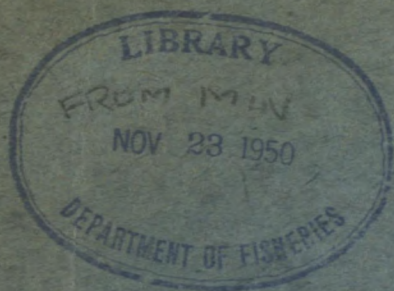


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1948



CONFIDENTIAL

FISHERIES RESEARCH BOARD OF CANADA

R E P O R T
OF THE
ATLANTIC BIOLOGICAL STATION
FOR
1 9 4 8

With Investigators' Summaries as Appendices

by

A. W. H. Needler, Director

REPORT FOR 1948 OF
ATLANTIC BIOLOGICAL STATION, ST.

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By A. W. H. Needler, Director

Biological fisheries research, the work of this station, is designed to enlarge and maintain the supply of raw materials to the industry, and to improve their availability through its contribution to techniques of capture. The work includes exploration for new resources, investigation of intensive fisheries to devise regulations which will give the best long-term yield, and development of methods of increasing production by positive cultural action. It also includes improvement of fishing techniques which, insofar as they are related to the habits of the fish, present problems with biological aspects. Investigations were carried on in 1948 in all these fields. One project, the attack on the problem of reducing cod-worm infestation, was concerned with the quality of the raw material, and another, the study of paralytic shellfish poisoning, with protection of public health with a minimum of interference with the industry.

Effort has been concentrated on those species, the use of which is limited by supply rather than demand and which together contribute a considerable proportion of the Atlantic coast fisheries income. In some cases there is prospect of improving the supply principally through cultural methods (oysters, soft-shelled clams, trout, salmon), in others principally through regulation (lobsters, scallops, smelts) and in still others principally through exploration (shrimp, bar-clams) or the development of fishing techniques (tuna and bill-fish), although more than one of these methods of attack is applicable to most individual species. Attention has also been given to the important groundfish fishery by laying the basis for meeting over-fishing should it occur, by improving catching methods to reduce costs in a highly competitive industry and by attempting to assist marketing of cod through reduction of round-worm infestation. An attack has been started on the problems of control of eel-grass, a potential menace to clam and oyster culture, and some additional assistance has been given to the development of the Irish Moss industry.

The results of the station's work are applied through advice to administration on the regulation or development of fisheries, and through advice to industry on means of exploitation and, especially in the case of bivalves, on means of increasing production through culture. Close contact is maintained with administration and industry to direct research along useful lines, and to assure that its results are used.

Co-operation with other bodies.

The Atlantic Oceanographic Group, the Atlantic unit of the Joint Committee on Oceanography which conducts co-operative research for the Navy, the National Research Council and the Fisheries Research Board, has its headquarters at the station, which provides laboratory and administrative facilities and seconded staff. The more intensive development of the hydrographic

picture in our waters which is made possible by this co-operation (especially through the use of Naval vessels) is already providing the background for a solution of fisheries problems. A summary of the activities of the Group in 1948 is appended.

The Atlantic Herring Investigation Committee conducts research on herring resources for the Governments of Nova Scotia, New Brunswick, Prince Edward Island, Quebec, Newfoundland and Canada. The Director of the station acts as its Scientific Alternate Chairman with major administrative responsibility and its Investigator-in-Charge (Dr. Leim) and Honorary Recording Secretary (Miss Parker) are members of the station's staff. The station affords it laboratory, office and accounting facilities. The Committee's work is advancing our knowledge of herring populations, fishing, hydrography, etc., which are a part of the general field with which the station is concerned.

The station has co-operated closely with the Dominion Department of National Health and Welfare in the development of principles and procedures for the protection of public health with a minimum of hindrance to the industry -- especially in the cases of sewage pollution and toxicity in bivalves.

Co-operation has been maintained with the provincial departments concerned with fisheries. There has also been close contact with the research programs conducted in the North Atlantic by United States agencies -- Federal, State and private.

Personnel and organization.

The personnel and organization of the station are presented in the appended statements as of August 1 when seasonal employees are most numerous. The staff in 1948 (including those seconded to AOG and AHIC) was as follows, with comparative figures for 1947 in brackets: full-time scientists - 13 (12); seasonal scientists - 20 (19); maintenance staff - 5 (5); clerical and administrative staff - 7 (6); technicians - 23 (22); total, without seasonals - 48 (45).

The writer, while remaining Director of the station, became Assistant Deputy Minister part time commencing April 1 for a period of two years, and assistance was required in the supervision of the work. Dr. Wilder was appointed Assistant Director for the same period, continuing in charge of the lobster investigation.

To meet a long-felt need Mr. L. R. Day was employed as a scientific assistant to the Director, making possible a much more effective fulfilment of various scientific responsibilities; some, such as supervision of library and museum, concerned with services within the station, and others, such as answers to enquiries and minor investigations, augmenting the station's services to the Department and the public.

Dr. G. F. M. Smith was employed as statistical consultant and gave valuable assistance both in the planning of investigations and in the interpretation of results. His assistance and constructive criticism contributed to the breadth and soundness of the approach to the station's various problems and it is planned to retain his services again next year.

The need for continued close contact with the Universities is fully recognized -- for seasonal assistance in investigations, for recruitment of scientific personnel and for maintenance of the quality of scientific work through breadth of information and stimulating contacts. The first two needs are well served by the seasonal employment of scientists, including members of university staffs as well as students. The last is not now adequately met and it is hoped that in future more opportunities may be made for such contacts, both through visits of our permanent staff to universities and through use of our facilities by university scientists in the summer.

Valuable contacts have been maintained by visits by our scientists to other scientific work or conferences and by visits of other scientists to the station. Among the former might be mentioned the attendance of Dr. Martin at the I.C.E.S. meeting at Copenhagen with associated visits to European scientific and industrial fisheries centres, and among the latter the arranged visit of Dr. Korringa, an able Dutch worker in the shellfish field.

A review of the station's staff indicates that, while some years ago investigations were severely limited by lack of the technicians needed to collect adequate data, technical assistance is now fully adequate to the capacity of the scientific staff and that, for the present at least, the need is for personnel able to digest data and develop ideas independently.

Museum

In 1948 a start was made in the establishment of a reference collection of aquatic organisms. It is planned to build up a body of well-identified material as an aid to the work of the station rather than for public display.

Information

Progress has been made in the important field of bringing the results of the station's work to the attention of the public and making them available to those who will use them. While individual contacts and correspondence both with administration and with all phases of industry will remain perhaps the most important channel through which information is made available for application, publications, radio, motion pictures, exhibitions and the press are important. Further advances are anticipated in this general field in close co-operation with the Information Branch of the Department. Details for 1948 are given in the appended list.

Publications. Progress Reports and circulars, which are intended for the fisheries public, have been continued. A series of circulars has been started describing briefly groups of particular interest on which confusion is widespread. The first of these (by Dr. Martin on the flatfish) has been distributed.

Radio. The station's releases through the CBC Fisherman's Broadcast were continued and increased in numbers, and assistance was given to the production of a larger broadcast on oyster farming.

Motion pictures. No motion pictures on the station's work were made at the Department's instance in 1948 but the National Film Board enlisted co-operation on a film on oyster farming and, to a minor degree, on one on the lobster fishery.

Exhibitions. The greater part taken by the Information Branch in the preparation of the Department's display at the Nova Scotia Fisheries Exhibition led to a better-organized and more pleasing presentation of the Department's work, including that of the station, and involved much less effort by our staff than in 1947.

Press. Some press publicity has been given to the station's work through direct contact -- notably a page in roto-gravure in the Montreal Standard -- but the chief outlet is through the Department's Information Branch. This contact is being improved by visits of its staff to the station during which the work can be reviewed from this point of view and releases prepared on interesting items and checked by the station's staff.

Physical equipment

No major changes were made in 1948 in the station's physical equipment. The need for completion of the fire-proof main building is becoming progressively more serious.

Distribution of expenditures

There are appended tables showing (1) the expenditures allocated to certain general purposes as well as specifically to investigations, and (2) expenditures fully allocated to investigations. These distributions are given for actual expenditures in the years 1945-46, 1946-47 and 1947-48, and for the anticipated expenditures of 1948-49 and the preliminary estimates for 1949-50.

REVIEW OF INVESTIGATIONS

A map has been included, immediately preceding Appendix No. 1, showing the principal places where work was carried on.

Lobster. The lobster fishery is the most valuable of our Atlantic inshore fisheries. Being highly intensive and limited by supply rather than by demand, there is prospect of maintaining or increasing its yield through proper management. Our investigations, under Dr. D. G. Wilder, are obtaining the knowledge on which to base sound regulations, to offer predictions of natural changes in abundance, or otherwise to increase the stocks or improve their exploitation. A brief summary of the work in 1948 is given in Appendix 1.

Knowledge of populations, natural and fishing mortalities, and growth is essential for the selection of the best size-limits and progress has been made towards obtaining the basis for recommendations in this regard. Estimations of the proportions caught in various localities and of the populations on which the local fisheries are based have been continued (Appendix 2). Off the north shore of Prince Edward Island, where the fishing is

inside 12 fathoms, experimental fishing off to 25 fathoms indicated that lobsters are scarce beyond 10 fathoms and that practically all the stock is fished, thus confirming our population estimates there and the absence of any considerable reserve stock (Appendix 3).

Marking and recapture of lobsters at Tignish, P.E.I., and Grand Manan, N.B., indicated an annual growth of 14.3% and 15.2%, and experiments are in progress at Port Maitland, Abbott's harbour and L'Archeveque, N.S., giving our first reliable information on this subject so important to management. (Appendix 4).

The results of our demonstration in the past few years of the effects of lath spaces on the sizes of lobsters caught are the basis for the proposed requirement of minimum spaces suited to the two size-limits now in force in the "market" and "canner" areas. It is expected that this will contribute to the effectiveness of the size-limit.

Following preliminary work in 1947 a more thorough survey was made of the occurrence of lobster larvae in the western part of Northumberland strait. Comparison with earlier data suggests a wide variation (6:1) in the production of first-stage larvae from year to year. By repetition of the survey it is hoped to discover what relation exists between larval abundance and subsequent commercial catches, with possible prediction of the latter, and to learn something of the factors responsible for variations in production. (Appendix 5).

Indications that heavy mortalities of impounded lobsters in Northumberland strait in 1947 might be caused by the "pink-tail" blood disease prompted an investigation in 1948, but no unusual mortalities occurred this summer and intensive search failed to reveal the presence of the causative bacterium (Gaffkya). (Appendix 6).

As a possible means of overcoming sewage pollution or the spread of bacterial disease in impounded lobsters, their resistance to chlorine was tested, but such low concentrations were found to be lethal as to render its use impracticable. It is planned to try other disinfectants in the hope that one can be found which is harmless to lobsters in effective concentrations.

Shrimp (Pandalus). Further exploratory fishing for shrimps in the spring of 1948 along the outer coast of Nova Scotia failed to discover commercial quantities, but it is planned to continue the search in 1949 in the winter season when the commercial fishery occurs in Maine, this having been prevented in 1948 by unusually widespread freezing of harbours. (Appendix 8).

Oyster. The oyster-farming industry, which is based to a very large degree on the results of the station's oyster investigations, continues to grow and there is continued need both for technical services to the industry, such as prediction of the settlement of spat, and for the development of improvements in oyster-farming methods. The future of the industry depends on research which, while it must be directed along practical lines, must include much fundamental work on the factors influencing all phases of oyster production and quality.

Since 1930 a member of this station's staff, for the time being Mr. R. R. Logie, has been in charge of both the Board's oyster investigations and the Department's program of oyster-culture development and administration, with headquarters for both at the sub-station at Ellerslie, P.E.I. While this arrangement has assured quick application of the results of research and was undoubtedly beneficial in the early stages of the combined program, the growing administrative work has proved an increasing hindrance to research by the Board's limited personnel. The Department has now employed an administrative officer who, after training under Mr. Logie, is expected to take over the field administration of oyster farming, leaving the Board's scientist freer to pursue scientific work.

A general summary of Mr. Logie's work is given in Appendix 9 from which will be seen the effort expended in 1948 in supervision of oyster-culture-development operations, technical services and adaptation of oyster-farming techniques to local conditions. Work was conducted at Shippigan, the Miramichi estuary, and Shediac, N.B., and Malagash and Orangedale, N.S., as well as at Ellerslie in the Malpeque bay area.

Further experiments have failed again to demonstrate the existence of strains with differing growth rates. An investigation on eel-grass has been commenced (see below) designed to discover means of controlling its spread which threatens the continued usefulness of many oyster grounds. Boring sponges were observed to reduce the value of oysters by damage to shells, and damage to meats is also suggested as in the case of scallops (see also Appendix 22). Severe damage to oyster sets by settlement of barnacles was again observed and attacks on both these problems are planned.

Experiments have shown the continued presence of the disease which decimated oyster populations in various Prince Edward Island areas. They confirm the resistance of Malpeque stock, and the development of resistance in the native stocks of other affected areas. They have also shown the susceptibility of oysters introduced from unaffected to affected areas and the continued threat of damage by the disease should it spread to the former. (Appendix 10).

Unexplained variations in spat production emphasize the need for more knowledge of the factors controlling the survival and movements of oyster larvae. Investigation of the latter has been started (Appendix 11).

The influence of light on both growth and quality of oysters, as shown by earlier experiments by C. J. Kerswill and J. C. Medcof, has been summarized (Appendix 12).

Paralytic shellfish poison. The work in this field is assuming the nature of routine assistance to administration, although some further progress has been made towards an understanding of how its occurrence is influenced by the factors controlling the organism which is the source of the poison. Toxic clams and serious cases of poisoning, including two deaths, were discovered in the area on the Atlantic coast where hydrographic conditions most closely approach those in the Bay of Fundy;

namely, the lower St. Lawrence river. (Appendix 14).

Soft-shelled clam (Mya). The demand for soft-shelled clams far exceeds a dwindling supply both in the Maritime provinces and New England, and an investigation of methods of clam farming and fishery management has been carried on for some years in Dr. Medcof's charge. Much of the basis has been laid for the methods and policies best adapted to our conditions and results have been applied to regulation of the industry. With the termination of much of the detailed experimentation on clam-farming methods, attention is still being given to plantings to test the potentialities of promising areas, to an experiment in the effect of controlled as against random digging, to investigation of the means of control of a very serious enemy - the whelk, Polinices triseriata, - and to exploring other aspects of our clam resources. (Appendix 13).

Detailed randomized plot experiments at Petpeswick and elsewhere have shown the effects of crowding on growth and have compared the values as seed stock of stunted clams from high levels and small clams with more normal growth rate (Appendix 15), and experiments have been carried out on many other aspects of clam - farming methods. Growth has been disappointingly slow and prospects for profitable clam farming are limited to a few specially favourable areas. A number of plantings have been made to test the potentialities of these (Appendix 16) and it is hoped that a limited clam-farming industry may yet be developed.

The smooth whelk or clam drill (Polinices triseriata) has been shown to kill such a high proportion of the clams in some areas as to be a most serious factor limiting production. Experiments in control indicate that, while destruction of the drills themselves is not feasible, the gathering of the conspicuous egg masses offers some promise, and a large-scale test is under way. (Appendix 17).

Scallop. Our investigation of the valuable scallop fishery, which is limited by supply rather than by demand, is being intensified under Dr. Medcof's charge.

In the Digby area the fishery is intense and is currently suffering from a scarcity of scallops. Although fluctuations in abundance occur which are attributable to natural factors such as water temperature (Appendix 19), there are indications that the fishery is wasteful in taking scallops at too small a size. A review of detailed records of fishing by the same fleet of boats over a six-year period has yielded much information of value to regulation of the fishery (Appendix 20). Preliminary results of marking experiments indicate a moderate intensity, and, combined with information on growth rate and yield of meat in relation to size, confirm the need for a size-limit not lower than the present 4" (Appendix 21). Enforcement being difficult because shells are discarded at sea, the effect of mesh size of the drags on the sizes of scallops caught is being studied in order to develop an effective means of protecting small scallops (Appendix 23).

A sponge which bores in scallop shells was found to be responsible for reducing the yield of meat and for a brown discoloration which lowers its market value (Appendix 22).

Investigations on the Digby scallop fishery are directed towards obtaining the basis both for its regulation for maximum yield and its prediction. In other areas further exploration of the potentialities of the fishery is needed.

Bar-clams (Mactra). Exploration for bar-clams, now drawing to a close, has discovered quantities which could profitably be picked by hand in some areas but failed to offer prospects of profitable dragging, with two possible exceptions -- a very limited area in Miramichi bay and deep water off Digby. In the latter, extensive and densely-populated beds of stunted bar-clams might be used to relieve the shortage of clams for bait in the trawl fishery during the summer dogfish season (Appendix 24).

Groundfish. The groundfish fishery is the most important on the Canadian Atlantic coast when offshore and inshore fishing of all kinds are included. There is as yet no evidence of over-fishing and this branch of the industry is limited by processing and marketing rather than by supply. Our investigations have two principal aims: (1) provision of the basis for recognizing over-fishing should it occur and for recommending remedial action, and (2) improvement of the industry's competitive position by increasing the effectiveness of our fishing effort with better methods and better knowledge of fish stocks and movements (Appendix 25).

The suggested establishment of an international body to investigate and regulate the groundfish fishery of the north-western Atlantic indicates the need for sound information in this field on which to base Canada's policy. With the entrance of Newfoundland, Canada will have immediate proximity to one of the greatest fishing areas of the world and one already exploited to increasing degree by many nations. Canada's interests in this resource are, in the long run, threatened both by possible over-fishing and by possible pressure for too many restrictive measures.

Our investigations on the offshore fishery and fish stocks may eventually require intensification. We are, in the meanwhile, obtaining the information necessary to recognize changes in the abundance of groundfish and the relation of the fishery to them. This includes special statistics on catches (covering most of our offshore fishery and sampling the inshore), on fishing effort and on the sizes and ages of fish. This is already yielding information on seasonal and annual changes in availability (Appendix 26). Information is also being obtained on the variations in abundance of year-classes which are part of these changes and which offer some prospect of predicting them (Appendix 27). The incidence of cod-worms at various times and places is contributing to the knowledge of cod movements so necessary both to an understanding of changes in abundance and to more effective fishing (Appendix 28).

The groundfish fishery is so highly competitive both internationally and domestically that relatively small changes in costs of production may have an important effect. It is, therefore, urgently necessary for the industry to adopt the most efficient methods. It is also necessary to make as efficient methods as possible available to all branches of the industry --

small as well as large. The station has already played an important part in testing the value of "long-lining" (the hauling of set lines with power) in our waters and in its demonstration and adoption, and in the recent establishment of inshore flounder dragging on a small but increasing scale. In 1948 preliminary tests with promising results were made of the "Danish seining" method (Appendix 29). It is planned to carry these further and also to explore the potentialities of other methods including, in the near future, gill-netting.

Both of our principal aims in the groundfish field depend on thorough knowledge of the species fished and their life histories and habits. Further studies of the winter flounder populations (Appendix 30) have indicated the limitation of prospects for commercial flounder dragging largely to western Nova Scotia until the industry develops the techniques of handling the smaller flatfish which predominate in the Gulf of St. Lawrence. The seasonal movements of flounders have been studied in relation to their reaction to physical factors such as temperature, salinity and light (Appendix 31), a type of research which must be extended if we are to understand the distributions and movements of our commercial species.

It has now been shown that the round-worm occurring in cod, which is so costly to the industry through its effect on marketing, matures in the harbour seal, with an early stage intervening between the seal and the cod. A worm, apparently the same and also maturing in the seal, occurs in smelt, eelpout and probably Canadian plaice. While continuing the search for the host or hosts between seal and cod, it is planned to concentrate effort on a study of the seals associated with an attempt by the Department to reduce their numbers.

Herring. The station's work on this species was limited in 1948 to its participation in the activities of the Atlantic Herring Investigation Committee, through the services of the Director as Scientific Alternate Chairman, of Dr. A. H. Leim as Investigator-in-Charge and of Miss N. M. Parker as Honorary Recording Secretary, and through the provision of laboratory and accounting facilities. The aim of the Committee's work has been to extend the seasons and areas over which herring may be taken and to increase their availability also by improvement of catching methods, in the hope that use may be extended by, for example, a larger fish-meal operation.

A summary of the work of the Committee is given in Appendix 33. Further exploratory fishing has confirmed the absence of sufficient concentrations for purse seining except in the colder months, and bottom trawling has so far been unsuccessful (Appendix 34). An attempt is being made to develop a mid-water trawl (Appendix 35). It has been shown that there are six separate herring populations in the Gulf of St. Lawrence region and that certain year-classes dominate the fishery (Appendix 36). Further information was obtained on the seasonal and geographic variations in fat content (Appendix 37).

Mackerel. Dr. L. P. Chiasson, a seasonal investigator, continued his study of various aspects of mackerel life history

and fishery in the Gulf of St. Lawrence, which was initiated in 1946 in association with the work of A.H.I.C. (Appendix 38).

Tuna. Mr. L. R. Day commenced a preliminary investigation of the tuna stocks and fishery on the outer coast of Nova Scotia. It indicated that the fishing effort may be made more effective by adoption of Pacific-coast methods, especially the use of tuna lures. Tuna support a considerable sport fishery, with associated tourist industry, as well as a commercial fishery with some possibility of expansion. (Appendix 39).

Billfish. This fish (Scomberesox saurus), a summer visitor to our waters, is of such high quality that there is good prospect of its use if a reliable supply can be obtained. Preliminary investigations, by Mr. Day, indicate that the billfish is a fast-growing species with a life of about three years, and that success or failure of year-classes would, consequently, result in wide fluctuations in abundance. They are now caught principally in traps set for other species and, as they are schooling fish, more mobile methods such as torching or the use of small-meshed gill-nets might be more effective.

