of others were taken from the stomachs of two swordfish, which were harpooned this summer in the Brown's-George's Bank area. (See Appendix 54).

Lampadena sp. (?). Lantern-fish.

Two specimens, tentatively identified as this species, were taken from the stomach of a swordfish which was harpooned this summer in the Brown's-George's Bank area. (See Appendix 54).

Hippocampus hudsonius DeKay. Sea Horse.

Two specimens were obtained by L. R. Day in St. Margaret Bay, N. S., in September.

Fistularia tabacaria L. Trumpetfish.

One specimen was taken in St. Mary Bay, N. S., in September. Length 44 cm. to tip of caudal fin.

Pneumatophorus grex (Mitchill). Chub Mackerel.

Two specimens, about 22 cm. long. were taken by L. R. Day in St. Margaret Bay, N. S., in September.

Sarda sarda (Bloch). Common Bonito.

Taken in unprecedented numbers in trap-nets in St. Margaret Bay, N. S., in September. Length 35 to 39.5 cm.

Vomer setapinnis Mitchill. Moonfish.

A specimen, 5 cm. long, was taken by L. R. Day in St. Margaret Bay, N. S., in September.

Pomatomus saltatrix L. Bluefish.

Several specimens, from 13 to 17 cm. long, were taken by L. R. Day in St. Margaret Bay, N. S., in September.

Aspidophoroides monoptygius Bloch. Alligatorfish.

A juvenile specimen, 23 mm. long, was taken in a surface tow about 5 miles off Richibucto Head, N. B., on June 18. The pectoral fins were long and black tipped, presumably juvenile characters.

Remora brachyptera Lowe. Swordfish Sucker.

A specimen, about 12 cm. long, was taken from a swordfish which was harpooned in the Brown's-George's Bank area during the summer.

Several other finds were reported but the specimens have not arrived at the Station for checking. Pending further examination they are listed as follows:

A Moray eel, Halifax Harbour. Reported by Mr. G. Sullivan.

A shark sucker (probably Remora remora L.), off Nova Scotia. Reported by Mr. M. Fraser.

An escolar (Ruvettus pretiosus Cocco), off Nova Scotia. Reported by Dr. W. J. Dyer.

A dolphin (Coryphaena hippurus L.), off Nova Scotia. Reported by Dr. W. J. Dyer.

Mammal

Beluga or White Whale.

A specimen, weighing 800 lb. or more, was killed in a weir at Maces Bay, N. B., on June 11. It was reported, with photograph, in the Saint John "Telegraph-Journal" of the following day. Dr. V. D. Vladykov confirmed the identification from

the photograph.

Correction to Appendix 81, 1951 Report

In the above Annual Report a flying fish was recorded doubtfully as Exocoetus volitans. After the Report was issued the specimen was obtained and proved to be another species -- Cypselurus furcatus (Mitchill). The identification was made by Dr. C. M. Breder.

L. R. Day  
A. H. Leim

Appendix No. 93

ANNUAL REPORT, ATLANTIC OCEANOGRAPHIC GROUP\*

Introduction

1. The Atlantic Oceanographic Group, under the Canadian Joint Committee on Oceanography, is responsible for the furthering of oceanographic activities on the Atlantic coast. To this end, the Group carries out a program involving projects which meet the requirements of the organizations represented on the Joint Committee. In addition, co-operation with other organizations interested in the problems of the sea is encouraged, resulting in co-operative investigations in waters of common interest. In particular, the Group attempts to meet the requirements of the Fisheries Research Board and the Royal Canadian Navy.

2. The Fisheries Research Board, involving the Atlantic Biological Station, the Newfoundland Fisheries Research Station and the Arctic Fisheries Investigation, is interested in the general nature of the waters in the fishing areas, the variations that occur, and the fundamentals of circulation and of other large-scale phenomena which may be related to the actual fishery problems being investigated. While the fishery biologists are able to give particular attention to the waters of their immediate problem, the Group attempts, in the main, to present the overall picture, and to assist the fishery biologists in any of their special requirements.

3. The special needs of the Royal Canadian Navy in the field of oceanography are met chiefly through the activities of the Naval Research Establishment of the Defence Research Board of Canada. The Atlantic Oceanographic Group has the responsibility of fulfilling Naval requirements in the field of general oceanography, for here too the overall picture of the physical and chemical nature of the waters is required, and the

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\* Slightly abbreviated and re-arranged by the Director

changes that occur both on a time and space basis are of particular concern. Specialized problems arise too in limited areas, which are met by investigations that are generally carried out on a co-operative basis between the Naval Research Establishment and the Group.