Smelt. Smelt are in high demand, and the fishery in the principal producing area, the Miramichi estuary, intensive and its catch declining. Our investigations, continued in 1948 by Mr. R. A. McKenzie, are designed to provide the basis for improvement of production and regulation of the fishery (Appendix 42).

It has been shown that removal of obstructions in spawning brooks causes an increase in the spawning area occupied and that the consequent reduction of crowding of eggs leads to a higher production of larvae. Some further attention was given to this field and to the application of the results (Appendix 43) and to a study of the relationship between the size of the spawning run and the number of larvae produced (Appendix 44). The correlation between abundance of larvae and abundance of the same year-class when it reaches the fishery is being studied.

Earlier work had shown that the smelt which are in the Miramichi estuary at the close of fishing form the vanguard of the spawning run occupying principally the main branches of the river, leaving the brooks closer to the sea to be occupied by later runs of somewhat smaller fish. Smelt were marked in the spring of 1947 in the earlier and later parts of the spawning run as it passed through the estuary, and in three brooks to see whether the various parts of the run (1) remain distinct and come in the same order from year to year, leaving a very large unexploited part, (2) act as a single mixed stock less intensively fished than had been supposed, or (3) act as a single stock by smelt entering earlier as they become larger. Recoveries of marked smelt in the 1947-48 fishery (Appendix 44) and in the 1948 spawning run (Appendix 45) indicate that the groups had mixed to some degree but that they had, on the whole, retained their relative position in the run. Further work is required to make these results conclusive.

Trout. The adoption of a broader program by the Fish Culture Development Branch improves the prospect for application of the results of the station's trout investigations and increases the pressure on its staff in this field. The value of trout angling to the tourist trade and to the recreation of our own people is recognized by provincial and Dominion governments alike and they look to the Board for research to develop the principles and procedures to maintain and improve this resource. The station's investigations, under Dr. M. W. Smith, continued in 1948 to give particular attention to trout production in artificial ponds, to the fertilization of natural lakes, to the relationship between stream and sea stocks and to the control of competitors or enemies by poisoning. (Appendix 47).

The high yields from a Prince Edward Island pond over six years (Appendix 48) are in sharp contrast to those from the relatively infertile lakes of Charlotte county. The production of trout in similar ponds is being studied to determine the techniques of obtaining the optimum production of trout (Appendix 49). Varied densities of trout are being tried in controlled ponds and production as high as 27 lb. per acre was obtained in 80 days. Drainage for short periods has been found to have only a moderate effect on bottom fauna, the Chironomid larvae being more severely reduced than oligochaetes.

Fertilization of Crecy and Gibson lakes, near St. Andrews, N.B., led to (1) rapid decline in the concentration of fertilizers, apparently by utilization or precipitation, (2) blooms of blue-green algae during the autumn following fertilization, (3) no marked improvement in zooplankton, (4) some improvement in bottom fauna, and (5) reduction of dissolved oxygen to a dangerously low level in Gibson lake in the following winter. Introduced fingerling trout grew faster after fertilization but there is no indication of a sustained improvement of the yield to anglers. (Appendix 50).

At Ellerslie brook, P.E.I., a counting fence has been operated at head of tide continuously since June, 1946, and since April, 1947, all trout passing it have been tagged (Appendix 51). The trout population of this small brook has been estimated as 15,500 fingerling, 4,400 yearling and 950 older trout (Appendix 52). It is planned to discover the effects, on the population and on the movements, of the establishment of a pond just above the head of tide. Information is also being obtained on the relative tendencies of the progenies of sea-run and residual trout to run to sea.

In co-operation with the Fish Cultural Development Branch a test of the newly-developed poison, Fishtox, was carried out on Cassidy lake, N.B. An application of 5 parts per million caused mortalities the completeness of which will be tested by a stronger application next year. It is planned also to conduct trials under highly stratified conditions supplemented by small-scale experiments. It is hoped that a poison effective under such conditions can be found, earlier work having demonstrated the difficulty of a complete application and the quick recovery of populations which are merely reduced. (Appendix 53).

Atlantic salmon. The station's Atlantic salmon investigations, by Dr. P. F. Elson and Mr. H. C. White, have been limited largely to the problems of smolt production and in 1948 special attention has been given to the effects of the control of bird predators, which, in earlier experiments on the utilization of hatchery stocks, had been important in making survival low. (Appendix 55).

The smolt run from the last of a series of five plantings varying in density was estimated in 1948 (Appendix 56). Regardless of numbers planted or methods of dispersal, the survival to smolt stage was low (1.8% to 5%), apparently largely as a result of predation by mergansers and kingfishers. Plantings comparable with the heavier of the earlier series were made in 1947 and 1948 (Appendix 57). Control of bird predators, initiated in 1947, has resulted in a great increase in all species occurring in the experimental stretch, including young salmon (Appendix 58), and trout angling has been improved (Appendix 60). Less intensive bird control on streams near the experimental stretch resulted in much the same increase in fish populations (Appendix 59). The experiments must be continued until the fish populations reach an equilibrium but results to date indicate the value of bird control in streams which, like the Petitcodiac system, have many other species, as well as in those which, like the Margaree, have a more dominantly salmonoid population.

The experiments have yielded some knowledge of techniques of controlling both mergansers and kingfishers (Appendix 63) and further observations have been made on the feeding and occurrence of ducks (Appendices 61 and 62) and kingfishers (Appendices 65, 66 and 67) elsewhere in the Maritime provinces, indicating their wide importance to salmon production. A collection of diagnostic fish bones is being made and described as an aid to recognition of fish in the food of birds or fish (Appendix 68).

A review of the effectiveness of smolt trapping emphasizes its limitations in practice (Appendix 70). Tests of seining indicate its reliability as a means of assessing fish populations in streams within fairly wide limits of accuracy. An attempt is being made to develop an electrical method suitable for moderately large streams (Appendix 71).

Eel-grass. Eel-grass seriously threatens oyster and clam production in many areas, but improves conditions in a few. An investigation of its biology, its relation to shellfish culture and its possible control, was commenced in 1948 by Mr. A. R. A. Taylor. Much has been learned of its biology, its effects in retarding oyster growth have been shown, and control measures of various kinds are being tested with some promise. (Appendices 73 to 76).

Irish Moss. The station again conducted a survey of the quality and handling of Irish Moss in association with an effort by the Department to improve them through education of the producers and through the institution of voluntary inspection (Appendix 77).

Hydrography. The work in 1948 of the Atlantic Oceanographic Group is presented in Appendix 78 at the request of the Oceanographer-in-Charge, Mr. H. B. Hachey, and a summary by Dr. L. Lauzier of the hydrographic work of the Atlantic Herring Investigation Committee in close co-operation with A.O.G. is given in Appendix 79. Intensive hydrographic work was concentrated in the Gulf of St. Lawrence area in which A.H.I.C. is particularly interested, but progress is also being made in developing the general picture in our waters, so important to fisheries research and development.

Acknowledgements. We are grateful for the continued co-operation of industry, universities and other branches of Dominion and provincial governments, which is so important to the conduction and efficacy of the station's work.

1945
Marketed value
in PE9, NS + NB

Purposes of Expenditure
(Net expenditures after final allocation of costs and revenue)

Investigations	Actual	Actual	Actual	Antici-	Preliminary	
	1945-46	1946-47	1947-48	pated	estimates	
				1948-49	1949-50	
1. Lobster	24,595	30,798	25,847	32,127	32,210	12,500,000
2. Shrimp	0	843	7,371	6,936	2,775	-
3. Oyster	9,663	12,648	12,944	14,176	17,606	395,000
4. Shellfish poison	2,181	3,362	2,943	1,212	4,220	-
5. Soft-shelled clam	4,389	8,668	8,549	11,506	9,702	380,000
6. Scallop	0	1,956	3,099	7,905	10,103	545,000
7. Bar clam	1,074	6,389	8,363	6,124	3,623	30,000
8. Groundfish general	15,630	19,562	19,596	24,038	30,000	20,500,000
(a) Yellowtail	0	2,435	304	0	0	
(b) Cod worms	0	2,035	2,105	4,171	2,485	
(c) Halibut	0	14,530	18,291	0	0	
(d) Long-lining	0	6,230	0	0	0	
(e) Can. Plaice	0	0	1,441	0	0	
(f) Flounders	0	0	5,119	8,020	2,135	
(g) Danish seining	0	0	0	6,660	20,690	
(h) Gill netting	0	0	0	0	18,190	
9. Herring	522	0	0	0	0	
9A. Herring (through AHIC)	8,509	12,112	12,738	12,395	14,397	6,400,000
10. Mackerel	0	885	2,006	1,395	1,871	2,000,000
11. Smelt	11,964	16,258	17,017	17,806	22,366	740,000
12. Trout	11,079	11,975	15,646	18,566	30,907	-
13. Salmon	3,221	2,665	12,448	17,730	23,814	370,000
14. Eel-grass	0	0	0	1,440	3,934	-
15. Seaweeds	2,119	1,885	566	730	3,046	185,000
16. Hydrography (through AOG)	440	7,505	11,937	20,795	33,670	
17. Seals	0	0	0	0	9,166	
18. Miscellaneous	0	0	0	3,650	6,412	
19. Conferences (FAO and ICES)	496	577	567	390	0	
20. Museum	0	0	0	889	2,374	
21. General Services	783	1,644	1,813	1,921	2,000	
22. Cottages and apartments	4,604	3,624	3,061	843	543	
23. Wharf	4,400	4,665	3,250	3,200	2,500	
24. M/B "Mactra S" (Capital)	0	4,354	1,067	0	0	
25. M/B "Pandalus" (Capital)	0	3,625	990	0	0	
26. Electrical collection	0	0	0	0	4,500	
Totals	105,669	181,230	199,078	224,625	315,239	

PE9 3,076,811
NS 30,706,900
NB 13,241,594
Maritimes 47,025,305
Que 7,438,330
Atl. 54,463,635
B.C. 44,531,858
Marine. 98,995,493
Inland 14,875,607
Canada 113,871,100

1945.
Marketed values.

Swordfish 1,200,000
Tuna 60,000
Alewife 410,000
Shad 80,000

Purposes of Expenditure
(With partial allocation of costs)

	Actual <u>1945-46</u>	Actual <u>1946-47</u>	Actual <u>1947-48</u>	Antici- pated <u>1948-49</u>	Preliminary estimates <u>1949-50</u>
1. Director	5,435	6,008	6,510	0	0
2. Asst. Director	0	0	0	2,765	3,450
3. Statistical consultant	0	0	0	1,465	3,150
4. Office and admini- stration	6,207	7,941	9,756	12,107	18,692
5. Library	896	1,678	1,720	2,579	3,505
6. Publications	0	113	342	760	1,800
7. Laboratory					
(a) Suppl. and Equip.	1,463	2,247	2,335	2,000	3,600
(b) Services	1,670	2,371	2,885	4,000	5,950
8. Bldgs. and Grounds at St. Andrews	10,407	9,898	13,169	14,945	20,330
9. Cottages and apart- ments	5,000	4,098	4,912	2,800	2,500
10. Wharf	4,400	4,004	3,250	3,200	2,500
11. Vehicles at St. Andrews	534	2,168	2,594	2,840	6,230
12. Boats at St. Andrews ("Clupea H" etc.)	1,802	3,179	2,784	3,070	3,370
13. M/B "Mactra S" (cap.)	0	3,741	1,067	0	0
14. M/B "Mactra S" (op.)	0	3,965	4,724	5,988	6,340
15. M/B "Pandalus" (cap.)	0	3,106	990	0	0
16. M/B "Pandalus" (op.)	0	3,595	5,443	7,378	6,930
17. M/V "J.J. Cowie" (op.)	0	15,559	15,352	14,368	15,140
18. Fishing gear	595	456	854	2,630	8,500
19. Lobster	17,876	24,635	21,013	21,231	25,380
20. Shrimp	0	0	1,344	433	740
21. Oyster	7,255	10,310	10,356	11,902	15,030
22. Shellfish poison	991	1,938	1,882	976	3,000
23. Soft-shelled clam	2,638	6,635	6,140	8,866	7,555
24. Scallops	0	1,582	2,472	3,139	5,425
25. Bar clam	797	1,437	2,194	550	580
26. Groundfish general	9,856	14,545	14,601	18,018	22,230
(a) Yellowtail	0	1,899	200	0	0
(b) Cod-worms	0	1,479	1,443	1,641	930
(c) Halibut	0	2,065	2,405	0	0
(d) Long-lining	0	1,331	0	0	0
(e) Canadian Plaice	0	0	1,113	0	0
(f) Flounders	0	0	2,752	2,425	560
(g) Danish seining	0	0	0	1,894	3,400
(h) Gill-netting	0	0	0	0	3,800
27. Herring	252	0	0	0	0
28. Herring (through AHIC)	6,697	8,145	8,725	7,659	7,833
29. Mackerel	0	767	1,766	1,222	1,665
30. Smelt	9,601	13,970	14,980	15,517	19,040
31. Trout	6,907	9,242	11,212	12,878	21,015
32. Salmon	2,478	2,665	10,958	15,281	20,755
33. Eel-grass	0	0	0	1,262	3,500
34. Seaweeds	1,570	1,534	499	639	2,710
35. Hydrography (through AOG)	274	5,364	8,460	14,737	22,801

	<u>Actual</u> <u>1945-46</u>	<u>Actual</u> <u>1946-47</u>	<u>Actual</u> <u>1947-48</u>	<u>Antici-</u> <u>pated</u> <u>1948-49</u>	<u>Preliminary</u> <u>estimates</u> <u>1949-50</u>
36. Seals	0	0	0	0	6,450
37. Misc. Investigations	0	0	0	2,588	4,520
38. Conferences (FAO and ICES)	496	577	567	390	0
39. Museum	0	0	0	518	1,790
40. Electrical collection	0	0	0	0	4,500
Total	<u>106,097</u>	<u>184,247</u>	<u>203,769</u>	<u>226,661</u>	<u>317,196</u>

ORGANIZATION
(as of August 1, 1948)

Director

Assistant Director

Scientific Assistant to Director

A.W.H. Needler, Ph.D.

D.G. Wilder, Ph.D.

L.R. Day, M.A.

A. Scientific and Investigational Staff

1. Lobster (including Shrimp)

Senior Biologist in charge

Technician I

" I

Assist. Technician II

" " II

" " II

Sen. Res. Assist.- Seasonal

D.G. Wilder, Ph.D.

G.J.W. Sullivan

R.C. Murray

L.G. Kervin

U.J. Walsh

W.W. Yorston

D.S. Willoughby, B.A.

2. Oyster

Assoc. Biologist in charge

(also in charge of Dept. of
Fisheries Oyster Culture Staff)

Assist. Technician II

" " II

" " II

Jun. Res. Assist.- Seasonal

" " " "

" " " "

" " " "

" " " "

" " " "

R.R. Logie, M.A.

Alice J.L. Wyman, B.A.

Barbara L. Shaw, B.Sc.

(resigned Sept. 1)

P.C. MacCaul

A.J. Wilson

J.A. Delahunt

R.J. Kerr

M.V. MacInnis

J.H. Neil

3. Clam and Scallop (including bar-
clam and toxicities)

Biologist in charge

Technician I

Sen. Res. Assist.- Seasonal

Jun. " " "

J.C. Medcof, Ph.D.

J.S. MacPhail

A. Larocque, B.Sc.

Frances I. Beairsto

4. Groundfish

Biologist in charge

Technician I

" I

Assist. Technician III

" " III

Stenographer I

Sen. Res. Assist.- Seasonal

" " " "

" " " "

W.R. Martin, Ph.D.

Jas. Craig

D.N. Fitzgerald

Ruth I. Peterson, B.Sc.

M.F. Fraser

Shirley B. Gibson

F.D. McCracken, M.A.

D.M. Scott, M.Sc.

A.R. Kempton

5. Herring

Principal Biologist (Investi-
gator-in-Charge A.H.I.C.)

A.H. Leim, Ph.D.

6. Mackerel

Assist. Biologist - Seasonal

L.P. Chiasson, Ph.D.

7. Smelt
 Assoc. Biologist in charge R.A. McKenzie, M.A.
 Assist. Technician III I.M. Jones
 " " I Evelyn R. MacMillan
8. Salmon
 Biologist in charge P.F. Elson, Ph.D.
 Assoc. Biologist H.C. White, B.A.
 Assist. Technician II H.W. Coates
 Sen. Res. Assist.- Seasonal J.A. Aikins, B.Sc.
9. Trout
 Biologist in charge M.W. Smith, Ph.D.
 Assist. Technician II Lena C. Miller, B.Sc.
 " " II C.R. Hayes
 Sen. Res. Assist.- Seasonal G.K. Higgins, B.Sc.
 Jun. " " " R.M. Spence
 " " " " R.V. Scott
10. Eel-grass
 Assist. Biologist - Seasonal A.R.A. Taylor, B.A.
11. Irish moss
 Sen. Res. Assist.- Seasonal A.E.C. MacRae
12. Miscellaneous (including tuna
 and billfish, museum and library)
 Assoc. Biologist in charge L.R. Day, M.A.
 Stenographer I (Library) Lois G. McMullon
 Jun. Res. Assist.- Seasonal Marjorie I. Vail
 (Museum)
13. Statistical Consultant
 Assoc. Biologist - Seasonal G.F.M. Smith, Ph.D.
14. Hydrography
 Senior Hydrographer (Senior
 Oceanographer J.C.O. and Oceano-
 grapher-in-Charge A.O.G.) H.B. Hachey, M.Sc.
 Assoc. Hydrographer H.J. MacLellan, M.Sc.
 Assist. Technician III E.L. Graham
 Stenographer III (employed by
 N.R.C. through F.R.B.) Helen E. Rigby
 Sen. Res. Assist.- Seasonal Audrey L. Mooers, B.Sc.
15. General Laboratory Assistance
 Jun. Lab. Assist. II Mary Holmes

B. Administrative and Maintenance Staff

1. Director's Secretary and Office
 Stenographer III Nina M. Parker
 Stenographer II Winifred E. Dougherty
 Clerk I Juanita C. Conley

2. Accounts, Stores and General
Supervising Clerk
Clerk III
J.A. Rogers
Frances L. Stinson

3. Buildings, Grounds and Boats
Curator
Maintenance Supervisor IV
Caretaker II
" II (Watchman)
E.G. Rigby
H.Y. Brownrigg
K. Johnston
W.D. Stuart

- "J. J. Cowie"
Assist. Tech.III (Captain)
Engineer
Two additional crew
F.A. Magarvey
B.W. Hart

- "Mactra S"
Technician I (Captain)
Two additional crew
H.H. Butler

- "Pandalus"
Assist. Tech.III (Captain)
One additional crew
A.L. Outhouse

4. General Field Assistance
Collector
A.E. Calder

STAFF

(to December 1st, 1948)

(Total staff as of December 1st numbered 47)

A.W.H. Needler, O.B.E., M.A., Ph.D., F.R.S.C. Director
A.H. Leim, B.A., Ph.D. Principal Biologist
D.G. Wilder, M.A., Ph.D. Senior Biologist
H.B. Hachey, M.B.E., E.D., M.Sc. Senior Hydrographer
P.F. Elson, M.A., Ph.D. Biologist
W.R. Martin, M.A., Ph.D. Biologist
J.C. Medcof, M.A., Ph.D. Biologist
M.W. Smith, M.A., Ph.D. Biologist
L.R. Day, M.A. Assoc. Biologist
R.R. Logie, M.A. Assoc. Biologist
R.A. McKenzie, M.A. Assoc. Biologist
H.C. White, B.A. Assoc. Biologist
H.J. MacLellan, M.Sc. Assist. Hydrographer (to June 30),
Assoc. Hydrographer (from July 1,
on leave with half pay from Oct.1)

Seasonal:

G.F.M. Smith, B.A., Ph.D. Assoc. Biologist (May 15 - Sept.13)
L.P. Chiasson, B.Sc., Ph.D. Assist. Biologist (May 31 - Sept. 2)
A.R.A. Taylor, B.A. Assist. Biologist (May 17 - Sept.10)
J.A. Aikins, B.Sc. Sen. Res. Assist. (June 14 - Aug.31)
G.K. Higgins, B.Sc. Sen. Res. Assist. (May 10 - Sept.14)
A.R. Kempton Sen. Res. Assist. (May 1 - Sept. 8)
A. Larocque, B.Sc. Sen. Res. Assist. (June 3 - Sept. 7)
F.D. McCracken, M.A. Sen. Res. Assist. (May 6 - Sept. 23)
A.E.C. MacRae Sen. Res. Assist. (June 21 - Sept.8)
D.M. Scott, M.Sc. Sen. Res. Assist. (April 28 - Aug.24)
D.S. Willoughby, B.A. Sen. Res. Assist. (May 19 - Sept.24)
Frances I. Beairsto Jun. Res. Assist. (June 1 - Sept.30)
J.A. Delahunt Jun. Res. Assist. (June 1 - Sept.12)
R.J. Kerr Jun. Res. Assist. (June 1 - Sept.15)
M.V. MacInnis Jun. Res. Assist. (June 1 - Sept. 6)
J.H. Neil Jun. Res. Assist. (June 1 - Sept.10)
R.V. Scott Jun. Res. Assist. (May 20 - Sept.14)
R.M. Spence Jun. Res. Assist. (May 17 - Sept.24)
Marjorie I. Vail Jun. Res. Assist. (May 31 - Aug. 31)
A.J. Wilson Jun. Res. Assist. (June 1 - Aug. 31)

Alfreda B. Needler, M.A., Ph.D. Volunteer Investigator
Dorothy H. Martin, M.A. Volunteer Investigator
Verna Z. Smith, M.A. Volunteer Investigator

E.G. Rigby Curator
A.E. Calder Collector
H.Y. Brownrigg Maintenance Supervisor IV
K. Johnston Caretaker Grade II
W.D. Stuart Caretaker Grade II (Watchman)

J.A. Rogers, A.C.B.A. Supervising Clerk
Nina M. Parker Stenographer Grade III
Winifred E. Dougherty Stenographer Grade II
Frances L. Stinson Clerk Grade II
Shirley B. Gibson Stenographer Grade I
Lois G. McMullon Stenographer Grade I
Juanita C. Conley Clerk Grade I (May 1 - Oct. 31)
Mary E. Lawson Stenographer Grade I (from Nov.1)

Ruth I. Peterson, B.Sc., R.T.	Assist. Tech. Grade III
Lena C. Miller, B.Sc.	Assist. Tech. Grade II
Audrey L. Mooers, B.Sc.	Assist. Tech. Grade II (from May 25)
Barbara L. Shaw, B.A.	Assist. Tech. Grade II (to July 31)
Alice J. L. Wyman, B.Sc.	Assist. Tech. Grade II (from June 29)
Evelyn R. MacMillan	Assist. Tech. Grade I
Mary Holmes	Jun. Lab. Assist. Grade II

James Craig	Technician Grade I
D.N. Fitzgerald	Technician Grade I
J.S. MacPhail	Technician Grade I
R.C. Murray	Technician Grade I
G.J.W. Sullivan	Technician Grade I
M.F. Fraser	Assist. Tech. Grade III
E.L. Graham	Assist. Tech. Grade III (from Apr. 1)
I.M. Jones	Assist. Tech. Grade III
H. Ward Coates	Assist. Tech. Grade II
C.R. Hayes	Assist. Tech. Grade II
L.G. Kervin	Assist. Tech. Grade II
P.C. MacCaull	Assist. Tech. Grade II
U.J. Walsh	Assist. Tech. Grade II
W.W. Yorston	Assist. Tech. Grade II

H.H. Butler	Technician Grade I (from Jan. 15/48)
F.A. Magarvey	Assist. Tech. Grade III (March 22 - Oct. 31)
A.L. Outhouse	Assist. Tech. Grade III (from Apr. 4)

Employees of Atlantic Herring Investigation Committee
with headquarters at Atlantic Biological Station

A.H. Leim, B.A., Ph.D.	Investigator-in-Charge (seconded by Fisheries Research Board)
L. Lauzier, M.Sc., D.Sc.	Hydrographer (seconded by Quebec Department of Fisheries)
S.N. Tibbo, M.A.	Zoologist (seconded by Newfound- land Dept. of Natural Resources)
Beulah A. M. Bartlett, B.Sc.	Assist. Tech. Grade II (to Nov. 8)
Phyllis J. Gibson	Jun. Lab. Assist. Grade II
Jean H. Foley	Stenographer I (Apr. 20 - June 19)
Marian E. Tabor	Stenographer II (from Aug. 2)
W.R. Collishaw	Master (to Oct. 31)
H.F. Strum	Master (from Oct. 7)
L.J. Lewis	Master
R.J. Simpson	Assist. Tech. Grade II (March 8 - Oct. 31)
A.F. Leger, B.Sc.	Jun. Res. Assist. (June 3 - Sept. 12)
K.G. Sollows	Jun. Res. Assist. (May 28 - Sept. 12)
D.S. Johnson	Engineer (May 25 - Oct. 31)

Personnel of Atlantic Oceanographic Group
with headquarters at Atlantic Biological Station

H.B. Hachey, M.B.E., E.D., M.Sc.	Oceanographer-in-Charge
H.J. MacLellan, M.Sc.	Assoc. Hydrographer
Helen E. Rigby	Stenographer III
E.L. Graham	Assist. Tech. Grade III
Audrey L. Mooers, B.Sc.	Assist. Tech. Grade II

PUBLICATIONS

- Day, L. R. "Fishing eels." Atl. Biol. Stn. Circular No. 13. (In press)
- Hachey, H. B. "Present status of Oceanography in Canada." (Presented at International Association Oceanography, Oslo Assembly, 1948. Submitted for publication in Canadian Geophysical Bulletin).
- Hachey, H. B. and McLellan, H. J. "Cycles of temperature in surface water of the Canadian Atlantic coast." Prog. Rept. Atl. No. 43, Note No. 106, pp. 7-9.
- "High surface sea-water temperatures in 1947." Prog. Rept. Atl. No. 42, pp. 4-6.
- "Trends and cycles in surface-water temperatures on the Canadian Atlantic coast." Jour. Fish. Res. Bd. Can. (In press)
- Martin, W. R. "Flounders of the Maritimes." Atl. Biol. Stn. Circular No. 12.
- Medcof, J. C. "A snail commensal with the soft-shell clam." Jour. Fish. Res. Bd. Can. 7(5): 219-220.
- "Meat yield from Digby scallops of different sizes." Prog. Rept. Atl. (In press)
- "'Puddling' - a method of feeding by herring gulls." "The Auk". (In press)
- Needler, A. W. H. "Estimating fishing intensities." Bull. Bingham Oceanographic Collection, Vol. XI, Art. 4, May 1948, pp. 165-171.
- Smith, M. W. "Yield of speckled trout to anglers from certain lakes in New Brunswick and Nova Scotia." Prog. Rept. Atl. No. 42, Note No. 103, pp. 7-10.
- "Fertilization of a lake to improve trout angling." Prog. Rept. Atl. No. 43, Note No. 105, pp. 3-7.
- "Movement and population of speckled trout in a Prince Edward Island stream." Prog. Rept. Atl. No. 43, Note No. 107, pp. 9-13.
- "Preliminary observation upon the fertilization of Crecy lake, N. B." Trans. Amer. Fish. Soc. (1945), 75: 165-174, 1948.
- "Improved trout angling in a small lake after poisoning undesirable fish." The Canadian Fish Culturist, 3(4), pp. 3-6.

- Sullivan, C. M. "Bivalve larvae of Malpeque bay, P. E. I."
Bull. Fish. Res. Bd. Can. (In press)
- Wilder, D. G. "The growth of lobsters at Grand Manan, N. B."
Prog. Rept. Atl. No. 41, Note No. 102, pp.14-16.
- "The protection of short lobsters in the market
lobster areas." Atl. Biol. Stn. Circular No.11.

PUBLICITY

BROADCASTS

CBC Fisherman's Broadcasts:

April 22	H. B. Hachey	International ice patrol and the Labrador current
April 29	S. N. Tibbo	Bay of Islands herring investigation
May 6	W. R. Martin	Flounder dragging
May 13	H. C. White	The salmon's redd or nest
May 20	P. F. Elson	The life cycle of the salmon
May 27	P. F. Elson	Young salmon in streams
June 3	P. F. Elson	The sea life of the salmon
June 10	R. A. McKenzie	Clearing smelt streams
June 17	R. A. McKenzie	Smelt predators
June 24	W. R. Martin	Halibut fishing
July 2	H. B. Hachey	Warm surface waters in 1947
July 8	R. R. Logie	Oyster spat production in Shippigan area
July 15	M. W. Smith	Movements of speckled trout
July 22	M. W. Smith	The life history of the eel
July 29	H. C. White	Methods of catching eels
August 26	J. C. Medcof	The sunfish
September 2	D. G. Wilder	The growth rate of lobsters
September 9	D. G. Wilder	The effect of fishing on the stocks of lobsters
September 16	J. C. Medcof	The Digby scallop fishery
September 23	D. G. Wilder	Exploration for shrimp
September 30	J. C. Medcof	Bar clam survey
October 7	M. W. Smith	Poisoning undesirable fish in lakes
October 14	M. W. Smith	Lake fertilization
October 21	J. C. Medcof	Clam drill study
October 28	J. C. Medcof	Clam drill control
November 4	D. G. Wilder	The life history of the lobster
November 11	D. G. Wilder	Offshore lobster fishing
November 18	F. D. McCracken	Winter flounder dragging
November 25	S. N. Tibbo	The life history of the herring
December 2	L. R. Day	Herring populations
December 9	S. N. Tibbo	Herring tagging experiments
December 16	L. R. Day	Good and bad herring years

CBC Summer Fallow Programme:

May 10 A half-hour trans-Canada dramatic presentation of the story of the development of modern oyster culture production.

CBC International Service Programme, "Canadians at Work":

September 25 A half-hour broadcast on the Canadian Atlantic herring, including an account of the Atlantic Herring Investigation Committee's work.

FIILMS

National Film Board feature in oyster farming photographed at P.E.I. Biological Station. Not released as yet.

MAGAZINE AND NEWSPAPER ARTICLES

- August 25 "Where fish are studied" - a description of the Atlantic Biological Station's work. In the Saint John Telegraph-Journal's New Brunswick Parade.
- September 15 "Monarch of the oysters" based on information received from P.E.I. Biological Station. Maclean's Magazine.
- October 16 "Fish fact-finding." Pictorial coverage of the Atlantic Biological Station's work. In the roto-gravure section of the Montreal Standard.

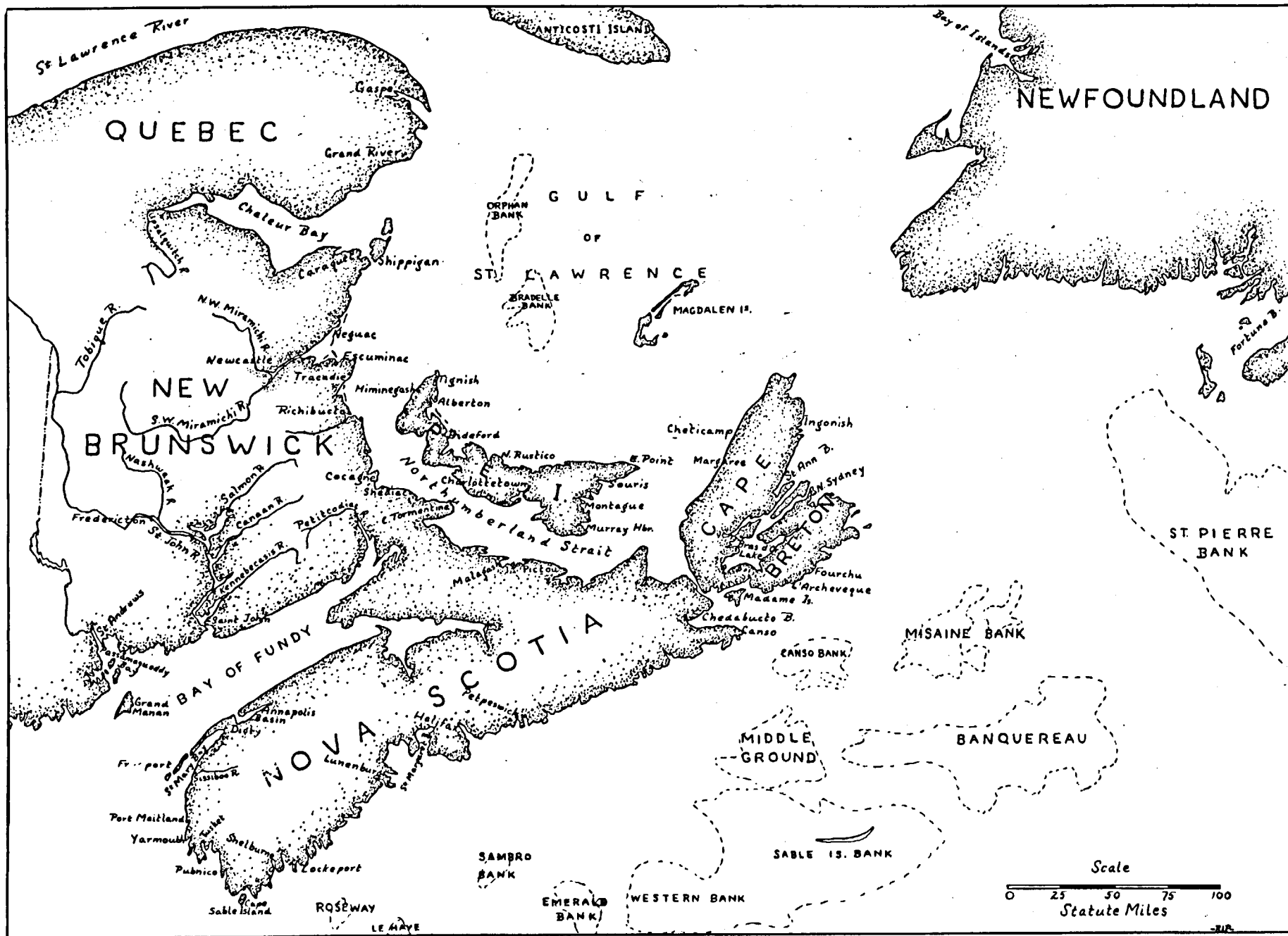
EXHIBITIONS

- September 14-18 Lunenburg Fisheries Exhibition. Two sections illustrating lobster investigations and fishing methods.

INDEX TO SUMMARY REPORTS

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Shellfish poisoning	14	20 - 21
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Outline map showing principal places of work referred to in summaries.



St. Lawrence River

QUEBEC

NEWFOUNDLAND

GULF OF ST. LAWRENCE

NEW BRUNSWICK

NOVA SCOTIA

BAY OF FUNDY

PRINCE EDWARD ISLAND

ST. PIERRE BANK

MISAINÉ BANK

MIDDLE GROUND

BANQUEREAU

SABLE IS. BANK

SAMBRO BANK

EMERALD BANK

WESTERN BANK

Scale

0 25 50 75 100
Statute Miles

SUR

GENERAL SUMMARY OF LOBSTER AND SHRIMP INVESTIGATION

As in the past few years, a major part of the lobster investigation was centred around lobster population studies. Population estimates based on tag returns and catch statistics were made at seven ports. In most cases a good correlation can be shown between these estimates and other indices of abundance such as catch per trap haul or catch per boat. At each port the average sizes of legal-sized lobsters are remarkably constant from year to year and show no relation to population density. (Appendix 2).

On the north side of Prince Edward Island fishermen do not fish beyond 12 fathoms, though there is an extensive area of water less than 25 fathoms deep. If, as in other parts of the Maritimes, appreciable numbers of lobsters occur in the 12- to 25-fathom zone, then P.E.I. fishermen are now fishing an unknown fraction of the total stock. Fishing conducted by the "J. J. Cowie" at 5 to 25 fathoms off Alberton indicates that lobsters in this area are scarce beyond 10 fathoms and that fishermen are now fishing virtually the complete stock. More reliance can now be placed on fishing mortality estimates based on inshore taggings. (Appendix 3).

Growth studies designed to determine the growth rate of lobsters under natural conditions through marking were continued in 1948. Experiments completed at Tignish, P.E.I., and Grand Manan, N.B., indicate an annual growth of 14.3% and 15.2% respectively. New experiments were started at Port Maitland, Abbott's hbr., and L'Archeveque and should be completed in the spring of 1949. (Appendix 4).

Systematic towing for lobster larvae was initiated this year as a possible means of predicting subsequent abundance of legal-sized lobsters. Several years' work will be required to establish the relation of larval abundance to subsequent commercial catches. Comparison of the 1948 results with similar data collected in 1938 and 1939 indicates a year-to-year variation of 6 to 1 in the production of first-stage larvae. (Appendix 5).

Heavy mortalities of impounded lobsters in the summer of 1947 suggested an epidemic of the "pink-tail" disease, a blood disease caused by Gaffkya bacteria. Field observations from June 1, 1948, to September 21, 1948, at Caribou, N.S., and Cape Binet, N.B., failed to reveal presence of the disease this year. Over 1,100 blood smears and 500 culture plates were prepared from freshly-caught and impounded lobsters but the presence of Gaffkya could not be demonstrated. No unusual mortalities occurred among impounded lobsters this summer. (Appendix 6).

A disinfectant such as chlorine would be useful in combating sewage contamination and possibly the spread of disease among impounded lobsters. Tests show, however, that lobsters cannot withstand continued exposure to concentrations of chlorine as low as 0.2 to 0.3 ppm. Exposure to 4.0 ppm. for 80 minutes was definitely lethal and exposures to this concentration for 5 or 10 minutes seemed responsible for subsequent

death. Further tests using other, possibly less toxic, disinfectants are needed. (Appendix 7).

Exploration from Pubnico, N.S., to Chedabucto bay, N.S., in 5 to 95 fathoms from March 29 to April 30 failed to reveal commercial quantities of the pink prawn, Pandalus borealis. A few commercial-sized specimens of this species were taken in two drags off Shelburne, N.S., in 70 and 95 fathoms. Life history studies of the shrimp species occurring in Passamaquoddy bay were initiated. It is planned to continue the survey in 1949 starting early in February. (Appendix 8).

D. G. Wilder

Appendix No. 2

LOBSTER POPULATION STUDIES

Lobster population studies were continued in 1948 in two canner-lobster areas and in five market-lobster areas. The purpose of this work is to determine the effect of the fishery on the abundance and size composition of the lobster stocks and to provide a basis for sound regulatory measures.

At each port from 500 to 1,000 legal-sized lobsters were tagged with monel metal carapace tags and distributed over the fishing grounds either just before or as soon as possible after the opening of the season. Commercial catches were examined throughout each season, from 5,000 to 15,000 lobsters being measured at each port. Daily catch records were obtained for almost all the fishermen at each port.

Initial population densities have been estimated from the total landings, the number of tags returned and the size of the areas fished and are presented in the following table. Previous population estimates for the same ports, revised to correspond with increasing knowledge of the areas, have been included for comparison. Two other indices of abundance, the average catch per trap haul and the average catch per boat (based on 10 highest boats), are included for comparison with the estimated population densities. The percentage tag returns and the average size of lobsters are also listed. All figures in the table refer to legal-sized lobsters only.

The data show a good correlation between catch per trap haul and population density at Tignish, Miminegash and Port Maitland. Similarly there is a good correlation between catch per boat and the estimated population density at Tignish, Miminegash, Fourchu, L'Archeveque and Port Maitland.

The Fourchu data are of particular interest since in 1947 the minimum legal size was increased from 7" total length to 3 1/8" carapace length (about 9" total length). According to these data the population density of market lobsters at Fourchu in 1948 was 86% higher than in 1947, whereas in the nearby, similar grounds at L'Archeveque where no change was made in the size limit the increase from 1947 to 1948 was only 27%. The greater improvement at Fourchu is also reflected in the catch per trap haul and the catch per boat.

Port		Pop'n. density lbs. per sq. mi.	Av. catch per trap haul lbs.	Av. catch per boat per year lbs.	Av. size cm.	% tag returns
Tignish*	44	16,500	0.81	9,400	19.6	56
P.E.I.	45	27,200	1.23	12,900	20.1	45
	46	21,000	0.86	12,300	20.1	71
	47	13,000	0.58	6,900	19.8	66
	48	11,800	0.38	6,700	20.0	68
Miminegash*	45	14,900	0.79	6,100	20.7	70
P.E.I.	46	11,100	0.63	4,500	20.6	76
	47	7,500	0.57	3,800	20.3	84
	48	11,000	0.67	4,600	20.5	83
Fourchu ⁺	45	4,400	0.72	3,500	25.9	45
N.S.	46	6,200	0.75	4,500	25.6	50
	47	3,600	0.69	3,200	25.6	41
	48	6,700	1.15	6,100	25.5	45
L'Archeveque ⁺	45	12,000	1.04	3,700	25.3	62
N.S.	46	11,600	0.78	3,500	25.4	68
	47	8,800	0.78	2,600	25.4	64
	48	11,200	0.91	3,700	25.7	71
Port Maitland ⁺	44-5	53,300	1.73	18,500	25.4	20
N.S.	45-6	22,900	1.32	14,300	25.4	44
	46-7	24,400	1.34	11,500	25.0	35
	47-8	22,900	1.32	13,700	24.9	46
Abbott's hbr. ⁺	45-6	16,500	0.84	5,000	25.4	63
N.S.	46-7	13,600	0.81	5,400	25.6	62
	47-8	14,000	0.88	7,000	26.1	68
Seal cove ⁺	46-7	14,200	1.53	9,600	25.9	53
N.B.	47-8	17,300	1.41	12,000	26.0	59

* canner-lobster areas, size limit 7" total length

⁺ market-lobster areas, size limit 3 1/8" carapace length (about 9" total length)

The average sizes of legal-sized lobsters are remarkably constant from year to year and show no relation to the estimated population densities.

D. G. Wilder

Appendix No. 3

OFFSHORE LOBSTER FISHING, ALBERTON, P. E. I.

On the north side of P.E.I., lobster fishing is conducted almost entirely in water less than 12 fathoms deep, although in this region the bottom slopes very gradually and there is an extensive area of water less than 25 fathoms. Since depths up to 25 fathoms are fished successfully in other parts of the Maritimes it seemed possible that considerable quantities of lobsters might occur off P.E.I. in the 12- to 25-fathom zone. If this were the case the fishermen would be fishing an unknown fraction of the total lobster stock, thus making the interpretation of fishing mortality estimates based on inshore taggings difficult.

To determine the relative abundance of lobsters in relation to depth, lots of 10 lobster traps were fished at 5-fathom intervals from 5 to 25 fathoms off Alberton, P.E.I., from June 8 to July 3. Adverse weather conditions seriously interfered with these operations but the results appear clear-cut.

Depth - fathoms	5	10	15	20	25
No. of trap hauls	91	93	102	86	24
No. of lobsters caught	26	62	0	0	0

From these observations it is concluded that in this area lobsters are relatively scarce beyond 10 fathoms and that virtually the complete stock is now subjected to fishing.