4. It is obvious that to meet the above requirements, observations at sea over extensive areas are required. In addition, fundamental studies are involved to give substance to the observations.

5. The Canadian Hydrographic Service, one of the organizations represented on the Joint Committee, has a very extensive program of charting and current work on the Atlantic coast, involving six large and several smaller ships in 1952. In addition, on a co-operative basis with the Atlantic Oceanographic Group, the Service carries out an extensive program of oceanographic observations in the areas of interest to their main projects.

6. At the Atlantic Biological Station, a very extensive library of oceanographic observations is being maintained which is in active use by interested organizations. Copies of all data cards are forwarded as well to the Woods Hole Oceanographic Institution and the U. S. Hydrographic Service, which organizations supplement our files with data collected by them in waters of common interest.

7. The International Ice Patrol, maintained by the United States Coast Guard on behalf of nations bordering on the North Atlantic, gives particular attention to the waters of the Labrador and Greenland Seas in attempts to deal with the fundamentals of iceberg distribution in the North Atlantic Sea Lanes. These observations, and subsequent analyses, are of particular interest to the studies of the waters of the Canadian Atlantic Coast, which are so greatly influenced by waters of the Labrador Current.

8. For the past four summers Commander Nutt, of Dartmouth College, has taken the schooner "Blue Dolphin" up the coast of Labrador to make investigations in marine biology and in physical oceanography. The Labrador coastal waters from the Strait of Belle Isle to Hudson Strait have been covered in a broad program of oceanographical investigation, while particular attention has been given to the Hamilton Inlet - Lake Melville region.

9. French, Danish and Portuguese "Mother Ships" of fishing fleets, which operate on the Grand Banks and Greenland West Coast, carry out a considerable program of routine observations on water conditions in these areas, sometimes supplemented by extensive cruises over the Grand Banks, in the Gulf of St. Lawrence, and across Davis Straits.

10. During 1951 the Quebec Department of Fisheries established the Marine Biological Station at Grand River, P. Q., as well as two field stations, one in the Magdalen Islands, and the other on the North Shore of the Gulf of St. Lawrence. Two boats and the necessary oceanographic equipment are available to

these stations for investigations in the northern portion of the Gulf of St. Lawrence. A program of oceanographic investigations has been undertaken during the past year. Close co-operation with the Atlantic Oceanographic Group has been assured.

11. It follows from the foregoing that the investigation of Atlantic Coast waters is being carried forward on a large scale by several agencies and nations. In some of these investigations, there is close co-ordination; in others, an exchange of reports, publications and data contribute to the overall requirements of more intimate knowledge of the waters of the Western North Atlantic.

12. The International Commission for the Northwest Atlantic Fisheries has given consideration to the oceanographic requirements for fisheries investigations on an international basis. Under the plans now being considered, it is expected that all countries participating in the fishery will contribute to a co-ordinated scheme of oceanographic observations.

### Personnel

13. 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 (May 1 - October 1; (on leave of absence remainder of year)
Mr. J. A. Sullivan	Assistant Technician III
Mr. G. B. Taylor	Assistant Technician II (from Sept. 14)
Mr. J. H. Hull	Assistant Technician II (from Oct. 6)
Mr. L. H. Brownrigg	Assistant Technician I (resigned Aug. 7)
Mr. C. C. Cunningham	Assistant Technician I
Miss M. M. Meating	Stenographer 2A
Prof. D. G. MacGregor	Seasonal Investigator (June 10 - Sept. 13)
Miss J. E. Johnston	Seasonal Technician (May 28 - Sept. 20)

14. Mr. R. W. Trites is on leave doing graduate work at the Oceanographic Institute of the University of British Columbia, where he qualified for a Master of Arts degree during the past year. He returned to full-time status for the summer months, to work on an oceanographical problem of the Pacific Oceanographic Group.

15. Mr. L. H. Brownrigg resigned as of August 7.

16. Prof. D. G. MacGregor of Mount Allison University was associated, in his work on correlations between sea and air, and general long-term trends in water conditions, with Mr. H. J. McLellan.

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\* Member of Atlantic Biological Station staff working with the Group under instruction from the Director.