Forty of the legal-sized lobsters caught were tagged and liberated off Alberton in 20 fathoms. To date only one of these, a 19-cm. male, has been reported. This lobster, which was liberated June 29, was found in the stomach of a cod landed at Tignish, P.E.I., on July 2.

The offshore fishing was conducted by Capt. F. A. Magarvey in the "J. J. Cowie". L. G. Kervin was responsible for recording the observations.

D. G. Wilder

Appendix No. 4

LOBSTER GROWTH STUDIES

Experiments which were started in the spring of 1947 with the view to obtaining information on the growth rate of lobsters under natural conditions were continued and extended during the current year.

At Tignish, P.E.I., a total of 2,446 lobsters from 6" - 8" total length were distinctively marked in five 1/8" carapace length groups by means of a hole punched in one of the five sections of the tail fan. These were liberated on the fishing grounds from June 13-30, 1947, just prior to the moulting period. During the 1948 spring fishery, 56 of these were recovered, of which all but two had moulted.

A similar marking was conducted at Grand Manan, N.B., from June 10-24, 1947, in which 2,285 marked lobsters from 8" - 10" total length were liberated. From November, 1947, to June, 1948, a total of 178 of these were recovered. Of these 165 (93%) had moulted.

The average carapace lengths in inches of the lobsters when marked and when recaptured were as follows:

Size group	Tignish, P. E. I.			Grand Manan, N. B.						
	Marked No.	Lgt.	Recap'd. No.	Lgt.	Growth Inches	Marked No.	Lgt.	Recap'd. No.	Lgt.	Growth Inches
I	326	2.13	1	2.33	0.20	486	2.81	19	3.28	0.47
II	513	2.25	10	2.53	0.28	534	2.94	41	3.42	0.48
III	626	2.38	27	2.73	0.35	492	3.06	48	3.52	0.46
IV	504	2.50	9	2.87	0.37	429	3.18	25	3.62	0.44
V	477	2.62	7	3.02	0.40	344	3.32	32	3.80	0.48
	2,446		54			2,285		165		

The average growth in carapace length based on all the recaptured specimens which had moulted was 0.34" or 14.3% at Tignish and 0.47" or 15.2% at Grand Manan.

Similar marking experiments were conducted this year at Port Maitland, Abbott's hbr., and L'Archeveque, N.S., where 2,901, 3,746 and 3,431 lobsters were marked respectively. At Port Maitland and Abbott's hbr., commercial catches will be examined for these marked lobsters from December, 1948, to June, 1949, and at L'Archeveque from May to July, 1949. If reasonably reliable estimates can be made of the total number of marked lobsters recaptured, a direct measure of the value of the size-limit regulation can be derived.

D. G. Wilder

Appendix No. 5

PLANKTON TOWS FOR LOBSTER LARVAE

With a view to determining annual variations in the abundance of lobster larvae as a possible means of predicting subsequent abundance of legal-sized lobsters, a programme of systematic towing was initiated this year in the northern part of Northumberland Strait. From June 5 to September 13 whenever weather permitted, half-hour tows were made with a specially designed 12-foot plankton net at a series of 12 stations.

During this period a total of 128 tows were made in which a total of 1,570 larvae were caught. The four larval stages first appeared in the catches on the following dates: First stage - June 21; Second stage - June 29; Third stage - July 2; and Fourth stage - July 19. Unfavourable weather conditions prevented towing after September 13 but by this date negative tows were being obtained for all but the fourth larval stage. The number of each stage caught during the season was as follows:

First stage	Second stage	Third stage	Fourth stage	Total
931	302	189	149	1,570

If these figures represent the relative abundance of the four stages, the natural mortality from the first to the fourth stage is 84%.

To determine the relationship between the estimated abundance of larvae and the subsequent abundance of legal-sized lobsters will, of course, require the continuation of this work for several years. Some suggestion, however, as to the annual variation in the abundance of larvae can be derived from a comparison of the 1948 data with similar data collected in this area in 1938 and 1939. The average catch of each stage per half-hour tow during comparable periods in each year was as follows:

	<u>First stage</u>	<u>Second stage</u>	<u>Third stage</u>	<u>Fourth stage</u>	<u>Total</u>
1938	10.6	3.0	1.8	3.5	18.9
1939	1.8	1.4	0.9	0.8	4.9
1948	7.2	4.2	3.5	2.1	17.0

The field work was conducted from June 5 to July 18 by Capt. H. H. Butler in the "Mactra S" and from July 19 to September 13 by Capt. A. L. Outhouse in the "Pandalus". Capt. Calder designed the special plankton net and instructed the skippers in its use. L. G. Kervin assisted in the collection and tabulation of the data.

D. G. Wilder

Appendix No. 6

LOBSTER BLOOD DISEASE

Early in July, 1947, sudden, heavy mortalities occurred among impounded lobsters in the Northumberland strait area. Microscopic examination of blood smears from some of these lobsters strongly suggested an epidemic of the "pink-tail" disease, a blood disease caused by a gram-positive tetrad bacterium belonging to the genus Gaffkya.

To obtain further information on the disease and possibly to predict an epidemic if such should occur a detailed study was made during the summer of 1948, observations being made at Caribou, N.S., from June 1 to August 11 and at Cape Binet, N.B., from August 12 to September 21.

At Caribou freshly-caught lobsters and culls from Caribou and the Magdalen is., and impounded lobsters from Caribou (held since May 20), Newfoundland and Cape Breton (held since June 12) were examined at regular intervals from June 1 to August 4. In all, over 1,100 blood smears and over 500 culture plates were prepared and examined but in none of these groups could the presence of Gaffkya be demonstrated.

As a possible alternative source of the Gaffkya organisms, samples of sea water from the Caribou vicinity were examined and both a gram-positive and a gram-negative tetrad were isolated. Suspensions of the gram-positive organism were injected into lobsters on July 1 and July 16 but no mortalities which could be ascribed to the organism occurred and attempts to re-isolate

this organism from the injected lobsters failed.

Closure of the factory at Caribou necessitated a transfer of the work and from August 12 observations on the organisms isolated at Caribou were continued at Cape Binet, N.B.

On August 19, eight lobsters were injected with a broth suspension of the gram-positive tetrad and all died within 9 days, no mortalities occurring among the controls. In an attempt to repeat this experiment on September 1 only two of the injected lobsters died within two weeks, equal losses occurring among the controls. Since attempts to re-isolate the organism failed there is no evidence that any of these mortalities were caused by the organisms injected. During the summer lack of adequate laboratory facilities prevented the application of the standard bacteriological tests to this organism. These tests which have now been made show that this organism is not the bacterium to which U.S. workers ascribe the "pink-tail" disease.

In a very preliminary study of the gram-negative tetrad isolated from the sea water at Caribou, two lobsters were injected on September 4 and died on September 10, the controls surviving. In this case since it was possible to re-isolate the organism from both injected lobsters there is a suggestion that bacteria other than Gaffkya may be responsible for some lobster mortalities.

The failure to isolate any gram-positive tetrads from freshly-caught or impounded lobsters or to identify the organism isolated from the sea water at Caribou as Gaffkya, together with the lack of abnormal mortalities in the commercial operations, indicate that the "pink-tail" disease, if present, was much less severe this year than in 1947. Possibly the explanation lies in the unusually high summer water temperatures during 1947.

Summary of D. S. Willoughby's
notes by D. G. Wilder

Appendix No. 7

THE EFFECT OF CHLORINE ON LIVE LOBSTERS

Recognition of the fact that the waters in certain areas, where lobsters are held prior to shipment, are polluted by sewage led to the suggestion by Dr. E. Hess that the resistance of lobsters to a disinfectant such as chlorine be determined. The possible use of a disinfectant in the control of the "pink-tail" disease added further interest.

If lobsters were sufficiently resistant to chlorine the disinfectant could be used commercially by adding it to the water supply where lobsters are held in tanks or by exposing the lobsters for short periods to somewhat higher concentrations.

To determine whether or not lobsters could withstand continued exposure to chlorine three experiments were conducted as follows:

- Exp. #1 - 10 lobsters exposed to approximately 4.0 ppm. Cl. for 24 hours. All died within 94 hours, the average time to recorded death being 36 hours.
- Exp. #2 - 10 lobsters exposed to 0.2 - 0.5 ppm. Cl. for 113 hours. All died within 160 hours, the average time to recorded death being 108 hours.
- Exp. #3 - 10 lobsters exposed to 0.2 - 0.3 ppm. Cl. for 233 hours. All died within 233 hours, the average time to recorded death being 212 hours.

From these experiments it was concluded that lobsters could not withstand continued exposure to concentrations of chlorine as low as 0.2 ppm., and that a water supply sterilized with chlorine must be dechlorinated before exposing the lobsters.

To determine the length of time that lobsters could be exposed to chlorine without adverse effects lots of five lobsters were held in 4 ppm. for 5 minutes, 10 minutes, 80 minutes, 5½ hours and 24 hours. Of those exposed for 5½ or 24 hours all died within four days. Four of those exposed for 80 minutes and all of those exposed for 5 or 10 minutes survived for 10 days when observations ceased. On the basis of these experiments it was concluded that lobsters could withstand exposure to 4.0 ppm. Cl. for at least 10 minutes without adverse effect. However, when these lobsters were re-examined about 2 weeks later most of them were dead. Since no unusual mortalities among other lobsters were noticed during this interval it is believed that the short exposures to chlorine were responsible for these deaths.

Additional experiments are needed to determine the effect of short exposures to lower concentrations of chlorine and to determine the resistance of lobsters to other, possibly less toxic disinfectants.

D. G. Wilder

Appendix No. 8

SHRIMP SURVEY

In the 1947 shrimp survey which was conducted from June 13 to October 4 a few Pandalus borealis (the pink prawn), the one species which appears to grow large enough for commercial purposes, were taken off Grand Manan and Canso. The largely negative results of this survey were not entirely unexpected since the shrimp fishery in the similar Maine waters is conducted during the late winter and early spring.

This year the survey was started earlier, continuing from March 29 to April 30, and extending from Pubnico, N.S., to Chedabucto Bay, N.S. A total of 24 half-hour drags were made at 24 stations at depths ranging from 5 to 95 fathoms. In addition, 14 drags were made with a shrimp trawl in the Bras d'Or lakes from May 13 to 26 at 5 to 10 fathoms in connection with the groundfish investigation.

Although a few shrimp of the smaller varieties were taken in 9 of the drags, commercial-sized Pandalus borealis were caught at only two stations off Shelburne, N.S. Four specimens averaging 13.6 cm. in total length were taken in 95 fathoms and two specimens averaging 14.2 cm. were taken at 70 fathoms.

The failure again this year to find commercial quantities of large shrimp, though disappointing, is not considered conclusive evidence that a shrimp fishery in our waters is not feasible. The Maine shrimp fishery was also a failure this year and it may be that, for reasons as yet unexplained, the shrimp failed to concentrate inshore.

The survey will be continued in 1949, starting early in February and making a more thorough search in south-western Nova Scotia.

In addition to this exploratory work, life history studies of the shrimp species which occur in Passamaquoddy bay were initiated this summer. Samples of shrimp which are being collected at two-month intervals are being examined by Alfreda B. Needler.

The survey was conducted by Capt. F. A. Magarvey in the "J. J. Cowie". Mr. U. J. Walsh served aboard in the capacity of observer.

D. G. Wilder

Appendix No. 9

GENERAL SUMMARY OF OYSTER INVESTIGATIONS

The Prince Edward Island Biological Station at Ellerslie, P.E.I., a sub-station of the Atlantic Biological Station, again served as the headquarters for the Board's oyster investigations and for the field supervision and administration of oyster culture. The Board's scientist was responsible for both programmes, but on October 25 Mr. G. A. C. Wilson reported for duty as Administrative Officer and he will eventually assume complete responsibility for the Department's administration in this field. When this arrangement is completed, much of the time of the Board's investigator, currently occupied with administrative matters, will be released to research efforts. It is anticipated that the present high degree of co-operation between oyster investigations and oyster culture administration will continue with benefit to both.

Due to this pressure of administrative duties, it was impossible to undertake any long-term investigations but many matters of concern to the fishery were examined with the aid of seasonal Research Assistants. At Ellerslie A. R. A. Taylor commenced a study of eel grass, Zostera marina, which is intended to lead to the development of methods of control. R. J. Kerr commenced an investigation of vertical distribution of oyster larvae (Appendix 11); A. J. Wilson continued his work on certain features of the oyster disease and on growth rates. The writer continued the study of comparative death rates of resistant and

non-resistant oysters exposed to the oyster disease and devised a standard sampling technique to obtain a more reliable estimate of spatfall (Appendix 10).

Field investigations from which local oyster culture methods will be developed were prosecuted at Shippigan, N.B., by M. V. MacInnis; at Hardwicke, N.B., on Miramichi bay by J. H. Neil; and at Shediac, N.B., by J. A. Delahunt. In addition the writer conducted a survey of the waters of The Great Lagoon, Magdalen Islands, to assess their suitability for oyster production, in response to a request from the Quebec Department of Fisheries.

A visit was made to Dr. V. L. Loosanoff of the U. S. Fish and Wildlife Service at his laboratory in Milford, Conn., at which time the operation of the seed-oyster industry in that area was observed. Visits were received from Mr. H. G. Bright, an emissary of the South African Fisheries Development Corporation; from a French mission of two prominent oyster growers and Dr. Louis Lambert of l'Office Scientifique des Peches Maritimes; and from Dr. P. Korringa, oyster scientist employed by the Netherlands Government. From each of these visits much valuable information was obtained concerning the oyster industry in other countries, some of which may be adaptable to our industry.

The 1948 spawning and growing season. Spawning was vigorous throughout July and in early August, but the major set was late, taking place on the last day of July and the first two of August. In the Malpeque bay area the Department's collectors, placed mainly in Bideford river and Paugh's creek, caught a good set of 2,000-2,500 spat per filler but test collectors put out in Trout river, the main commercial catching ground, had less than 1,000 per filler, a poor figure. The commercial growers caught so much spat last year that they did not put out any collectors this year so that the poor set in Trout river had no ill effect on the industry. However, it is difficult to explain the poor showing of Trout river this year and the need for more knowledge of the factors affecting settlement of spat is indicated. Similarly, the set at Malagash, N.S., a reliable collecting area, was a total failure this summer for reasons that are not immediately apparent. In this case a violent storm occurred just before the predicted settlement date and may have had something to do with it, but in the present state of our knowledge this must be regarded as a guess. In all other areas collectors put out to catch sets predicted by Miss Alice Wyman yielded good catches of about 1,500 per filler.

The oysters grew well during the summer and seemed to "fatten" somewhat earlier in the autumn than they did last year. It would appear that the incidence of oysters badly damaged by boring sponges, presumably of the genus Cliona, is on the increase. In any case, the growers are complaining more vigorously about it. This sponge honeycombs the shell with burrows and spoils its appearance in addition to rendering the shell very fragile. Investigations will be commenced to discover whether the meats of such oysters are thinner or not, but off-hand it would not appear that they are. Even if the damage is confined to the shell, it does definitely render the oysters

unattractive in the market and its widespread occurrence could be very serious to the industry (see also Appendix 22).

Growth rate studies. In 1947 experiments were commenced to discover whether or not fast-growing strains existed in any oyster population of a given age. The results failed to reveal any such strain, but the design of the experiment was criticised as crude. Accordingly, the method was improved this year and the experiment was repeated. Before a positive statement of results can be made the data will have to be considered by the use of statistical analysis, for which there has not yet been time, but a quick examination of the figures leads to the tentative conclusion that no fast-growing strain has yet been demonstrated.

Investigations at Shippigan, N.B. Last year it was felt that enough was known about the peculiarities of spat sets in the oyster-producing waters of this district to attempt large-scale trials of the indicated areas and methods. The facilities of the newly-established experimental oyster farm were employed to set out 5,000 fillers in the lee of Bandy island. Four fillers were wrapped in a bundle and the bundles were strung from ridge-poles rather than from floating equipment because of the shallowness of the water at low tide. The settlement date for the most promising brood of larvae was predicted by M. V. MacInnis and turned out to be earlier than in other areas. A good set of 1,500-2,000 per filler was caught on July 23 and the ensuing few days. For about a week growth was good and it appeared that a successful method of catching the natural spat-fall had been demonstrated. At some time in this week an enormous set of barnacles covered the collectors and the subsequent rapid growth of the barnacles smothered the greater part of the oyster set. Those that did manage to survive were crowded and soon became distorted in shape. A check-up of barnacle sets in the entire area of St. Simon south inlet showed that they were confined to definite small localities which are not constant from one year to another. There would seem to be little possibility of avoiding them by placing the collectors elsewhere than at Bandy island. This is undesirable in any case since Bandy island is by far the most promising collecting area. Some hope of solution is offered by the results of trials in the United States of the efficacy of DDT in inhibiting barnacle sets. Spraying of the shell collectors used there reduced the oyster set slightly, but almost completely prevented the attachment of barnacles. This method will be tried next season.

Investigations at Hardwicke, N.B. The following are extracts from Appendix No. 14 to the Report of the Atlantic Biological Station for 1947 concerning the work in Miramichi bay: "The bay is very windy and almost never calm and the water of the producing areas is therefore constantly strongly agitated and frequently exposed to near-gales. This summer experimental collector floats were torn loose and lost and egg-crate-filler collectors more securely anchored were smashed flat within their wrappings.....It is now abundantly clear that standard techniques and materials will not work in the exposed areas of the main beds and the choice lies between the application of standard methods in more sheltered areas and the establishment of new techniques."

This summer the first of the two alternatives offered in the final sentence above was investigated. Results were no happier than before and it would appear that this area does not possess a sheltered locality in which a set takes place. In the estuaries of the Bay du Vin and Eel rivers and in Fox island cove collectors of the egg-crate-filler type survived the elements but the catch was negligible, less than 100 per filler. The second alternative now stands alone and will be attempted by the use of a more durable collector. Tile used in the French manner will be tried.

Investigations at Shediac, N.B. The Shediac bay area was once a prominent producer of high-quality oysters. A combination of overfishing and a peculiar, constant spat loss depopulated the beds. There has been no considerable production since the 1920's. The annual production now is of the order of 100 barrels, whereas it reached a peak, in 1914, of 4,000 barrels. A reasonable annual potential for the bay would seem to be in the vicinity of 2,000 barrels.

An investigator was sent to the area this year to discover whether any nearby stocks of oysters existed which could be used to repopulate Shediac bay. Almost at once he found such a stock in Shediac river, which is tributary to the northern part of the bay and is adjacent to the former producing beds. Accordingly the work was focussed on attempting to predict the settlement of the larvae of this stock and to catch them on the standard type of cardboard collector. Periodic examination of oysters from the parent stock showed that spawning was heavy throughout the summer, but at no time were any larvae caught in surface or in deep tows. It is possible that deep tows were attempted too late to have much chance of success. Regardless of this total failure, the prospects of success are much too alluring to abandon and a further attempt will be made to find the workable method of catching these larvae.

R. R. Logie

Appendix No. 10

OYSTER DISEASE INVESTIGATIONS

Mortalities in P.E.I. tray-reared stock. For some years a check has been kept on the course of recovery of native stocks in Enmore and Johnston rivers from the oyster disease which struck these areas in 1935 and 1937 respectively. This has been accomplished by rearing on trays, moored side by side in the rivers in question, native oysters and disease-resistant Malpeque stock. As long as the disease persisted and the native stock had not developed a high degree of resistance, higher percentage mortalities would occur in the native than in the Malpeque oysters. At first these two sets of figures showed a wide difference, with mortalities of eighty and ninety per cent in the native stocks and a negligible mortality in the introduced Malpeque oysters. Of late years, however, the contrast is not so great and, if this trend continues, they will level off at values between which there is no significant difference. There is evidence of such an end-point in the Enmore river

results this year. The interesting point must then be considered as to whether this parity of mortalities is achieved through the development of resistance to the disease or whether the disease itself has died out. It is possible to decide this question by introducing to the suspect waters oysters of known susceptibility to the disease.

Mortalities in Enmore river. In 1947 an unfortunate accident occurred which interrupted the continuity of observations in this river. However, results are now available for mortalities suffered in the 1948 season.

Mortalities in experimental stock, Enmore river

<u>Year class</u>	<u>Percentage of spring survivors which died in 1948</u>
Malpeque 1942	24.4
Native 1942	25.8
Malpeque 1943	20.5
Native 1943	18.8
Malpeque 1944	19.2
Native 1944	18.1

These death rates are very high and some factor was operating on both stocks to cause it. It might possibly have been overcrowding. Assuming that this factor operated equally on both stocks, there would not appear to be any evidence of the disease killing the native stock at a higher rate than the Malpeque oysters. It is impossible to conclude at this juncture that these figures demonstrate the disappearance of the disease as a serious factor. The assumption made above may not be altogether proper; also the disease is known to cause the greatest havoc in the one-, two- and three-year-olds which are not represented in the experimental lots. The loss of these year-classes has now been remedied and further results should be interesting.

Mortalities in Johnston river. In the 1947 report a table was included to show the mortalities from 1944-1947 inclusive. This table is expanded below to cover the 1948 results.

Mortalities in experimental stock, Johnston river

<u>Percentage of spring survivors which died in:</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>
Malpeque 1943	0.4	1.3	1.0	0.8	4.3
Native 1943	9.0	18.3	25.9	11.8	6.6
Malpeque 1945			0.3	1.3	0.4
Native 1945			2.5	6.6	5.7

(Continued)

Percentage of spring survivors which died in:	1944	1945	1946	1947	1948
Malpeque 1946				0.3	2.9
Native 1946				12.5	9.0
Malpeque 1947					0.6
Native 1947					10.4

These figures show the disease to be still operative in Johnston river but on a declining scale. The 1948 death rate of Malpeque 1943 oysters is suspiciously high by reference to the other Malpeque death rates and may be due to other reasons than the disease. The remaining figures are in agreement in pointing out the continued presence of the disease.

Mortalities in introduced New Brunswick and Nova Scotia oysters. In the 1947 report the commencement of this investigation was noted, together with the reasons for it. Briefly the situation is as follows: If, as is suspected, the oyster disease has never been in New Brunswick or Nova Scotia waters, oysters from these waters introduced into previously affected waters in Prince Edward Island should suffer one of two fates: (1) if the disease is still present in their new habitat, they should succumb in large numbers; (2) if the disease is not present, they should show only a small death rate comparable to that of the resistant native stock. This latter result could also be achieved if the disease had been in their native waters years ago and had resulted in the persistence of a resistant strain through natural selection.

In the table the mortalities which occurred in both the 1947 and the 1948 seasons are shown. The figures in each case represent the percentage of the oysters alive in the spring which died during the same summer.

Area of origin	In Bideford river		In Enmore river	
	1947	1948	1947	1948
Malpeque bay, P.E.I.	6.0	12.3	1.0	8.7
Bedeque bay, P.E.I.	1.6	14.9	2.0	9.0
Malagash, N.S.	5.0	29.2	1.0	0.4
Shippigan, N.B.	3.1	34.2	2.0	13.2
Bras d'Or Lakes, N.S.	3.4	51.1	2.8	19.7
Miramichi bay, N.B.	1.1	72.2	5.0	24.9
Tracadia, N.B.	5.2	87.7	2.7	23.3

At the end of the 1947 season it was concluded that the results for that year did not show any significant difference in the death rates of the various oysters and that the disease probably had an incubation period of longer than one summer. The 1948 results go far toward bearing out this conclusion; the 1947

figures were included for purposes of information only and do not have any real place in the current discussion. Once it is noted that death rates in general were higher in 1948 than in 1947 they have served their purpose.

Several points emerge at once from an examination of the 1948 figures tabulated above:

- (1) Mortalities are consistently higher in Bideford river than in Enmore river;
- (2) The mortalities in Bideford and in Enmore river can be grouped in two classes: Malpeque and Bedeque in the one group and all others in the second group. In this latter group there is a considerable range.
- (3) Malagash furnishes both the exception to these generalizations and the borderline case in separation into groups.

Further points noted for consideration are as follows: virtually all deaths occurred during the warm-weather months of June, July, August and September; in Enmore river these deaths showed no peaks in any of these four months; in Bideford river the deaths were generally most numerous in July and August with the percentages of the season's total occurring in these two months as follows: Malpeque 44.7, Bedeque 49.6, Malagash 50.0, Shippigan 80.1, Bras d'Or 91.8, Miramichi 94.5, Tracadie 96.0.

The low mortalities suffered in Enmore river by supposedly susceptible oysters is in line with results previously reported in this appendix for native stocks. The two sets of data considered together point to the conclusion that the low mortalities are the result of a decrease in virulence of the disease itself rather than of a development of resistance. At the same time it must be noted that a definite range of mortalities existed in this river and that very few young oysters were present in the test samples. The foregoing can be summed up by saying that the disease appears to be on the decline in this river and that in two years of exposure it has not demonstrated itself as an important lethal agent in new and presumably susceptible stocks.

In Bideford river a different situation obtains. Striking mortalities occurred which, it is believed, are attributable to the disease. In only very few and rather doubtful cases were dying oysters observed and the bulk of the figures are based on actual deaths. In some of these the symptoms of the disease were absent, but in the majority they were present, with one conspicuous exception. The characteristic yellow pustules or lesions described by all previous workers on this disease did not appear.

It is difficult to explain the widely differing death rates. Since Malpeque oysters are known to be resistant, it can

be assumed that the deaths in these oysters were not caused by the disease. Since the death rate of Bedeque oysters did not differ widely from that of Malpeque stock it can be concluded that they too are resistant, a fact that was suspected for other reasons. It seems reasonable also to assume that the same factor that killed Malpeque and Bedeque oysters operated in a like manner on the other stocks and that the residual mortality was due to the disease. The high mortality in the months of July and August is also characteristic. Whether the difference in percentage mortalities is attributable to differential susceptibilities of the stocks tested or whether there is a time lag which is merely delaying the reaching of maxima remains to be seen from further observations.

It is interesting to note in passing that the oyster disease first manifested in Malpeque bay in 1915 and that diseased native oysters were last noted in 1932. If the demonstration of its continued presence in 1948 be accepted, it means that this disease has persisted for more than thirty years, in the latter half of which it has not manifested itself. The fascinating speculations aroused by this situation need hardly be emphasized.

R. R. Logie and A. J. Wilson

Appendix No. 11

DISTRIBUTION OF OYSTER LARVAE

In order to understand properly the setting behaviour of oysters with a view to improving spat catches, it is necessary to discover how the free-swimming larvae are distributed through the water and, if possible, what causes such a distribution. A certain amount has been found out in other countries, but it is doubtful whether the results are directly applicable to this country. Particularly in Prince Edward Island, hydrographic conditions are different and these seem to be important to larval distribution. In a great measure the spat-producing waters of Prince Edward Island are sheltered, shallow, salt-water inlets with little or no fresh-water inflow and a small tidal amplitude. In the summer months there is no thermocline and only in a few instances is there a halicline.

It would be interesting to know a great deal more about both the horizontal and the vertical distributions and no picture which does not include both can be in the proper perspective, but it would be confusing to commence a study of both at the same time. In commencing this study observations were, therefore, confined this summer to the vertical plane. It was considered possible that the observations taken stood a chance of being immediately useful in indicating the depths at which collectors should be suspended and that, if any strata proved to be of a low productivity, they could be eliminated from future consideration of horizontal distribution. The work was concentrated on discovering just how the larvae were distributed in depth, at the

same time noting the variations in various hydrographic phenomena which might be causal.

Three locations were chosen, all in the near vicinity of the P.E.I. Biological Station: Bideford river, a medium-sized, salt-water inlet; Paugh's creek, a small and more sheltered inlet; and Trout river, a small creek with a fresh-water inflow. In all these localities spat are caught on a commercial basis. Preliminary measurements showed that there was very little flow in Bideford river and Paugh's creek and that most of it was tidal. There was no thermocline nor halicline. At the observation stations the depths varied between five and seven feet with the tide. In Trout river there was a small measurable flow other than the tidal flow and a halicline oscillated between the three- and four-foot levels below the surface. There was no thermocline. Water depth varied between seven and ten feet.

In these three areas samples were taken on an average of once every two days through the larval season. The sampling unit consisted of an inlet hose, a centrifugal pump and a water meter in sequence, the power being provided by a portable gasoline engine. Samples were regulated to 300 litres and were taken at intervals of one foot, where practicable, from the surface of the water to the bottom. The one-foot level immediately below the surface was difficult to distinguish from the surface itself due to superficial disturbance of the water by wind and the next lower level was therefore set at two feet. At each sampling at each level the salinity and the water temperature and, where applicable, the current velocity were determined. A record was kept of the stage of the tide and the general weather conditions at the times of sampling. The samples themselves were concentrated and the larvae in a fixed volume of the concentrate were measured and counted.

During the earlier part of the larval period, 300-litre samples did not contain very many larvae and the work entailed in determining their content was not unreasonable. When the period of heavy production of larvae arrived, they were present in such huge numbers that the work of counting even small fractional volumes took many months and there has not been sufficient time since its completion to assess the data properly. Preliminary examination shows that broad generalizations are easily reached. The following table illustrates one feature of the distribution:

<u>Location</u>	<u>Total larvae taken at all levels</u>	<u>Percentage of total in top four feet</u>
Bideford river	930,370	73.3
Paugh's creek	225,580	95.5
Trout river	353,650	82.6

It is obvious that the top four feet contain by far the most productive strata. At the same time, it would appear that the presence of a halicline is not the factor determining this concentration, as has been suggested by workers in the United States. In Trout river where there was a halicline at about the four-foot level, no greater concentration existed above or below it than in the other areas, where there is no halicline. It has also been suggested that larvae alter their level in response to a low

critical current velocity (0.25 feet per second). This does not seem to be a very obvious feature of the results in Trout river where such an effect could influence the distribution.

Further discussion of the results of this summer's work will have to await closer scrutiny of the movements of the different developmental stages. It is possible that such an analysis may show that the figures quoted above are resultants only and that consideration of the factors may be more illuminating.

R. J. Kerr, Alice Wyman and R. R. Logie

Appendix No. 12

THE EFFECT OF LIGHT ON THE GROWTH OF OYSTERS

The rising costs of materials and labour are making it more and more difficult for oyster farmers to maintain the standard, wooden, floating, rearing trays with wire cloth bottoms that have been in use now for several years. Young oysters will grow in shoal water and on intertidal beaches where they are to a large extent free from attack by starfish and interest in rearing them there is now increasing. In these places conditions are met with that are different from those in trays or on deep-water beds. One of these that is seldom considered is exposure to intense sunlight.

Several years ago the effects of sunlight were studied in a preliminary way by the writer and by Dr. C. J. Kerswill, then of the P.E.I. Biological Station. Recently the results have been assembled and studied with the present industrial problem in mind. They show that by exposure to strong sunlight either in trays or on the beach, the annual growth of oysters in diameter is reduced by one-third; their shells become more symmetrical, deeper-cupped, fluted, thinner, harder and stronger; the shell capacity rises and the fatness of meats increases; the growth of epiphytic plants is increased and of animals, decreased. Some of these features such as greater symmetry are advantageous; others such as slower growth are unfavourable. Just how significant these differences will prove in industrial operations remains to be seen. This summary of the results points out what we should look for with coming changes in practice.

J. C. Medcof

Appendix No. 13

GENERAL SUMMARY OF CLAM AND SCALLOP INVESTIGATIONS

For a number of years investigations of paralytic shellfish poison, soft-shelled clams, bar clams and scallops have been carried on from the Atlantic Biological Station. In 1948 work was continued in all these fields.

The annual appearance of paralytic shellfish poison in the Fundy area was a month late this year and although the toxicity of the shellfish was higher than usual, no illnesses were reported. Several areas in Nova Scotia and New Brunswick were quarantined for one to two months. Poison shellfish were reported for the first time from the St. Lawrence estuary where there were two deaths and several less serious illnesses. Some research is still going on but the work on poison is becoming more and more routine in nature. (Appendix 14).

The elaborate four-year clam-farming experiment at Petpeswick, N.S., was finished this year and showed that when clams were planted too close together their growth was seriously reduced, even though the survival during this period remained high -- 75 to 85%. (Appendix 15). Even the best growth was disappointingly low and it appears that clam farming will succeed only in a few of the most favourable parts of our coast. Many spot plantings are being made to explore the possibilities of various inlets. The results of some of these are encouraging. In other cases growth has been too slow or clam drills or wave action have completely or almost completely destroyed the planted clams. (Appendix 16).

Trial control of clam drills in Belliveau cove, N.S., has shown that manual collection of the snails themselves is not feasible but that gathering their conspicuous egg cases may be effective. A large-scale test of this is underway. (Appendix 17).

The value of various sorts of flat management is being assessed, surveys of the clam resources of the Maritimes and regular checks on the survival of natural "sets" of seed clams are being continued. (Appendix 18).

The scallop investigation has several phases. Mr. Dickie is seeking an explanation for the remarkable year-to-year fluctuations in the Digby, N.S., scallop landings. It appears that water temperature is the controlling factor, although much work has still to be done to substantiate this conclusion completely. (Appendix 19).

An analysis of a commercial firm's carefully-compiled records of the fishing operations by its boats over a six-year period has revealed very interesting features of the fishery that are of importance in the consideration of conservation problems. (Appendix 20). Tagging experiments to measure the fishing mortality and studies of growth rate and meat-yield relative to size are underway. These indicate that the fishery is of moderate intensity and that the present 4" minimum legal size limit is well chosen and should be better observed. (Appendix 21). This regulation is difficult to enforce because present gear retains many under-sized animals and only the shucked meats are landed. Experiments with drags having different-sized mesh are being conducted to see if an efficient drag that allows the escape of young scallops can be devised. (Appendix 23).

The problem of "dark-meat" was investigated and related to a shell disease. This was found responsible, not only for the well-known and undesirable brown discolouration, but also for a very low meat yield from infected animals. (Appendix 22).

The survey of bar-clam resources of the Gulf of St. Lawrence was almost completed this year and a little work done in the Bay of Fundy off Digby. In the former area bar clams are not present in quantities that would justify the operation of costly power dredges of the sort used off Long Island, N.Y. The only possible exception is a small area in Miramichi bay, N.B., and even there the proposition is doubtful. Extensive and densely populated beds of stunted bar clams were discovered in the deep water off Digby. These are probably toxic and, consequently, not useful as food but might be profitably used to relieve the trawl-bait shortage on the south shore of Nova Scotia during the summer dogfish season. This will be tested next year. (Appendix 24).

J. C. Medcof

Appendix No. 14

PARALYTIC SHELLFISH POISON

The Station continued its co-operation with the administrative services of the Department of Fisheries, with the Department of National Health and Welfare, and with the industry in regulating the production and sale of soft-shelled clams from areas affected by paralytic poison. A classification of these and a scheme of sampling them and regulating the fishery was worked out last winter and implemented this summer. This has achieved a considerable saving of sampling effort and reduced the chances of dangerously toxic shellfish finding their way to market. A seasonal scientific assistant, Miss F. Beairsto, was engaged principally to prepare extracts of poison for assay.

In the Bay of Fundy this year the poison appeared over a month later than in 1947 and the shellfish showed higher scores. The toxicity in mouse units per 100 gms. of raw meat of mussels at Head Harbour, N.B., and Centreville, N.S., were respectively 18,500 and 19,300. The Head Harbour maximum was 7,500 in 1947, 6,300 in 1946 and 32,000 in 1945. This is the first year since 1945 that the Annapolis basin has been affected which corroborates our theory that the poison appears there only in the years when it is worst in neighbouring districts.

Quarantines were imposed on the sale of raw clam meats from several harbours on both sides of the Fundy. Return to normal conditions was late and several New Brunswick areas were still closed at the end of October.

No known cases of poisoning were encountered in the Fundy area this year but a number, two of them fatal, were reported for the first time from outside. These occurred at Les Boules, P.Q., on the St. Lawrence river near its junction with

the Saguenay. This is the only other area on our coast where hydrographic conditions resemble those in the Bay of Fundy sufficiently to have made us suspect the presence of the condition. Efforts to sample the area for clam toxicities were made by this Station in 1946. It is unfortunate that they were not pressed, for had the poison been detected there then, the 1948 fatalities might have been avoided by quarantine of the dangerous grounds.

Two experiments were conducted to see if paralytic poison in canned shellfish degenerates during storage as certain results of examinations of commercial packs have indicated. The results of these tests show that degeneration is taking place and indicate storage as a potential treatment of toxic canned stocks.

In the Digby area of Nova Scotia it was found that periwinkles (Littorina litorea), which feed largely on attached littoral plants rather than on plankton, do not contain paralytic poison. In contrast, another snail, the red-banded conch (Neptunea decemcostata), which feeds on toxic scallops, does harbour considerable amounts.

During 1948 a paper has been written by Dr. A. B. Needler dealing with an investigation, carried out from 1944 to 1947 inclusive, into the cause of periodic paralytic shellfish poison in eastern Canada, especially the bay of Fundy. It is believed that the principal cause of paralytic poison is the dinoflagellate, Goniaulax tamarensis, in the food of the molluscs. There is a definite relationship, both from time to time and from place to place, between the presence of G. tamarensis in the plankton and the toxicity of shellfish taken nearby. No such correspondence was evident for any other plankton organism. The abundance of Goniaulax tamarensis is shown to be principally affected by water temperature, by the abundance of the ciliate, Favella ehrenbergii, and possibly by the diatom population.

The work on paralytic shellfish poison is becoming more and more routine in its nature. Very little research is now involved, and it is probably time to consider handing over more and more of it to some other branch of the Department.

J. C. Medcof

Appendix No. 15

EFFECT OF CROWDING ON GROWTH AND SURVIVAL OF SOFT-SHELLED CLAMS

The four-year experiment to show the effect of crowding on growth and survival at Petpeswick was terminated this year and has contributed much useful information. Effort will now be transferred to plantings to test the prospects for clam farming in various localities and under various conditions. Preliminary scanning of the data shows that survival is high but is reduced by crowding. Eighty-five per cent of the stock planted to a

density of 20 and 40 per square foot four years ago survived and 73% of those planted 80 to the square foot.

Growth has been slow by most standards. In the four years $1\frac{1}{2}$ " normal clams have grown only 24%, 18% and 7% when crowded 20, 40 and 80 to the square foot respectively. Stunted clams grew about three-quarters as fast as similarly crowded normals.

All the clams in the plots were dug out and shucked in September to see how crowding affects the yield of meat. The normal and stunted stock planted 20 and 40 to the square foot all yielded $9\frac{1}{2}$ pounds per level bushel of "round" clams. The 80-per-square-foot stock yielded only 9 pounds.

Further observations on the depth of clams in the soil showed that the stunted clams which formerly lived close to the surface in their native high flats have gradually adapted themselves to conditions in the experimental plots. After four years they now live at the same depths as normal clams. The stocks planted 20 per square foot live relatively deeper in the ground than the 40's or 80's even when allowance is made for their larger size. There was no difference between the latter two.

J. S. MacPhail carried out all the observations and compiled the results.

J. C. Medcof

Appendix No. 16

EXPERIMENTAL CLAM FARMING TO EVALUATE VARIOUS GROUNDS

Several transfers of stunted $1\frac{1}{2}$ " seed stock from high-level crowded areas to what seemed to be promising grounds were made this year and the results of similar plantings made in 1947 were assessed. This work was carried out jointly by J. S. MacPhail and the writer.

The five small-scale "spot plants" in Petpeswick harbour, N.S., in 1947, each involving only a few square yards and 1 to 2 bushels of seed, gave various results. One was surprisingly successful. It showed good survival and a 15% size increase in the single year. Three were almost completely destroyed by clam drills and the fifth disappeared entirely. This plot was in ground that showed evidence of shifting and the loss is tentatively attributed to wave or ice action. A re-check of the half-acre relay made on the "Big Flat" in 1944 showed an average survival of 30 to 40% over the four years and an average growth of about 30%. All the surviving clams are now over the 2" minimum legal size limit and most of them over $2\frac{1}{4}$ ".

In Musquodoboit harbour, N.S., 8 spot plants were made to test the suitability of grounds for commercial relays. One

commercial-type transfer of 22 bushels of 1½" seed was made to the "Cocoa sands" where a 1946 spot plant had shown good survival and growth.

Six spot plants were made in Passamaquoddy bay, N.B., where depletion of natural stocks is incipient and where culture methods, if applicable, might help to maintain production. Three of these made at Holt's point were completely destroyed by clam drills within a month. The other three, in the St. Andrews area, show better promise but it is still too early to assess the results. Drills are attacking these too.

It is planned to extend these plantings to explore the potentialities of various places and conditions.

J. C. Medcof

Appendix No. 17

STUDIES ON CLAM DRILLS (POLINICES)

This year the 1947 efforts to reduce the numbers of the lesser drill (*P. triseriata*) on experimental plots in Belliveau cove were assessed. From these it appears that manual collection of adult snails at low tide by day or night has little if any permanent effect. The numbers of snails that could be taken in this way even with great effort was small compared with the total populations of the areas and this year there was no significant difference in the per-square-foot abundance of larger snails on "cleared" and "uncleared" grounds.

The removal of drill egg cases, on the other hand, did have some effect because the 1947 year-class was less abundant in the cleared than in the uncleared area. This encouraging result from the small plots was followed up in 1948 by a more elaborate test involving the whole cove, which is a mile long, in the charge of A. Larocque, a seasonal research assistant. Egg cases were removed from one half and left to develop in the other. It will be impossible to judge the effects of this work before next spring because snails of the 1948 year class are still too small to be retained in the counting screens. So far as can be judged there was no set of seed clams in the cove this year. This may obscure the results of the test because the young drills feed to a large extent on young clams and all may die from starvation and leave no seed snails in either half of the cove.

A few points in the snail's life history were cleared up this year by work done at St. Andrews by Miss F. Beairsto, a seasonal scientific assistant. It was established by microscopic dissection that the two smallest size-classes in the Belliveau cove population are separate year-classes rather than sex classes of the same year-class. The latter was suspected earlier from the discovery that the two sexes grow to different ultimate sizes and probably at different rates. The sex of these small animals cannot be determined from gross inspection in the field.

Besides this, the length of the incubation period was carefully measured by tagging and studying collars of both the greater (P. heros) and lesser drill on the beaches at St. Andrews from the time they were laid until the young snails escaped from them.

A study of feeding behaviour was begun and some good photographs of the extended proboscis were obtained by enticing starved snails to feed on clam meats that were held in a narrow space between two flat plates of glass.

Surveys by J. S. MacPhail and the writer of a number of the principal clam-producing areas in the Maritimes have shown that the relative abundance of the two species of drills varies greatly from place to place. The lesser clam drill has not been found in the Gulf of St. Lawrence although the greater drill is abundant. Almost all the snails on tide flats there were small and few egg cases were found. Larger specimens and egg cases are nevertheless abundant in deeper water as shown by catches with the Danish seine and the bar-clam drag. In inlets on the south shore of Nova Scotia both species were common and more or less equally abundant and seemed to occupy the same grounds. In Bay of Fundy areas they tend to occur separately or, if present in the same area, to occupy different levels of the flats. The problem clam drills present is, therefore, quite complicated, and it should not be expected that control measures which may prove effective in one area will have universal applicability.