17. Dr. A. G. Huntsman of the Fisheries Research Board was associated with the Group in the preparation of a bulletin on the oceanography of the Strait of Belle Isle.

18. Miss J. Towers of the Naval Research Establishment spent several weeks abstracting data from the Group's files for use in a Naval Research project.

19. Mr. J. A. Shand of the Pacific Naval Laboratories spent a month with the Group on studies relating to sound transmission in the sea.

20. Mr. J. J. Pfeifer of the U. S. Hydrographic Office spent several days in St. Andrews arranging for the exchange of oceanographic data between the Atlantic Oceanographic Group and the Hydrographic Office. Our complete files have now been incorporated in the punch card system of the Hydrographic Office.

21. Mr. R. Raymond of the Marine Biological Station at Grand River, P. Q., joined the C.N.A.V. "Sackville" for the Spring cruise of Atlantic Coast waters, while Dr. E. W. Guptill of Dalhousie University joined the ship for the Summer cruise.

22. The Group was associated with Drs. J. C. Medcof and L. P. Chiasson of the Atlantic Biological Station in a survey of water conditions relative to the scallop fishery in Northumberland Straits.

23. Pooling of personnel, ships, and equipment of the Atlantic Oceanographic Group and the Naval Research Establishment took place in making a two-ship survey of "slope water" in June.

24. In a study of the bottom topography of the Laurentian Channel, relative to the tracing of fault lines of the Cape Breton area, the Group was associated with the following:

Dr. D. J. MacNeil, St. Francis Xavier University  
Dr. W. S. Whitehead, Massachusetts Institute of Technology  
Mr. S. Simpson, " " " "  
Mr. C. Hills, Harvard University  
Dr. Wm. Butcher, Woods Hole Oceanographic Institution  
Dr. J. T. Wilson, University of Toronto.

#### General Program - 1952

25. The program of the Atlantic Oceanographic Group for 1952 was concerned chiefly with the regular seasonal cruises of the waters of the Bay of Fundy, Scotian Shelf and Gulf of St. Lawrence, and an extensive study of some of the fundamentals of "slope water". The investigations of the "slope water" regime involved the ships and personnel of both the Atlantic Oceanographic Group and the Naval Research Establishment. In addition, specialized studies of the waters of Grand Manan Channel, Passamaquoddy Bay, and the Strait of Canso were carried out. Included in the program was a geological project fostered by the Nova Scotia Centre for Geological Sciences, involving a study of the bottom topography in the water areas off Cape Breton in

relation to the extension, under the sea, of fault lines of the Cape Breton area.

26. A continuing project, forming an important part of the program for 1952, is that of following the general trend of water conditions through observations made at selected points on the coast. For this purpose, observations are made as follows:

- (a) St. Andrews, N. B.: Surface water temperatures taken twice daily, our records extending back to 1921.
- (b) Lurcher Lightship: Surface and bottom water temperatures taken twice daily, our records involving several years of observations.
- (c) Halifax Lightship: Surface water temperatures taken twice daily, and bathythermograph recordings of the water column made twice daily, our records extending back to 1930 (in association with the Naval Research Establishment).
- (d) Halifax Harbour: Surface water temperatures taken twice daily, our records extending back to 1926.
- (e) Entry Island: Surface water temperatures taken twice daily, our records extending back to 1930.
- (f) Borden, P. E. I.: Surface water temperatures taken twice daily, our observations initiated in 1951.
- (g) Ellerslie, P. E. I.: Temperatures and salinities of the water column, five miles off shore, twice per month, our observations initiated in 1951.
- (h) Bay of Fundy: Temperatures and salinities of the water column, once per month, our records extending over a period of twenty-six years.
- (i) Passamaquoddy Bay: Temperatures and salinities of the water column, once per month, our records extending over a period of twenty-six years.

#### Associated Programs - 1952

27. Close liaison was maintained with the Fisheries Research Board, the Canadian Hydrographic Service, and the Naval Research Establishment. The Atlantic Oceanographic Group was associated with various programs of these organizations.

28. The Fisheries Research Board was interested in various oceanographic studies related to groundfish, shellfish and herring. In these activities, the Atlantic Oceanographic Group was more or less directly associated. In particular, a survey of water conditions, as related to a scallop fishery in Northumberland Straits, was made, and close association was maintained in the survey of temperature conditions relative to the herring fishery. Assistance, too, was given in connection with the studies on lobsters, and much information was made

available to those engaged in a study of the off-shore ground fishery.