J. C. Medcof

Appendix No. 18

MISCELLANEOUS CLAM INVESTIGATIONS

Experiments in management of clam digging

The two long-term Sissiboo river experiments, which are overseen by Chas. Hayes, a Department of Fisheries guardian, are still in progress but it is too early to assess the results. One of these is designed to show what yield per acre is obtained through "systematic" digging, which means that the whole flat is turned over once a year, as compared with "random" digging where the fishermen dig here and there wherever they are inclined. The other is to compare the yields when plots are systematically dug twice yearly, once yearly, once every second year and once every third year.

The data accumulated so far are still insufficient to show general trends.

Surveys

The detailed survey and mapping of Charlotte county, N.B., clam areas was completed this year by Mr. MacPhail. The results are helpful in control of paralytic shellfish poison, as

well as in advice to the industry.

Mr. MacPhail and the writer made a preliminary survey of New Brunswick clam areas in the Gulf of St. Lawrence from Point Escuminac to the Bay of Chaleur. This showed that there were one or two extensive areas where stocks suitable for shucking might be obtained. Most of the flats, however, are covered by dense growths of eelgrass and are seldom exposed at low water. They are stocked with large, old clams that would not sell well when shucked. They are extensively dug with garden forks and find a ready market as canned clams.

The writer made a preliminary survey of the Magdalen Islands, P.Q., clam areas. These are heavily fished for bait and are badly depleted. Unfortunately there are no local supplies of seed, as there are in most areas, that could be used for transfer to bolster natural production on the better grounds.

Assessments of spatfall

The screening of measured amounts of soil and the counting of survivors of the previous year's "set" of seed in some of the more important clam areas was continued this year by Mr. MacPhail. In some areas there were heavy mortalities of 1946 seed that were abundant last year and these have not been explained. In others, like the Sissiboo, survival has been good. There the 1947 set was the best in several years and should insure a good production four to six years from now.

J. C. Medcof

Appendix No. 19

FLUCTUATIONS IN THE PRODUCTION OF DIGBY SCALLOPS

There have been remarkable fluctuations in the annual production of the Digby scallop fishery since its institution in 1920 and an attempt is being made to discover their cause and possibly a method of predicting or even regulating them. Field work has occupied the summer months for the past two years and analysis of data is going on at the University of Toronto during the winter. This effort is timely because of a marked decline in the annual catch per boat during the past few years. Some encouraging progress has been made even though the complexities of the relationships involved are often baffling.

Studies of samples of scallop stocks, fishery statistics and hydrographic data indicate that changes in catch correspond with changes in abundance and that the latter are correlated with the water temperatures of the Bay of Fundy at the time scallops spawn. Low temperature in any particular year apparently results in a low production of seed scallops and a low production of commercial scallops seven years later, the average age of scallops in the commercial catches being about 7 years. Conversely, high temperature is related to high production.

From what has been done so far it is concluded that fluctuations in production are dependent chiefly on hydrographic conditions that are beyond human control and not, as has been suggested, on overfishing, breaches of the minimum size regulation or faulty conservation laws. This conclusion does not detract from the need for and importance of observing legal size limits in insuring the maximum dollar returns to the industry from the scallops that do develop (this point is dealt with in another summary) and, furthermore, it does encourage belief that further work will reveal methods of predicting major changes in abundance several years in advance.

Lloyd Dickie

Appendix No. 20

ANALYSIS OF SCALLOP FISHING RECORDS

For the past several years a Digby, N.S., firm has kept a careful and uninterrupted record of the fishing efforts of its scallop boats and recently made this available to the investigators. For each boat the records show the dates fished and the catch per trip as well as the average wharf price. An analysis of these data together with those compiled by the Department of Fisheries has shown many interesting and important facts and relationships that have not been clearly appreciated heretofore either by the industry or the Department.

Although the Digby scallop season lasts seven months - October 1 to April 30 - it provides on the average only 59 fishing days. Twenty-one of these occur in the first two months, October and November; 17 in the three winter months, December, January and February; and 21 in the last two months of the season, March and April. The monthly total catches follow the same pattern as the number of fishing days, but the catch per trip (trips are daily) shows a steady decline from about 390 pounds at the beginning of the season to about 280 at the end. This is believed to indicate the proportion removed by the fishery (see also Appendix 23).

In the seven months' season a boat catches close to 20,000 pounds valued at approximately \$10,000. The wharf price per pound rises steadily throughout the season but drops slightly in April. It does not show the inverse relationship with total landings that is to be seen in many fisheries where the old rule of supply and demand operates more obviously. It is related, however, to prices on the Boston market where the Digby fishery is not the principal source of supply.

Other facts that emerged help provide a better understanding of problems confronting the scallop fishery and year-to-year differences in the total annual productions of the fleet.

J. C. Medcof

Appendix No. 21

GROWTH, MEAT-SIZE AND SIZE LIMITS IN THE DIGBY SCALLOP FISHERY

The Department of Fisheries has been under pressure to reduce the present minimum size limit from diameter 4" to 3½" for scallops in the Digby, N.S., area where the fishery is intense. The Fisheries Research Board has been asked to render an opinion as to the wisdom of the proposed change and a few preliminary observations were made in 1947. This year a careful study was made of the relationships of growth rate, size and meat-yield which are of major importance in choosing a size limit.

For inshore beds off Digby the yield relative to size for 3" to 5" scallops is summarized below:

Diameter of scallop inches	Meat yield ounces	No. of meats per pound
3	0.21	76
3½	0.33	48
4	0.49	32
4½	0.67	24
5	0.93	17

The figures show that at 4" the yield is 1½ times that at 3½" and that at 4½" it is twice that at 3½".

Studies of growth rate show that it takes only one year for scallops to grow from 3½" to 4" and that thereafter the annual increase in diameter is considerably less. Within this interval of one year, then, the scallops grow at a substantially higher rate than at any other time during the period when they might be marketable and the meat yield increases by 50%. It seems most unlikely that natural mortality in this year would be great enough to offset the increase in yield. From this it is concluded that the size limit should not be reduced and that every effort should be made to enforce it.

J. C. Medcof

Appendix No. 22

DARK-MEAT AND THE SHELL DISEASE OF SCALLOPS

"Dark meat" has always presented a problem to scallop packers and fishermen alike throughout the Fundy area. The muscles of scallops suffering this condition are about the colour of brown wrapping paper and are inferior both in appearance and eating quality. Catches have to be culled for dark meat and, because it can be detected only after scallops are opened, there is a great deal of waste effort in fishing beds where there are many discards. The fishermen believe the discolouration is the result of old age and that dragging the beds reduces its frequency.

A study of stocks off Digby, N.S., this year showed that brown meats come from scallops whose shells are infected by a boring sponge (Cliona). On inshore beds the animals are not attacked until they are 8 or 9 years old and about $4\frac{3}{4}$ " in diameter. Offshore where growth is slower, the age is about the same but the size only about $4\frac{1}{4}$ ". It is not yet clear why younger scallops are not attacked.

Besides having discoloured meats scallops with diseased shells have a very low meat-yield. Even animals with moderately infected shells yield only half the weight of meat produced by healthy scallops of the same size.

A proper understanding of this problem will require an extensive investigation. Some remedy may be discovered. A similar problem exists with oysters (Appendix 9).

J. C. Medcof

Appendix No. 23

MISCELLANEOUS SCALLOP INVESTIGATIONS

Determination of fishing mortalities by marking

Some knowledge of what proportion of the total stock is annually removed by the fishery is necessary to intelligent consideration of conservation problems such as minimum legal size limits. Estimates can be made by scattering clearly-marked animals over the beds and observing the proportion recovered by the commercial fishery.

In September, 1947, approximately 1,100 scallops from two important inshore beds off Digby, N.S., were marked on the shell with a red dye and a reward of 25¢ apiece offered for their return. In the next seven months 32% were recovered from one bed and 12% from the other. This suggests fishing mortalities of the same order as those indicated by the decline in catch per trip during the season (Appendix 20).

In similar tests in 1948 scallops were marked with red celluloid disk tags attached by aluminum alloy wire and released on three of the principal beds. Some tags have been recovered already although the fishing season has just begun. The M. V. "J. J. Cowie", F. A. Magarvey, Captain, was used in this work with Mr. MacPhail and the writer in charge at different times.

Mesh size and enforcement of the size limit

The standard scallop drag has a bag made of wire rings with an inside diameter of $2\frac{3}{4}$ " and it retains many small scallops. Although there is a 4" minimum legal size limit it is specially difficult to enforce because only the meats are landed and infractions are common. It is hoped that an efficient drag can be devised which will permit the escape of a high proportion of

undersized scallops without reducing the take of legal-sized. Trials with four different ring sizes were made this year but the records have yet to be analysed.

Meat yield

Records are being compiled which show how the meat-yield of scallops varies with season, district and depth of water in the same district. The yield is highest in the cold months; higher in shoal than in deep water and higher on the New Brunswick side than on the Nova Scotia side of the Fundy. This information is useful in many ways and has already served as a basis for judgement of the present size-limit and for a study of the "dark meat" problem.

J. C. Medcof

Appendix No. 24

BAR-CLAM SURVEY

The survey of bar-clam (Spissula (Mactra) solidissima) resources of the Gulf of St. Lawrence was vigorously continued this year using the boat "Mactra S" from July 15 to October 15. Captain A. E. Calder acted as a liaison with the Station and Captain H. H. Butler was in charge of the boat. She was again equipped with a Long-Island-type hydraulic dredge with a 17" mouth loaned by General Sea Foods Ltd. The north and south shores of western Prince Edward Island from Malpeque bay to Summerside, the New Brunswick shore from Shippigan to Cape Tormentine and parts of the Magdalen Islands were explored.

In most areas the abundance decreased with distance from shore and in the whole exploration only two relatively small areas were discovered where clams were found in sufficient abundance below low-water mark to make one think that commercial operations with the hydraulic dredge might be profitable. Both these were in Miramichi bay near Portage island.

Dragging there at a speed of 40' per minute the boat took an average of a bushel of clams per 15-minute haul. In a day's work, which included steaming to and from the fishing ground from the base at Lower Neguac and 8 hours of actual dragging operations, 26 bushels were obtained. With prices of \$1.50 to \$2.00 per bushel such as were paid a few years ago this operation might be profitable but by comparison with returns from other types of fishing involving boats and gear of similar cost it would not be considered lucrative. There is less interest shown now by packers than there was a few years ago in obtaining supplies of bar clams and it seems unlikely that the deep-water stocks are likely to be used in the near future.

An unusual abundance of stunted bar clams was discovered during operations with the M.V. "J. J. Cowie" in the Bay of Fundy off Digby Gut just shoreward of the innermost scallop beds and in

20-40 fathoms of water. At 42 fathoms, $1\frac{1}{2}$ miles N. of the fairway buoy at Digby Gut, two one-minute hauls with a test dredge with an 8" mouth and no hydraulic attachments yielded 52 and 105 clams. The presence of bar-clam shells in hauls with scallop drags suggests that this bed of clams parallels the coast for many miles.

Next year it is hoped to complete the small amount of work that is left in the Gulf of St. Lawrence and examine the Digby resource in greater detail. It is expected that the toxic condition of most bivalves in the latter area will involve the bar clam and seriously limit the possibilities of the fishery there. Even if toxic, Digby bar clams might be useful as bait and be substituted for soft-shelled clams which are now extensively used on the outer coast of Nova Scotia by line-trawl fishermen during the summer and which are in high demand for both bait and shucking. This possibility should be carefully explored.

The Research Board is now in a relatively good position to answer inquiries about the bar-clam resources of the Maritimes.

J. C. Medcof

Appendix No. 25

GENERAL SUMMARY OF GROUND FISH INVESTIGATIONS

Investigations have been directed toward increased knowledge of groundfish resources in order to permit more rational exploitation.

Of primary importance is the assessment of long-term changes in abundance and the factors affecting such changes. A major part of the work has been the continuation of the collection of such statistics as catch, catch per unit of effort, size and age composition for both offshore and inshore areas (Appendices 26 and 27). The interpretation of this information depends on the continuation of life history studies and the recognition of different populations within each species. Differences in rate of growth, age composition and cod-worm incidence are being correlated with tagging and vertebral count studies carried out in earlier investigations (Appendix 28). Messrs. J. Craig, D. N. Fitzgerald and M. F. Fraser are responsible for the collection of a large part of the field data. Miss R. I. Peterson carries out age determination work and Miss S. B. Gibson assists with the compilation of the statistics.

A number of special studies are being directed toward increased exploitation of undeveloped groundfish resources. Exploratory dragging, life history studies and assessment of seasonal changes in distribution carried out in 1947 and 1948 have formed the basis for the development of inshore commercial dragging for winter flounders (Appendices 30 and 31). Experimental fishing of the Danish seine has indicated the potentialities of

this method for inshore flounder fishing (Appendix 29). Experiments designed to test the use of flying sets and power hauling of line trawl have been initiated in Prince Edward Island. The exploratory dragging was carried out by the M. B. "Pandalus" and the Danish seining by the M. V. "J. J. Cowie". A. R. Kempton was scientific observer for both programs. Distributional and physiological studies of the winter flounder are being conducted by F. D. McCracken.

An investigation of the life history of the cod-worm (Porrocaecum) has been continued in the hope that worm incidence may be reduced through control of the definitive host, the seal (Appendix 32). Mr. D. M. Scott is carrying out this work.

W. R. Martin

Appendix No. 26

ABUNDANCE OF GROUND FISH ON OFFSHORE BANKS

Catch statistics for both otter trawler and line-trawl vessel landings have been compiled as a means of assessing changes in abundance of fish on Nova Scotia offshore banks. Data on catch per trip and catch per day at sea are available for four large steam trawlers from 1931 and for four large vessels from 1939. These indices are listed by quarters for representative years to indicate changes in abundance.

Approximate catch per trip and catch per day at sea (in brackets) in thousands of pounds

	<u>1931</u>	<u>1937</u>	<u>1942</u>	<u>1944</u>	<u>1948</u>
<u>Otter Trawlers</u>					
Jan. - March	140 (23)	140 (22)	-	135 (25)	115 (19)
Apr. - June	125 (20)	150 (25)	110 (17)	275 (44)	165 (30)
July - Sept.	75 (12)	150 (24)	100 (16)	175 (30)	-
Oct. - Dec.	80 (13)	130 (19)	125 (18)	170 (35)	-
	<u>1939</u>	<u>1942</u>	<u>1944</u>	<u>1946</u>	<u>1948</u>
<u>Vessel</u>					
Jan. - March	35 (10)	65 (12)	-	95 (19)	90 (13)
Apr. - June	100 (17)	150 (20)	175 (23)	160 (29)	140 (25)
July - Sept.	60 (14)	170 (25)	165 (21)	165 (28)	-
Oct. - Dec.	60 (8)	105 (13)	115 (16)	105 (17)	-

The abundance of fish on Nova Scotia banks is well shown by contrasting catch per trip with the North Sea. In 1938, first-class Grimsby trawlers caught about 10,000 lbs. per 8-day trip. In 1946, as a result of decreased fishing, catch per trip increased to about 25,000 lbs. Nova Scotia trawlers catch more per day at sea than North Sea trawlers take in 8 days at sea.

On Nova Scotia banks catch per day of steam trawlers increased during war years to a peak in 1944 but by 1948 it had decreased to the pre-war level. In pre-war years more than half the catch was haddock but since 1942 haddock have contributed only a small part of the catch. The increased catches during war years were almost entirely due to large catches of large cod. By 1948 cod catches had decreased but were still above the pre-war level of abundance.

Catch per unit effort for vessels increased gradually from 1939 to 1946. Although a decrease from 1946 to 1948 was apparent, catches were still above the 1939 to 1941 level of abundance. The increased availability of fish to vessels during war years resulted entirely from increased abundance of cod.

W. R. Martin

Appendix No. 27

DOMINANT YEAR-CLASSES - HADDOCK AND COD

The following measurements and age determinations were made in 1947 and 1948.

		<u>Haddock</u>	<u>Cod</u>
1947	Measurements	8500	13000
	Age Determination	1650	2500
1948*	Measurements	7300	12000
	Age Determination	1500	2400

* To June, 1948.

Haddock

The 1943 year-class of haddock continued to be dominant in 1948 landings. In all inshore waters from Freeport to North Sydney, N.S., this year-class contributed about 40% of the landed catch. At Canso and North Sydney fast-growing fish of both 1943 and 1944 year-classes made up the greater part of the catch. Slower-growing fish of the 1943 year-class at Lockeport and Yarmouth averaged 49 cm. or 38 oz. by the spring of 1948. At Freeport haddock are slightly faster-growing and heavier for their length; the 1943 year-class had reached 51 cm. or 44 oz. by June, 1948.

The increased importance of the 1943 year-class has resulted from the 50% increase in weight since the spring of 1947 and the fact that most of those which were scrod in 1947 could now be marketed as large haddock at twice the value per pound.

The appearance of a good 1944 year-class gives further justification for forecasting improved haddock fishing in 1949.

On offshore banks the 1943 year-class did not appear in catches until late in 1947. The 1940 and 1941 year-classes contributed much of the catch until that time. In 1948 the 1943 year-class became dominant on Middle Ground and Banquereau. Samples taken at sea on Western Bank showed large numbers of 1943, 1944 and 1945 year-classes and suggested improved recruitment to the fishery. On St. Pierre the slow-growing 1942 and 1943 year-classes became important to 1948 fishing.

Cod

As a result of marked differences in rate of growth, the age composition of inshore landings of cod differs greatly from one area to another. At Freeport and Yarmouth the 1944 and 1945 year-classes were dominant; at Lockeport, those of 1939, 1943 and 1944; and at North Sydney, those of 1939 and 1941. In contrast to haddock, cod are progressively slower-growing from Freeport to North Sydney, N.S. At North Sydney in June, 1948, the 1939 year-class was of comparable length with that of 1943 at Freeport (71 cm.) and the 1941 year-class with that of 1943 at Lockeport and 1944 at Yarmouth (60 cm.). Fish of comparable length thus enter the fishery at different ages depending on the area fished.

The 1939, 1941 and 1943 year-classes predominated in 1948 landings from Middle Ground and Banquereau. Year-class dominance and rate of growth suggest that these offshore cod bear a closer relationship to cod from Cape Breton than to those of south-western Nova Scotia. The evidence conforms with previous results of tagging and vertebral count studies.

W. R. Martin

Appendix No. 28

COD-WORM INCIDENCE AND COD MOVEMENTS

Regular sampling of the number of nematodes found in cod fillets has been carried out throughout the Maritimes since 1946. These data have contributed toward the recognition of different cod populations.

Of outstanding significance is the contrast in worm incidence on offshore Nova Scotia banks and the Gulf of St. Lawrence. The incidence of infection rarely exceeds 10% on offshore banks but often reaches 95% to 100% in the Gulf of St. Lawrence.

Seasonal changes in worm incidence of market-size fish are of interest. Fillets examined at Caraquet, N.B., from the Gulf of St. Lawrence showed more than 90% infection in June, less than 75% infection from August to October with 62% in a September sample but high infection again in November. Similar seasonal changes from high infection in spring and fall to lower infection in summer were noted at Cheticamp, Ingonish and North Sydney, N.S., but infection was only about 50% of that found at Caraquet.

On offshore Nova Scotia banks incidence averaged about 6% from January to May but less than 5% from June to December.

The data suggest a movement of cod with low worm incidence into the Gulf of St. Lawrence in summer and a movement of cod with higher worm incidence to offshore banks in winter. Migration is not sufficiently extensive to produce very great changes in worm incidence. At all seasons sampled, infection was light offshore and heavy in the Gulf of St. Lawrence. The evidence conforms with results of tagging described by R. A. McKenzie in which a movement into the Gulf of St. Lawrence in spring and out in the fall was demonstrated.

Measurements of dragger catches landed at Caraquet showed small average length (less than 65 cm.) in June, July and November and high average length (more than 65 cm.) in August and September. Movement is believed to be limited for the most part to large cod.

W. R. Martin

Appendix No. 29

DANISH SEINING

In northern Europe Danish seining is an efficient method of catching bottom fish. The seine is fished by running a mile of rope in an arc from an anchored buoy to the seine and another mile of rope in a similar arc back to the starting point. The ropes and seine are then hauled along the bottom, sweeping the fish into a central path and into the net. During July and August, 1948, the M. V. "J. J. Cowie" was used to investigate the possibilities of Danish seining in the Maritimes. One of the two seines used was loaned through the courtesy of Dr. D. L. Cooper of the Nova Scotia Department of Industry and Publicity. Since large areas of smooth bottom are prerequisite to Danish seining the southern Gulf of St. Lawrence was selected for this work.

Preliminary studies were carried out without the special rope-hauling and coiling equipment normally used in this method and general inexperience in handling this gear further reduced the efficiency of operations. However, considerable progress was made in - (1) learning how to operate the gear, (2) determining the selectivity of species and sizes and (3) making preliminary assessment of the relative efficiency of this method as compared with flounder dragging.

A double-drum winch with double niggerheads was used. The drums carried otter trawl warps and the Danish seine ropes were hauled from the niggerheads. It was possible to switch quickly from Danish seining to flounder dragging and thus compare the two methods. The flounder drag was set and hauled in a total of 1½ hours and the Danish seine in 2 to 2½ hours. The two types of gear were believed to be actually fishing for about 1 hour per set.

Since the average catch of night sets (180 lbs.) was only 25% of the average catch of daylight sets (720 lbs.) made from the same stations, the driving action of the ropes was thus clearly demonstrated to be the special feature of Danish seining.

Catches made with the Danish seine were much greater than those made with the flounder drag as shown below.

Catch per set in lbs.