29. The program of the Canadian Hydrographic Service on the Atlantic Coast involved the Canadian Government Vessels "Acadia", "Cartier", "Fort Frances", "Dawson", "Kapusksing", and the chartered vessels "Theron" and "Algerine". Serial water samples and temperatures and B.T. observations were taken according to a co-operative program laid down by the Hydrographic Service and the Atlantic Oceanographic Group.

30. Aspects of the program of the Naval Research Establishment in which the Group was involved are related to studies on under-water sound propagation, studies on some fundamentals of "slope water" and Gulf Stream flow, and the general oceanography of the Halifax area.

### Some General Results

31. In 1952 four seasonal cruises were made of the waters of the Bay of Fundy, Scotian Shelf and the Gulf of St. Lawrence. In all cruises the sections on the Scotian Shelf were extended to locate the "slope water". This program of seasonal cruises is a long-term one in order to obtain a general knowledge of general oceanographic conditions, to study the seasonal cycles, and to observe the variations that occur. These seasonal cruises are sometimes extended or modified to serve a more detailed investigation of some feature or area, but, in any case, the prevailing conditions in any one season are assessed and made available for fishery or naval purposes. The tenth such cruise has been completed. The data collected, supplemented by those of previous years, have permitted the establishment of a very extensive card reference of hydrographic conditions in the areas covered. During the period covered by the ten cruises, the observations of the Winter cruise of 1950-51 proved to be exceptional in that surface cooling and ice formation, particularly in the Gulf of St. Lawrence, did not take place to the usual extent. During this winter period, surface water temperatures remained high and the intermediate layer on the Scotian Shelf, defined as having temperatures below 5° C., almost disappeared. During the more severe winter of 1951-52 temperature conditions were restored to normal.

32. During this period of seasonal cruises the "slope water" generally found well off the continental shelf was observed to have a very profound effect on the fishing areas of Scotian Shelf when incursions of this water occurred. Bottom water temperatures over some fishing areas increased from a winter normal of 4-5° C. to 12° C.

33. These seasonal cruises have been supplemented to a considerable degree by a large number of cruises over portions of the Scotian Shelf by the Naval Research Establishment, and by the co-operative cruises of the "slope water" by N. R. E. and the Group. The late Autumn cruise in November, 1951, was extended, using the ships of both N. R. E. and the Group to include sections over the southwestern portion of the Grand Banks and to give good coverage of the "slope water" between 54° and 61° West

Longitude. In addition, four crossings of the Laurentian Channel southwest of Cabot Strait were made. It has been shown that the "slope water" boundary, which can be readily located by certain abrupt changes in temperature distribution, is subject to wide but seemingly unsystematic variations in position. The "slope water", while of specific interest to studies relative to the effect produced on the Scotian Shelf, is also of particular concern in fundamental studies of Gulf Stream flow which sets the pattern for the general circulation of the Western North Atlantic. In our Canadian area, which embraces the confluence of the Gulf Stream and the Labrador Current, the "slope water" regime is of considerable interest and specific attention is being given to it.

34. A very detailed examination of the waters of the Scotian Shelf was made by means of temperature-salinity diagrams to show the complicated mixtures of water masses which make up shelf waters. Involved, in part, were the outflowing waters from the Gulf of St. Lawrence, Labrador water rounding the Tail of the Grand Banks, and "slope water" from surface, intermediate and greater depths. The influence of Gulf Stream and Central Atlantic water is indirect through the "slope water".

35. In 1946-48 the Atlantic Herring Investigation Committee carried out an extensive series of investigations of Gulf of St. Lawrence waters. These have been supplemented by the seasonal cruises of the Atlantic Oceanographic Group, and the collected data have been analysed under two reports dealing with outstanding features of these waters. The second of these which has been completed this year deals with the intermediate and deeper waters. The intermediate waters are defined as those having temperatures less than  $0.0^{\circ}\text{C}$ ., while below these are the deeper and warmer waters of temperatures greater than  $0.0^{\circ}\text{C}$ . and as high as  $5.6^{\circ}\text{C}$ . It has been observed that the intermediate cold-water layer undergoes a 30% decrease in volume, from a maximum in Spring to a minimum in August, while a seasonal influx of the warmer and deeper waters takes place during this period. It would seem, on the basis of present knowledge, that about one third of the intermediate layer is formed "in situ", the result of winter chilling, while the remainder has its origin outside of the Gulf.