			<u>No. of</u>	<u>Floun-</u>	<u>Cod</u>	<u>Hake</u>	<u>Other</u>	<u>Total</u>
			<u>Sets</u>	<u>der</u>				
Magdalen Is. to Cheticamp line	10 fath.	D.S.	1	124	5	-	378	507
		F.D.	1	35	59	3	22	119
	20 fath.	D.S.	2	506	10	-	44	560
		F.D.	2	241	60	-	118	419
	35 fath.	D.S.	5	645	42	1	32	720
		F.D.	7	68	63	1	10	141
Pictou 13 fath.	D.S.	2	738	-	12	16	766	
	F.D.	2	327	-	42	53	422	
Chedabucto bay 20-28 fath.	D.S.	1	4152	-	-	-	4152	
	F.D.	2	469	48	1	75	593	

D.S. - Danish seine.
F.D. - Flounder drag.

In Chedabucto bay two 1-hour flounder drags yielded 796 and 396 lbs. respectively, while two Danish seine sets made on the same ground produced 4152 and approximately 6000 lbs. Sets made in other areas were less productive but in every case the Danish seine showed larger catches.

Of particular interest was the selectivity of the Danish seine. It is apparent in the table above that the Danish seine proved to be efficient in the capture of flounders but inefficient in the capture of other species. Between the Magdalen Is. and Cape Breton 90% by weight of the fish taken by Danish seine were flounders, whereas only 50% of the flounder-drag catches made at the same stations were flounders. Differences in the size composition of catches made by the two methods were also apparent. The smallest plaice and winter flounders taken by the Danish seine were 5 cm. larger than the smallest taken by the flounder drag. The Danish seine took a greater proportion of fish 30 cm. and longer and the flounder drag took larger numbers of smaller fish. It was further indicated that the flounder drag was more efficient in the capture of the largest witch (over 50 cm.). The Danish seine proved to be efficient and selective in the capture of 30- to 50-cm. flounders.

Preliminary data suggest that Danish seining is a very effective method but further work with more efficient equipment must be carried out to assess the value of the method in commercial operations.

W. R. Martin,
A. R. Kempton

Appendix No. 30

WINTER FLOUNDER INVESTIGATIONS

Exploratory inshore dragging conducted in 1947 stimulated the development of commercial dragging in south-western Nova Scotia and aroused considerable interest concerning the potentialities of an undeveloped flounder fishery in other parts of the Maritimes. The 1948 flounder investigations have been, for the most part, limited to the winter flounder (Pseudopleuronectes americanus) since the 1947 survey indicated that this species offered the greatest possibilities for commercial development. Studies were directed along four lines:

- (1) Continuation of exploratory dragging in south-western Nova Scotia.
- (2) Assessment of variation in size composition, age composition, rate of growth, length-weight relationship, etc., throughout the Maritimes.
- (3) Analysis of commercial catches now landed at Digby and Yarmouth, N.S.
- (4) Studies of seasonal variation in distribution in Passamaquoddy bay, N.B., and Pubnico, N.S., together with a physiological investigation of this species at St. Andrews.

The M. B. "Pandalus" was engaged in flounder dragging from Annapolis basin to Green harbour, N.S., during May and June, 1948. Exploratory drags were made at 50 stations and other areas were explored but found unsuitable for dragging operations. Areas which produced more than 50 large flounders (over 29 cm.) per 15-minute drag were Annapolis basin, Barrington bay and Shelburne harbour. Large numbers of smaller flounders were taken at Tusket, Pubnico and Cape Sable. Catches of other marketable species were very small with not more than 8 fish per drag. The lack of interference with lobster fishing was shown by the fact that only two lobsters were taken during these dragging operations.

Aside from St. Mary's bay where successful commercial operations have been realized from April to September, 1948, Annapolis basin produced the best catches of large flounders. The possibility of profitable dragging in the Barrington-Shelburne area was also demonstrated. This exploratory work has already

resulted in the development of successful commercial flounder dragging in Annapolis basin.

Rate of growth has been studied for samples taken from Passamaquoddy bay, N.B., Annapolis basin, N.S., St. Mary's bay, N.S., East Tusket, N.S., Pubnico, N.S., Bear point, N.S., West Cape Sable, N.S., Barrington bay, N.S., St. Margarets bay, N.S., St. Anns bay, N.S., Bras d'Or lakes, N.S., Souris, P.E.I., Point Prim, P.E.I., Shippigan, N.B., and the Magdalens, P.Q. Only in Annapolis basin, St. Mary's bay, Barrington bay and in 19 fathoms off the Magdalens were flounders sufficiently fast-growing to exceed 35 cm. in six years' growth. In other areas sampled winter flounders do not grow sufficiently large to be of appreciable commercial value. At both the Magdalens and St. Mary's bay deep-water flounders grew appreciably faster than those taken from shoal water.

Analysis of the length-weight relationship demonstrates heavier fish for any given length in St. Mary's bay than in Annapolis basin. Those from Annapolis basin in turn were heavier than those from Passamaquoddy bay and Bear point.

Anal ray counts were high in south-western Nova Scotia and low in the Gulf of St. Lawrence. The lowest count (46.0) was found at Shippigan and the highest (49.6) at St. Mary's bay.

It is thus apparent that wide differences are found in winter flounder populations. Those offering the best possibilities for commercial development are in St. Mary's bay and Annapolis basin. The development of a market for flounders smaller than 30 cm. is essential to the development of a large inshore industry for winter flounders. Medium-sized flounders are now being partially exploited as lobster bait and fox food in such areas as Argyle, Pubnico and St. Mary's bay, N.S.

An experimental licence for commercial dragging in St. Mary's bay was granted to the "K. L. 63" on March 31, 1948. More than 200,000 lbs. of flounders were landed from April to August inclusive. Catch per drag was 387 lbs. in April, 657 in May; 524 in June, 289 in July and 392 in August. About 12,000 lbs. of other species - cod, haddock and catfish - were also landed in this period. The average length of landed winter flounders was 40 cm. (2 lbs.) in April, 39 cm. in June and 36 cm. (1½ lbs.) in July.

W. R. Martin

Appendix No. 31

SEASONAL VARIATION IN DISTRIBUTION AND PHYSIOLOGICAL STUDIES OF THE WINTER FLOUNDER

Seasonal variation in distribution was studied by sampling at various depths in Passamaquoddy bay during the winter months and at Pubnico, N.S., from May to July, 1948, using a 12-ft.

beam trawl.

By late November the I-group fish were most concentrated in five to ten fathoms with the older fish extending below ten fathoms. During January and March no fish were taken in less than five fathoms and the greatest concentrations of all age groups were below ten fathoms.

The catch per drag of all sizes decreased during January and March. Removing the rollers from the ground chain increased the catch per drag at all depths sampled during March and April, presumably because the chain without rollers was applied more closely to the bottom.

At Pubnico during the sampling period the I-group fish were most concentrated in one to two fathoms and the II-group in five to six fathoms. The III, IV and older groups of fish were most concentrated in shoal water with the largest catches being made in the inter-tidal zone.

During June and July the catch per drag was much lower than in May, with the largest decrease occurring in the smaller fish. The relative distribution of the age groups remained the same, except that in the inter-tidal zone the catch was almost nil.

Lethal temperatures and salinities. The winter flounder (Pseudopleuronectes americanus) and the smooth flounder (Liopsetta putnami) were compared in the laboratory by exposure to lethal temperatures and salinities.

The temperature at which 50% mortality occurred was higher for the smooth flounder than for the winter flounder at the same levels of acclimation. When acclimated to 15°C. this temperature was 24.8°C. for the winter flounder and 26.2°C. for the smooth flounder. No difference in resistance time to lethal temperatures was shown between small and large winter flounders.

Comparative resistance to reduced salinity was studied by exposure to fresh water. The resistance time of smooth flounders to flowing fresh water was longer than that of winter flounders. An increased resistance time to fresh water with increase in size of the winter flounders was apparent but at the largest sizes (30-35 cm.) a decrease to the level of the 10-15 cm. group was shown.

Winter flounders reacted to light (source: a 60-watt bulb) by moving to the covered end of a tank or by burying themselves when sand was available. This light source was more effective in causing the flounders to bury themselves than it was in causing them to move under cover.

F. D. McCracken

Appendix No. 32

COD-WORM INVESTIGATION

An investigation of the life history of the parasitic nematode, Porrocaecum, was continued during 1948. Larval nematodes, presumably of this species, were observed in the musculature of Atlantic cod, Greenland cod, Canadian plaice, witch, rosefish, smelt and eelpout but were not observed in pollock, haddock, tomcod, winter flounder, smooth flounder, brill, yellowtail, cunner and herring. The nematode was observed only in those species which have been found to inhabit deep water for at least part of the year.

Incidence of worms in cod is correlated with the distribution of the harbour seal. Such a correlation, demonstrated particularly in Cape Breton, N.S., suggests that seals are the definitive hosts for the cod worm.

Stomachs of 47 harbour seals, 24 harp seals and 1 hood seal were examined. Nematode infection was found to be of general occurrence in harbour and harp seals. Those identified to date from harbour seals belong to the genus Porrocaecum and those from harp seals, to the genus Contracecum. Harbour seal stomachs contained herring, Canadian plaice, winter flounder, smelt, sliverside, gaspereau, eelpout, rosefish, sand lance and some invertebrates. Harp seals contained capelin. The hood seal stomach contained neither food nor worms.

Twelve freshly-weaned seals were used in experiments to demonstrate that the harbour seal is a definitive host and to determine the identity of the nematodes found in different fishes. Five seals were infected with cod worms, three with worms from smelt, eelpout and Canadian plaice respectively and four were kept as controls. The seals were fed herring.

The controls did not contain Porrocaecum. It was established that the harbour seal is a definitive host of the cod worm and of nematodes from the musculature of smelt, eelpout, and probably Canadian plaice. The larval cod worms mature after about 17 to 20 days in the stomach of seals.

The fact that no Porrocaecum larvae less than 3 cm. have been recovered from fish suggests that another animal or stage is involved in the life cycle of the worm. The M. V. "J. J. Cowie" was used in the Bras d'Or lakes, N.S., during May, 1948, to follow up this belief. It was shown that initial infection can occur in cod less than 25 cm. in length. Small cod (less than 35 cm.) were feeding on amphipods and Crago septemspinosus. Larger cod were feeding extensively on smelt, winter flounder and small crustaceans. It is possible then that part of the infection in large cod may be transmitted by smelt. Smelt were feeding on amphipods and Crago septemspinosus. There is, therefore, some indication that a crustacean may be the primary host of the cod worm.

Future work will involve an attempt to discover the primary host, clarification of the relationship between smelt and cod with respect to the worm, and elaboration of the details of the life history and ecology of this nematode.

Summary of D. M. Scott's report
by W. R. Martin

Appendix No. 33

GENERAL SUMMARY OF HERRING INVESTIGATIONS IN 1948

As has been previously stated the chief object of the Atlantic Herring Investigation Committee is to increase the quantity of herring caught by extending the period during which they may be taken. The work is chiefly carried out in the Gulf of St. Lawrence.

The Fisheries Research Board of Canada has continued to contribute to the work of the Committee (1) through part-time services of Dr. Needler and Miss Parker who are Scientific Alternate Chairman and Honorary Recording Secretary, (2) through Dr. Leim being seconded to the Committee as Investigator-in-Charge, and (3) by contributing office and laboratory space and some equipment.

Field work has been carried on by the use of two boats, (1) the 84-foot M. V. "Harengus" which can be equipped with either purse-seine or trawling gear, and (2) the 46-foot M. B. "Gulf Explorer". Both boats are equipped with sonic-sounding equipment which is used in searching for herring schools. Concentrations of herring sufficient for purse seining have been found only during the late fall and winter months: at Bay of Islands, Newfoundland, in November, 1947, when catches up to 200 barrels were made, and in Fortune bay, Newfoundland, in March, 1948, when a catch that appears to have been much larger was made but was lost through failure of the gear. In both places weather interfered with continuous purse seining and there is doubt whether this method is commercially feasible on that account.

Since the end of May two types of bottom trawls have been tried from the "Harengus". These were the Dutch herring trawl and a Gourock otter trawl modified to hold herring. Many drags were made using this gear but the quantities of herring caught were small.

Sonic-sounder records were made wherever the boats operated over the southern part of the Gulf from the middle of May until late August and again in October. The results agree with those previously secured in indicating only scattered bodies of fish during these months.

In late August and early September the "Harengus" operated on the outer coast of Nova Scotia but failed to locate

any large catches of herring either inshore or on Sambro and Emerald Banks. Sonic-sounder indications of fish were also lacking except in close proximity to land.

During all this exploratory fishing quantities of groundfish were caught in the trawls.

A start has been made in the development of mid-water trawling gear. The development of this gear is believed to be important as the Committee has accumulated a body of evidence pointing to the occurrence of scattered schools of fish in mid-water in many areas. Kite-otters of the type developed during war-time minesweeping have been found to be of value in maintaining fishing gear at various depths and they will also act as otter boards in spreading the gear. Small quantities of "sardine" herring have been caught in this gear but further development is needed.

The study of herring populations has been continued by Mr. Tibbo, assisted by Mr. Day until the end of March. Field technicians have measured over 24,000 herring from 15 areas in the Gulf of St. Lawrence, Newfoundland and the outer coast of Nova Scotia. Age determinations and vertebral counts have been made on approximately 7,000 of these. The results support previous conclusions that six separate herring populations may be recognized in the area and show the dominance of certain year-classes in the fishery. As a further attack on this population problem, 2,375 herring were tagged at the Magdalen Islands at the end of the fishing season in early June.

Hydrographic investigations in the Gulf have been continued in co-operation with the Atlantic Oceanographic Group. Complete coverage of the Gulf was achieved in the spring and fall and the southern portion was covered in July and August. For several years these data have been collected three times annually and the July cruise was an addition in 1948 made to fill gaps in the cycle of temperature and salinity data. Frequent observations were made at four shore stations at Gaspe, North Rustico, Richibucto and Cheticamp. Preliminary study of the data by Dr. Lauzier indicates lower than average water temperatures in the Gulf in the spring and summer of 1948 but in October surface temperatures were about normal and the depth of the isothermal layer was greater than in 1947.

During the winter and spring a report was prepared on the investigations from March, 1947, to March, 1948. It was mimeographed in three parts for distribution and consisted of 83 pages plus 72 figures.

A. H. Leim

Appendix No. 34

EXPLORATORY FISHING FOR HERRING

In 1947, as previously reported, the Committee had concentrated on the purse seine as the means of catching herring and had encountered some success during late November in Bay of Islands when massive schools of herring were found. It was

decided to concentrate in 1948 on the use of various types of trawl gear but the change-over was not made until after a March-April trip to Fortune bay on the south coast of Newfoundland because this bay appeared likely to offer opportunities for the use of the purse seine and the bottom was unsuitable for dragging. All of the exploratory fishing which was carried out in 1948 was conducted from the M. V. "Harengus".

The first operations were in Fortune bay where the boat arrived on March 11. After some preliminary searching, herring were located in the upper part of the bay, particularly in Mal bay and in the entrance to Long harbour. They could be detected both in the daytime and at night, being usually somewhat dispersed during the dark hours. These bodies of fish were usually found near the windward shores, which made purse seining risky or impossible. On the evening of March 23 the wind died out sufficiently for a purse seine set off Woody head at the entrance to Mal bay. A very large catch of herring was made and some of the fish were landed but in attempting to secure the main body the seine parted and the bulk of the catch was lost. There is no certainty of the quantity of fish caught but it is believed to have exceeded 500 barrels. After the purse seine was repaired the herring apparently dispersed and quantities sufficiently large for purse seining could not be found although the search was continued until April 16.

When the "Harengus" returned to Nova Scotia the vessel was changed over to trawling rig. Two types of bottom trawls were employed, viz. a Gourock #4 otter trawl designed for herring and a Dutch herring trawl which was secured from Holland fully rigged in the manner in which it is employed in the North Sea. This gear was used in the Gulf of St. Lawrence as opportunity offered from May 22 to August 12. At first only the Gourock trawl was used in the Magdalen Islands area. In eight sets between May 22 and June 3 small quantities of yellow-tails and plaice and larger amounts of invertebrates were taken but only two herring were caught. In five hauls between June 17 and 19 in the area between East Point, P.E.I., and Sea Wolf island, Cape Breton, quantities of cod, hake and haddock were caught in addition to flounders; a few herring were taken. In one case 144 herring were landed and many small ones were seen to escape from the meshes of the net as it was being hauled.

In the period from July 13 to August 12, hauls with otter trawls were made at twenty-five stations in the Gulf of St. Lawrence, all of these south of the Laurentian channel. In several cases two or more drags were made at each locality. The Dutch herring trawl was only used a few times after extensive damage was caused to one of these nets. The area covered included most of the southern Gulf between Souris, Cheticamp, Magdalen Islands and Gaspé. In some cases several thousand pounds of cod and flounders were secured but herring catches were light. The following table records the herring taken:

Date	Place	Gear	No. of herring	Size
July 13	Off Miramichi	Dutch trawl	160	Small
" 16	" Murray hbr.	Gourock "	2	Small
" 17	" Cheticamp	" "	14	Medium
" 24	Pleasant bay, M.I.	Dutch "	315	Small
" 27	Off Sea Wolf Id.	Gourock "	147	Medium
Aug. 2	" Bradelle Bank	" "	2	Large
" 3	" Orphan Bank	" "	10	Medium
" 10	" Orphan Bank	" "	4	Medium

In most of the drags some cod were taken and invariably some large herring were found in the cod stomachs showing that herring were distributed over a wide area of the Gulf at the time this fishing was done.

While the "Harengus" was running from one fishing station to another, or while making hydrographic sections, the sonic sounders were operated. Scattered indications of pelagic fish were found on the records. These might have been herring. The type of record agrees with what was found in former years.

On August 21 the "Harengus" arrived at Halifax to do similar exploration and fishing on the outer coast of Nova Scotia. The industry reported very much reduced catches of herring along shore from Halifax to Shelburne as compared to normal years. It seemed desirable to investigate the possibilities farther from shore and on the banks. Trawler captains were reporting herring schools offshore on the banks and in the vicinity of Sambro Lightship. The "Harengus" traversed the Lightship area several times between August 24 and September 7 but found no indications of pelagic fish. A haul with the Dutch trawl on Sambro Bank and three hauls on Emerald Bank were productive of some groundfish but only a single herring was caught. Sonic-sounder records in Halifax harbour and Lunenburg bay were more promising but bottom conditions were unsuitable for dragging.

The general picture of the distribution of herring which emerges from the investigation to date shows marked concentration in specific areas during the late fall and winter months and again at spawning time, but the late spring, summer and early fall periods show only dispersed schools which do not lend themselves to efficient capture by the methods which have been employed thus far.

A. H. Leim

Appendix No. 35

DEVELOPMENT OF A MID-WATER TRAWL

Sonic-sounder records made throughout the Atlantic Herring Investigation Committee's work have very frequently indicated the presence of fish in the middle layers of water, too far from bottom to be taken in otter trawls and too much dispersed for effective use of the purse seine. On other occasions, as in Bay of Islands and Fortune bay, herring have been sufficiently concentrated but in locations where prevailing weather

conditions prevented their capture by any of the above-mentioned gear. The desirability of developing a new type of gear which can be towed in mid-water has thus been apparent. The literature describes some previous attempts to develop this kind of gear but nothing satisfactory appears to have resulted.

During the war minesweeping equipment was developed which was capable of towing a cable at the desired depth. It seemed worthwhile to ascertain whether this equipment could be adapted for maintaining fishing gear at the desired depth. Several kite-otters of the smallest size available (Pattern 8762, 3' x 2'10" x 5", with a plane surface of 6 square feet) were secured for this purpose.

After a few preliminary trials the "Gulf Explorer" was brought to St. Andrews early in July. It was of advantage to have the work undertaken close to headquarters and the region possessed two advantages: (a) in offering deep protected waters close to the Atlantic Biological Station and (b) in having small herring available during much of the year, permitting actual fishing to test the efficacy of the equipment. The "Gulf Explorer" was equipped with a suitable winch and engine for handling the gear and Mr. D. S. Johnson undertook the design and trial of equipment.

It was soon discovered that by making proper sling adjustments the kite-otters would serve not only to carry a net down to various depths but they would also act like otter boards and open the mouth of the net. A net somewhat similar to an otter trawl was made up with headrope and footrope 24 feet long, with a height of 6 feet and with a bag or "cod end" making an overall length of 33 feet. This has been used in conjunction with two kite-otters.

The depth at which the net tows, as judged by the angle the wire makes with the water, varies to some extent with the speed of the boat, but it seems feasible to operate the net at various depths depending on the amount of wire out. Spreading of the net has not been as satisfactory as was hoped for. Doubling up the kites so as to give more plane surface made no perceptible difference in the spread. A recent trial using the kite-otters singly and a more powerful boat (the "J. J. Cowie") achieved an angle of divergence of the towing wires of approximately 10°. With 20 fathoms of wire out, calculation indicates the kites as being 23½ feet apart. The net would be spread somewhat less.

At the present stage of development the gear has been operated in localities in Passamaquoddy bay where sardine herring have been present. A few have been caught in the net but the maximum catch has been about one bucketful after a 20-minute tow. This was at night when the net would presumably be less easily seen and avoided by the fish. The relatively slow speed of the net through the water, its small size and its being visible through phosphorescence are doubtless factors in permitting fish to escape it. It is planned to make similar trials during winter when the herring will be less active and when phosphorescence will be absent.