36. The surface layer in the Gulf, which was reported upon last year, has been subjected to further consideration on a different basis by Mr. N. O. Fothergill of the Canadian Hydrographic Service who was given access to our files of over 2,500 observations. Under Mr. Fothergill, the data were treated from a climatological standpoint. Calculations were made of the heat content of the surface layer at various times of the year, and charts were prepared showing the climatic influence on the surface layer of the Gulf of St. Lawrence.

37. The general oceanography of the Strait of Belle Isle has been the subject of an extensive report, in association with Dr. A. G. Huntsman. This report, which is ready for publication, deals with the hydrographic conditions in the Strait of Belle Isle and adjacent waters based on temperatures, salinities, densities, current measurements, and drift bottle

experiments. Special attention is given to fish, fisheries and planktonic invertebrates. The minimum depth of 100 metres, and minimum width of 9 miles in the Strait of Belle Isle, are limiting factors in the movements of water through it, and indicated water movements, at times, are as follows: (a) a progressive inward movement of water of Arctic and sub-Arctic origin on the north side, (b) a progressive outward movement of Gulf of St. Lawrence waters on the south side, (c) a dominant outward flow of Gulf water, and (d) a dominant inward flow of Labrador water. The three main water masses contributing to the waters found in the Strait are the surface layer of the Gulf of St. Lawrence, Arctic water, and waters of the West Greenland Current. Current measurements indicated a residual westerly trend on the north side of the Strait and a residual easterly trend on the south side. Distribution of plankton and the contrasts in the fisheries of different areas in and adjacent to the Strait of Belle Isle were in conformity with the features of the water movements and reveal the Arctic influence that is exerted by movement of ice-laden water to this region.

38. In the southwestern Gulf of St. Lawrence the water conditions are featured by a very strong stratification which reaches its maximum during the summer months. In addition to its seasonal variations, the stratification varies from year to year and from place to place. The main factors controlling the stratification are the discharges from river systems, mainly that of the St. Lawrence River system, vernal warming, autumnal cooling, and the winds. The waters of the southwestern Gulf were studied in some detail from regular weekly or bi-weekly observations made at Cheticamp, N. S., North Rustico, P. E. I., and Grand River, P. Q., between 1945 and 1949 under the auspices of the Atlantic Herring Investigation Committee. Outstanding features of this analysis were the establishment of semi-annual variation of temperature and salinity at a depth of 30 metres in the North Rustico area and the time lag of six weeks between the minimum surface salinity at Grand River and at Cheticamp. Maximum temperatures at a depth of 30 metres in the North Rustico area were observed in June-July and September-October, while minimum salinities were observed in May and August. This phenomenon of semi-annual variation in temperature and salinity is related to the formation of the surface layer, which is accompanied by the development of a strong thermocline. With this development, two distinct layers are present and the boundary between them varies in depth. In the Spring, with no layering present, the temperatures and salinities at a depth of thirty metres at North Rustico follow those of the surface. As the surface layer develops the temperatures and salinities at thirty metres become those of the layer below the thermocline, with lowered temperatures and increased salinities. Eventually the surface layer thickens to greater than thirty metres, and at this stage the temperature at thirty metres are observed to have increased and the salinities to have decreased, approximating the values of the surface. Superimposed on this gradual process are the distributions brought about by winds, tides, internal waves or other phenomena which cause vertical shifts in the depth of the thermocline. The lag in minimum salinity, as between Grand River and Cheticamp, is related to the processes of the formation

and flow of the Gaspé Current, the details of which are not too well known at this date.

39. There are several features of this water layering in the Gulf of St. Lawrence that are of direct concern to fisheries. At certain depths the bottom water temperatures may at times be determined by either the surface layer or the intermediate layer, which in summer may differ in temperature by fifteen degrees or more. Under the disrupting influence of wind or barometric pressure, sudden changes in the bottom water temperatures in a given area can occur with disastrous effects to certain forms of marine life. Some extensive destruction of scallop beds has been attributed by marine biologists to these temperature changes and during the past summer assistance was given in surveying some of these scallop areas. The formation and subsequent development of the surface layer between Spring and Autumn is, no doubt, an important factor in the distribution of such fish as the herring. On this basis, special attention has been given to the collection of detailed temperature information in collaboration with field studies on herring in the Gulf of St. Lawrence.

40. The general oceanographic conditions on the Atlantic Coast are followed through a periodic analysis of surface water temperature data collected at several strategic locations on the coast. Mean temperatures were generally lower than those of the previous year, although all were higher than the long-term average. The past few years have seen surface water temperatures reach the highest average values on record. There has been some slight regression from these maximum values.

41. Special attention was directed to the development of water temperatures about Prince Edward Island in relation to studies on lobster larvae. Weekly and fortnightly sampling of the waters was carried out at two locations off Ellerslie, P. E. I., and Richibucto, N. B.

42. 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 Atlantic Oceanographic Group and the Canadian Hydrographic Service, and a series of observations is being made which might be compared to a similar series, to be made after the Strait has been closed. Oceanographic sections at different phases of the tide have been made in May, July, August and October, and the Hydrographic Service is operating tide gauges and making current observations as well as frequent B. T. recordings of the water temperature structure in the Strait.

43. A study of correlations of water temperatures with meteorological indices was instituted during the past season, based initially on some earlier promising results and using the large collection of regular surface water temperatures from various points on the Atlantic Coast. While these series have been of use in biological studies and in studying water conditions throughout the area, it was hoped that they might eventually point to the underlying causes of long-term temperature

fluctuations. Such indices as the intensity of the Icelandic low and the Bermuda-Azores high, the pressure gradients over the ocean, etc., were used in analysing the temperature data but with no highly significant results.

44. In past years considerable attention was given to Bay of Fundy waters. As an area involving the greatest tides in the world, many of its oceanographic features are unique. During the past two years attention has been given to processing much data that has received very little attention. A manuscript on the general hydrography was revised. The Group was associated with Dr. B. H. Ketchum of the Woods Hole Oceanographic Institution, in dealing with the problem of exchanges of fresh and salt water in the Bay of Fundy. A preliminary study has been made of long-term changes in oceanographic conditions through the analysis of a large body of data collected at a well-chosen station over the past twenty-five years. The fact that the plotted variations in salinity and temperature have sinusoidal characteristics will allow some calculations on the interchanges of heat between the various depths.

45. Attention has been given to the waters of Grand Manan Channel where detailed information is required on water conditions and currents at all stages of the tide. The field work was completed during the past summer, with the exception of one further set of current observations. In general, the waters are for all purposes quite uniform in character from top to bottom, being well mixed by the tidal action over shoals.

46. In Passamaquoddy Bay, using quick sampling methods, attempts were made to get a more realistic picture of the water characteristics throughout the Bay and in the various passages.

47. The contributions of the Canadian Hydrographic Service and the Naval Research Establishment to a better knowledge of our waters continue to expand. The Canadian Hydrographic Service, in addition to its program of collecting oceanographic observations from seven ships operating on the Atlantic Coast, and its program in the Strait of Canso, has initiated some interesting investigations on Miramichi Bay, at Sambro Lightship, and in Halifax Harbour. In Miramichi Bay problems of bottom topography, involving fills in the channel and erosion of important sand bars, are being dealt with.

48. At Sambro Lightship simultaneous current and wind observations were made by the Hydrographic Service from October 18 to May 19, and these were analysed to show the important relationships between winds, tidal currents, and semi-permanent currents. A given current at Sambro Lightship is a complex mixture of wind current, tidal current, and dominant semi-permanent current. Its velocity can range from zero to 1.4 knots with an average of 0.35 knots. Its direction can be considered as variable, depending on the wind and other factors. In Halifax Harbour it has been found that the tidal currents are weak, seldom exceeding 0.5 knots and are thus strongly influenced by the wind.

49. In addition to several projects prosecuted on a co-operative basis, the Naval Research Establishment continues to make extensive oceanographic observations on the Scotian Shelf and is particularly interested in some problems of the Gulf Stream and the "slope water".

50. It is generally believed by some Canadian geologists that the Laurentian Channel may be a fault graben rather than a river and/or glacier valley. On this basis its geology is a matter of economic interest to the Cape Breton coal fields and a matter of fundamental interest to geology generally. Many major and minor fault lines have been traced to the beaches of northern Nova Scotia, Cape Breton Island and Newfoundland. Their progress under the sea is of fundamental, as well as economic, interest. In association with the Nova Scotia Centre for Geological Sciences, an echo-sounder survey was made of a considerable area in the Gulf of St. Lawrence. The echo sounder was successful in picking up several extensions of known faults, and analysis of the records is now in hand.

#### Papers Presented and Special Lectures

51. An Oceanographic Session was arranged for at the Quebec meeting of the Royal Society of Canada in June, and two papers were presented by the A. O. G. staff as follows:

- (a) "Features of the Intermediate and Deep Water Layers in the Gulf of St. Lawrence". L. Lauzier and W. B. Bailey.
- (b) "Studies of the Slope Water off the Scotian Shelf". H. J. McLellan, L. Lauzier and W. B. Bailey.

52. At a symposium on Problems of the Gulf Stream System held in Washington, D. C., under the auspices of the American Geophysical Union, Mr. McLellan presented a paper dealing with certain aspects of "slope water". At a meeting of the Nova Scotian Institute of Science, Mr. McLellan also presented a paper entitled: "The Effect of Freezing on the Sulphate-Chlorinity Ratio of Sea Water".

53. As an honorary lecturer at the University of New Brunswick, the writer delivered a series of three lectures during the year. The writer also had the pleasure during the past year of addressing the staff of the Scripps Institute of Oceanography at La Jolla, California, and the Geology classes at St. Francis Xavier University. On the Fisherman's Broadcast over C. B. C., a talk was given on Water Temperature Trends.

#### General Liaison

54. Liaison was maintained with all institutions having an interest in oceanographic problems of the Western North Atlantic.

55. Dr. Lauzier was associated with the Quebec Department of Fisheries in drawing up a program of oceanographic investigations for the Marine Biological Station at Grand River,

P. Q., which will give special attention to fishery problems in the northern part of the Gulf of St. Lawrence.

56. Copies of all B. T. records were supplied to the Woods Hole Oceanographic Institution and the U. S. Hydrographic Office. The Naval Research Establishment at Halifax, N. S., has made extensive use of our records, and the above-mentioned organizations continue to augment our files with data collected in areas of interest.

57. Mr. Bailey visited all ships of the Canadian Hydrographic Service before they sailed on their seasonal activities. He assisted in outlining methods of collecting oceanographic data and supplied them with requirements for same. In November, 1951, he visited the Newfoundland Fisheries Research Station in order to co-ordinate interests in the investigations in Newfoundland waters. In June the C.N.A.V. "Sackville", with Mr. H. J. McLellan as scientist-in-charge, also visited the Newfoundland Station.

58. The writer visited West Coast institutions during the past year, including the Scripps Institute of Oceanography at La Jolla, the U. S. Naval Electronics Laboratory at San Diego, the Oceanographic Laboratories of the University of Washington, the Oceanographic Institute of the University of British Columbia, the Pacific Naval Laboratories and the Pacific Biological Station.

59. Upon invitation, the writer attended the opening of the new Naval Research Laboratory at Halifax, N. S., attended discussions relative to Naval Research programs, and spent a day on H.M.C.S. "Magnificent" observing naval manoeuvres.

60. Water temperatures from St. Andrews, N. B., and Entry Island, P. Q., were supplied daily to the Meteorological Service of Canada.

61. The writer attended various meetings of the International Commission for the Northwest Atlantic Fisheries, acting as an assistant to the Canadian delegates and advisers. An active part was taken in the work of a sub-committee on hydrography. As part of the entertainment by the Canadian Government, the C.N.A.V. "Sackville" was made available for a cruise and luncheon, when members and associates of the International Commission were the guests of the Honourable the Minister of Fisheries of Canada.

62. Mr. Bailey spent a few days at the Woods Hole Oceanographic Institution at Woods Hole, Massachusetts, to learn something of their activities and methods. Dr. Lauzier represented the writer at the October meeting of the Associate Committee on Geodesy and Geophysics of the National Research Council.

63. While the writer found it impossible to attend the meetings of the Associate Committee on Geodesy and Geophysics of the National Research Council during the past year, reports on oceanographic activities were submitted as required for publication in the Geophysical Bulletin.

64. Requests for information and data were received from organizations other than those associated with the Joint Committee on Oceanography, including:

- (a) U. S. Fish and Wildlife Service, relative to long-term data in the Bay of Fundy;
- (b) Professor Stevenson of the University of Wales in connection with his studies on shore life along the Canadian Atlantic;
- (c) Various groups interested in problems relative to the St. Lawrence Waterway.

Publications and Reports

Papers and Manuscript Reports from the Group are included in the general list of publications.

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Report for 1952.

F.R.B. of Canada. Atlantic biological station, St. Andrews, N.B.

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