HERRING POPULATION STUDIES

In 1946 a three-year program was initiated to study herring in various areas around the Gulf of St. Lawrence to see if there were separate and distinct groups making up the total population. This is the final year in the program and although the samples taken during the 1948 season have not been fully examined as yet there are indications that they will confirm the results obtained during the two previous years. On the basis of length and age composition, rates of growth, maturity of the gonads and mean vertebral counts, it appears that the population in the Gulf area is segregated into six more or less distinct groups. These are: (a) the estuary of the St. Lawrence; (b) the Gaspé coast; (c) the Southern Gulf; (d) the west coast of Newfoundland; (e) the south coast of Newfoundland, and (f) the Atlantic coast of Nova Scotia. It is possible that further divisions exist within these areas and could be detected by studies involving the taking of larger samples for statistical analysis and by using the more direct tagging method.

During the 1948 season a total of 136 samples were obtained from 15 areas and consisted of 24,492 length measurements, 7,072 scales for age determinations and 7,171 vertebral counts. The 1941 and 1943 year-classes, which made up a large percentage of the catches in most of the Gulf areas during the 1946 and 1947 seasons, were still present in the 1948 samples although in considerably reduced numbers. There was apparently a very successful year-class in 1944 in some areas and these herring entered the commercial fishery as four-year-olds during the 1948 season. At Seven Islands on the north shore of the Gulf 54.6 per cent of the catch was made up of the 1944 year-class. The length and age composition for all areas is similar to that obtained in previous samplings and there is no indication of any great difference in growth rates for different year-classes.

In general, the mean vertebral counts for the 1948 season tend to be higher than in previous years but follow the same pattern; that is, with the highest counts from areas in the estuary of the St. Lawrence and the lowest counts from the southern part of the Gulf.

Table I gives a summary of the mean vertebral count data obtained from nine areas during the 1946, 1947 and 1948 seasons, together with the number of specimens from which the means were calculated.

Area	Mean vertebral counts		
	1946	1947	1948
St. Lawrence Estuary	55.86 (788)	55.81 (1558)	55.93 (1318)
Gaspé Coast	55.64 (2304)	55.71 (1561)	55.67 (1535)
Bay Chaleur	55.54 (303)	55.58 (799)	55.65 (529)
Magdalen Islands	55.61 (717)	55.64 (484)	55.70 (599)
Southern Gulf	55.49 (1539)	55.59 (1647)	55.56 (1765)
Newfoundland West Coast	55.60 (636)	55.48 (533)	
Newfoundland South Coast		55.75 (531)	55.83 (218)
Nova Scotia Atlantic Coast	55.55 (1389)	55.50 (2073)	55.54 (1059)
Bay of Fundy	55.48 (329)	55.60 (212)	55.62 (106)

Tagging

Preliminary tagging experiments at Black's harbour, N.B., and Bay of Islands, Newfoundland, showed that from 40.5 to 53.1 per cent of tags actually passing through a filleting or a reduction plant could be recovered. These results seemed promising and the first tagging of live herring was done during the early part of June at the Magdalen Islands. In all, 2375 herring were tagged and released near Amherst harbour. Two types of tags were used, green celluloid and silver-plated steel, and were inserted in the body cavity of the herring. Of the 2375 tags used, 1860 were of green celluloid and 515 of silver-plated steel. The tagging was done towards the end of the fishing season at Magdalen Islands to allow as large an escapement as possible. Fishing continued for approximately a week after the tagging was done and nine tags of the green celluloid type were recovered, all of them from the area in which they had been tagged.

S. N. Tibbo

Appendix No. 37

CONDITION OF HERRING FROM THE GULF OF ST. LAWRENCE

Samples of herring from representative parts of the Gulf have been collected for fat determinations and some values for 1947 not previously reported are offered here in comparison with 1948 values. Several 1948 samples are being held in cold storage for determination as soon as possible. In most cases the determinations were made on individual fish. The values are expressed as a percentage of the wet weight of the fish and all determinations were by ether extraction.

Place	Date	Number of Specimens	Fat Content	
			Range	Average
Seven Ids., Que.	19-6-47	12#	6.0 - 7.8%	6.8%
" " "	9-9-47	12#	12.4 - 13.9	13.3
Caraget, N.B.	29-8-47	12#	13.1 - 14.0	13.5
Shediac, N.B.	7-5-47	20#	3.2 - 7.7	5.1
North Rustico, P.E.I.	10-5-47	48*	5.0 - 8.0	6.5
St. Ann Bay, N.S.	24-5-47	12#	4.3 - 5.9	5.0
Madame Id., N.S.	-7-47	8*	12.3 - 17.1	14.7
Halifax Hbr., N.S.	15-8-47	12#	10.9 - 13.6	12.3
Bay of Islands, Nfld.	11-2-48	12#	5.3 - 9.4	7.4
" " " "	24-3-48	12#	10.4 - 13.4	12.2
Fortune Bay, Nfld.	23-3-48	12#	9.7 - 11.7	10.8
" " "	30-3-48	12#	10.3 - 11.8	11.0
North Rustico, P.E.I.	7-5-48	12#	6.7 - 10.4	8.6
Seven Ids., Que.	28-5-48	10*	8.4 - 9.9	9.2

* Composite samples

Individual determinations

These determinations are chiefly of interest in connection with the utilization of the herring.

A. H. Leim

Appendix No. 38

MACKEREL INVESTIGATIONS

During the summer of 1948 mackerel investigations were continued in the southern Gulf area and along the outer coast of Nova Scotia.

Plankton tows taken in the southern Gulf from May 25 to August 7 confirm the conclusion reached in 1947 that spawning starts about the middle of June and continues throughout the period studied.

Samples of mackerel taken from commercial catches were measured from June 3 to August 28. The average sizes listed below show definite variations related to time, place and method of capture.

<u>Place</u>	<u>Date</u>	<u>Gear</u>	<u>No. meas.</u>	<u>Av. size cm.</u>
New Hbr., N.S.	June 3-5	3½" gill nets	1362	45.1
Jeddore, N.S.	June 7	3½" " "	100	45.7
Petit de Grat, N.S.	June 12-15	3½" " "	1444	45.8
Petite Anse, P.Q.	June 14-25	3½" " "	251	44.3
Magdalen Is.	June 23-24	3½" " "	877	45.6
N. Rustico, P.E.I.	July 8	2½"-3" " "	114	40.1
Shediac, N.B.	June 30-July 1	2 7/8"-3" drift net	343	43.4
Lr. Neguac, N.B.	July 2-3	2 7/8"-3" " "	423	41.7
N. Lake, P.E.I.	Aug. 25-28	Hook and line	746	36.7
N. Rustico, P.E.I.	Aug. 26	" " "	984	37.1

The age composition of the catch as determined from an examination of over 1,000 scale samples was as follows:

<u>Year-class</u>	<u>1941</u>	<u>1942</u>	<u>1943</u>	<u>1944</u>	<u>1945</u>
%	1.0	10.0	46.0	37.4	5.6

The scale readings also show that the rate of growth is rapid during the first three years but falls off rapidly after the fourth summer.

<u>Year-class</u>	<u>1941</u>	<u>1942</u>	<u>1943</u>	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>
Av. length cm.	46.2	46.0	45.3	44.4	43.0	30.1	27.1
Number	12	129	295	484	72	9	128

An examination of the mackerel catch statistics covering the period 1931 to 1946 reveals no correlation between the spring landings along the outer coast of Nova Scotia and the autumn landings in the southern Gulf area.

Summary prepared from report submitted by L. P. Chiasson

Appendix No. 39

A PRELIMINARY SURVEY OF THE TUNA FISHERY IN ST. MARGARET BAY, N.S.

The bluefin tuna (Thunnus thynnus Linnaeus) has, in recent years, increased in popularity on the Nova Scotia coast both as a sport fish for angling and as a commercial food fish.

The commercial fishing is centered in the St. Margaret bay and Halifax harbour area where "jumper tuna" (tuna ranging from 75 to 150 pounds in weight) school in great numbers from June through to November of each year. The trap-nets, harpoons and baited surface trawls which are used to exploit the fishery are not able to meet the demands of the canning industry.

With a view to providing a fishing method which might increase the catch of tuna the efficacy of the successful Pacific Coast "tuna lure" was tested during visits to St. Margaret bay, N.S., from the 10th to 12th and the 20th to 24th of September, 1948.

Five types of "tuna lures" were trolled at distances of from five to ten fathoms from the rear cockpit of a 30-foot harpoon boat. Although all types were given an equal trial, only the largest which had a red, white and yellow feather and yellow plastic body with red eyes, attracted and caught tuna. The lures passed directly through eight schools of "jumper tuna"; five strikes or bites were recorded and two fish, averaging 100 pounds in weight, were boated, the remaining three either shook off or straightened the barbless double hooks.

From the data collected during six days at St. Margaret bay some measure of the relative efficiency of the four fishing methods was obtained and is shown in the following table:

"Tuna lure" - 2 tuna were caught by 1 boat in 8 hours fishing, or 0.25 fish/boat/hour.

Harpoon - 18 tuna were caught by 11 boats in 32 hours fishing, or 0.05 fish/boat/hour.

Surface trawl - 3 tuna were caught by 50 hooks in 32 hours fishing, or 0.02 fish/hook/hour.

Trap net - 74 tuna were caught by 40 traps in 144 hours, or 0.01 fish/trap/hour.

These data suggest that the "lure" will attract and catch "jumper tuna" but that the double barbless hooks, such as are used on the Pacific Coast to catch albacore which range in weight from 25 to 50 pounds, are too light for the 75- to 150-pound Atlantic Coast bluefin tuna. In comparison with the other methods, the "tuna lure" would appear to be the most efficient.

The length-weight-age relationship of four tuna* taken from St. Margaret bay is shown in the following table:

Method of Capture	Length in inches	Natural wt. in pounds	Dressed wt. in pounds	Growth zones recorded from Scales	Vertebrae
Harpoon	48.5	80.0	62.0	4+	
"	53.0	97.5	86.0	5+	
Lure	53.75	99.0	71.5	6-7 ?	7
Harpoon	57.0	118.5	96.0	6+	
Average	52.5	98.75	78.75		

* In addition, 50 dressed tuna averaged 74 pounds in weight with a range of from 50 to 110 pounds and scales examined from 17 of those 50 showed 4 to 7 growth zones.

This relationship closely approximates that described by M. Sella (1929) from Eastern Atlantic tuna of apparently the same species and which was as follows:

Age 4 years	Length 46 inches	Weight 55 pounds
" 5 "	" 53 "	" 88 "
" 6 "	" 60 "	" 128 "
" 7 "	" 66 "	" 169 "

In contrast to the 45- to 60-inch range in length and the 4- to 7-years' range in age indicated for the St. Margaret bay tuna, the bluefin tuna of Long Island, N.Y. (Westman and Neville 1941) range in length from 20 to 50 inches with a corresponding age of one to five years. The length-age relationships would seem to dovetail and suggest that there may be one population of tuna along the Atlantic Coast of North America and that the recruits for the St. Margaret bay fishery are drawn from the waters to the south.

Stomach contents of 14 "jumper tuna" were examined and found to contain varying quantities of small billfish, herring and some squid.

Plans have been made to collect further data for the length, weight and age of the bluefin tuna with a view to providing further information on their growth, movements and abundance along the Nova Scotia coast. The development of the efficiency of the "tuna lure" with trolling booms and "chumming methods in an effort to augment the catch of tuna will be attempted.

L. R. Day

Appendix No. 40

A PRELIMINARY STUDY OF THE BILLFISH IN ST. MARGARET BAY, N.S.

The billfish, needlefish, saury or skipper, Scomberesox saurus Walbaum, has potentiality for development as a food resource of our Canadian Atlantic waters. These tasty fish are found in immense schools from early June through to November in St. Margaret bay, N.S., where thousands of pounds have been caught in traps set for mackerel, herring and tuna. However, the

sporadic nature of their appearance from year to year and the difficulty of maintaining a constant supply has, in part, retarded the development of a fishery for billfish.

To obtain information on the biological and economic aspects of this little-known fish, a random sample of 605 was taken on August 28-29, 1947, by Dr. A. H. Leim from a trap-net in St. Margaret bay. Scales were taken from 151 and lengths were recorded for all the fish in the sample. Attempts to obtain further samples in September, 1948, were unsuccessful due to the sporadic nature of the catches and the fact that any billfish caught were considered a nuisance by the fishermen and immediately released.

The size-distribution of the 1947 sample is shown in the following table:

*Length in cm.	18	20	22	24	26	28	30	32	34	36	38	40	42	Total
No. of lengths	1	20	207	191	43	6	4	4	0	18	77	33	1	605

*Lengths measured in half-cms. from tip of bill to the end of the longest lobe of the caudal fin extended straight back and shown in 2-cm. groups.

The bimodality of the size distribution suggested that there may be year-classes which have been a total failure or that the distribution is made up of two adjacent year-classes. An examination of 26 scales representative of those taken from the fish making up the two modes revealed that those from the first mode had no winter ring or check, while those from the second all had a characteristic ring which might be considered a winter check in growth. Thus it appears that the size distribution is made up of fish of age group I and age group II which average 23.5 cm. and 38.5 cm. respectively.

The difference of 15 cm. in average length between age group I and II suggests extremely fast growth and it might be further assumed that the greatest length of approximately 45 cm. as recorded by American and European observers could readily be attained in the largest age group II billfish by adding approximately 3 cm. to their length between the end of August and the onset of the physiological winter.

The above suggests that the billfish is a fast-growing species with a life span of 3 years at the most and that the success and failure of year-classes could subsequently be reflected in, and could account in part for, the sporadic appearance of this fish from year to year.

Further investigations are planned on the life history of the billfish and the use of small-mesh gill nets and torching methods as a means of sustaining a supply such as is necessary for a successful commercial fishery.

L. R. Day

Appendix No. 41

GENERAL SUMMARY OF SMELT INVESTIGATIONS

Since the trend of the Miramichi smelt landings has been generally downward during the last 30 years, investigations have been carried on by the Fisheries Research Board to obtain information on which to base action which will serve to arrest this downward trend, if possible increase the landings, and maintain the highest possible long-term yield.

Improvement of spawning conditions

It has been shown in previous years that stream clearance, by increasing the area occupied by spawners and thus reducing crowding of eggs, will increase the number of larvae produced in the brooks and the Department has had some clearing done during the past few years for this purpose in tributaries to the Miramichi. Clearing has also been done, especially in 1947 and 1948, to prevent the trapping of large numbers of adults above obstructions when freshets drop. With the exception of some large jobs, the accumulated obstructions have now been removed and a clear passage established, and future work will be mainly maintenance at relatively low cost.

In order to extend this work to other areas 21 fisheries officers from the north and east coasts of New Brunswick visited the Miramichi in groups of two and three during the 1948 spawning season. They were shown a great number of typical examples of obstructions to smelt spawning runs and are now in a position to survey the streams in their own districts from this standpoint. (Appendix 42).

Although stream clearance will increase production of smelt larvae in the brooks, there is as yet no definite correlation between the size of the parent Miramichi spawning stock and the number of larvae collected annually at Newcastle bridge. To what extent the number of larvae influences the number of smelt entering the fishery has also to be determined. Final assessment of the value of stream clearance depends on information on these two points.

Since it now seems that the spawning in main branches above head of tide may be especially important to the fishery, some thought should be given to flood control in the headwaters as well as to clearance of tributary brooks. The spawning in the main branches occurs during freshet conditions which usually abate before the eggs hatch, leaving the majority of them high and dry along the banks. (Appendix 43).

Divisions of the Miramichi smelt stock

Earlier work has shown that the Miramichi smelt fishery is based on only a part of the total stock and that the residue of the fishery forms the first part, or vanguard, of the general spawning run. It becomes important, therefore, to learn not only what proportion of the total stock is subject to the fishery but also to discover whether or not the various parts of the stock

(a) remain distinct year after year leaving the same part always unexploited, (b) become thoroughly mixed between seasons, (c) behave as a single stock through smelt shifting, as they grow older and larger, from the unexploited to the exploited part of the stock. The answers to these alternatives will govern the measures needed to assure the highest possible long-term yield.

Through marking fish at a number of points in the fishing area near the end of both the 1945-46 and 1946-47 commercial seasons and examining smelt on all the spawning grounds it was found that the residue of the fishery, identified by these marked fish, was not mixed throughout the spawning run either in time or area but formed the head of the run, going farthest upriver and spawning in the lower fresh waters of the main branches, while the tributary brooks were occupied by smelt that entered the fishing area (inner estuary) after the commercial season is over.

During the 1947 spawning season from 25,000 to 30,000 fish were marked in each of three widely-separated brooks to determine when and where these, as well as the remainder of those marked in the 1946-47 fishery, would appear in the 1947-48 fishery and 1948 spawning run.

After examining almost three million smelt in the 1947-48 fishery (Appendix 44) it was found that the marked residue of the 1946-47 fishery had not mixed thoroughly with the 1947 brook stocks. The main concentration of the stocks marked in the brooks appears to have remained outside the fishing area in the open water as it was during the 1946-47 season. Thus, after almost a year at large, these two parts of the stock were still, on the whole, separate.

A fairly thorough survey, in which 352 thousand of the 1948 spawning run were examined (Appendix 45), yielded the following information: (a) the fish marked at the end of the fishery, as in the two previous years, were found only in the lower fresh waters of the main branches, not in the brooks; (b) the fish marked in the brooks were found only in the brooks, not in the fresh waters of the main branches; and (c) marked smelt constituted a higher proportion of the run in the brook where they were marked than in other brooks examined, suggesting a tendency to return to the same brook.

Preliminary vertebral counts on samples of smelt from various parts of the fishery, and of the spawning run, suggest that significant differences might be found confirming the divisions of the stocks suggested above, and it is planned to follow this lead further.

Rough estimations based on small systematic sampling of the larvae at the head of tide in the main branches indicate that the order of production may be in the neighbourhood of two to five million larvae and the Renous river produced over half of these in 1948. Though the 1948 spawning run in the brooks was the lowest in the last 4 or 5 years, that in the headwaters was the best for quite a number of years (Appendix 43).

bullhorn

General

A number of minor aspects of the general problem have been examined to some extent (Appendix 46). Cormorants, believed to be serious spawning smelt predators in 1947, did not appear in great numbers in 1948. However, mergansers right on the spawning grounds in numbers of streams are believed to prey on smelt almost exclusively at this season.

R. A. McKenzie

Appendix No. 42

STREAM CLEARANCE FOR SPAWNING SMELT

It has been shown that removal of obstructions leads to occupation of a greater spawning area with consequent reduction in crowding of eggs and that production of larvae is increased by reduction in crowding. Furthermore, certain streams are obstructed in such a manner that spawning smelt ascend but are trapped above the obstructions by receding water levels before spawning is completed. Large quantities of adult smelt die in such situations and are lost to the fishery, although the larvae from eggs deposited in these streams no doubt go down over or through these obstructions to the sea.

Stream clearance, chiefly to alleviate the latter situation, has been carried out on the Miramichi by the Department of Fisheries during the autumn of 1948 under supervision by the smelt investigation of the Fisheries Research Board. This year's clearance work, along with that of other years, will make the Miramichi streams fairly free from obstructions to spawning smelt, with the exception of a number of bigger jobs such as old dams and water-falls. Maintenance work, however, will be required every year to keep the streams in good condition.

Twenty-one fisheries inspectors from the east and north coasts of New Brunswick visited the Miramichi for a day during the 1948 smelt spawning period to become acquainted with stream clearance procedures so that this work may be extended eventually to other smelt-spawning areas. Almost the entire time during these visits (two or three men at a time) was spent in the field where obstructions caused by such things as highway culverts, wire fences, lumbering pulp wood and pit-prop operations, natural waterfalls and brush jams, old dams and piles of pulp wood dumped over bridges into streams, were examined to enable the officers to survey the streams in their own districts and having similar obstructions removed.

R. A. McKenzie

Appendix No. 43

THE SPAWNING SCHOOLS IN RELATION TO THE NUMBER OF LARVAE PRODUCED

In order to determine the needs for protecting the spawning stocks or for improving conditions in spawning streams it is necessary to know the relationship of the spawning stock to the number of larvae and, in turn, of the latter to the year-class

abundance as they enter the fishery.

Visual estimation of the relative volume of the annual spawning run in the brooks has been replaced by systematic fishing of 10 typical brooks, but the size of the spawning run to the lower fresh waters of the main NW and SW Miramichi, is still estimated visually. Because of the great day-by-day variation in width, depth, current speed, descending logs and pulpwood, etc., no better means of determining the volume of the spawning run to these parts of the Miramichi has been found to date. However, the possible distinctions which are coming to light between various parts of the Miramichi smelt stock indicate the necessity of investigating the headwaters spawners more thoroughly.

Systematic sampling of larvae at Newcastle bridge, just below the confluence of the NW and SW branches and 14 miles below the head of tide in them, has been carried on each year. New bridge pier construction now prohibits comparison of annual collections made prior to 1948 with that of 1948 or later. The table shows the relative abundance of spawning fish and larvae collected during the past years. The 1948 headwaters spawning run was very good, while the run into the brooks on the whole was the poorest in the last 4 years.

	<u>Visual estimation of spawning run</u>		<u>Total catch of systematic fishing of 10 brooks</u>	<u>Newcastle Bridge larval collections</u>
	<u>Brooks</u>	<u>Headwaters NW and SW</u>		
1942	poor	good		11,500
1943	1942 x 2	fair SW, poor NW		1,150
1944	as 1943	good SW, poor NW		17,588
1945	1943	fair SW and NW	1038 lb.	2,777
1946		poor SW and NW	681 lb.	3,848
1947		fair SW and NW	712 lb.	2,786
1948		very good SW and NW	618	8,240*

* Due to construction of a new bridge pier 1947-48, collections from now on should not be compared with earlier ones.

Because the headwaters spawners may be chiefly responsible for the commercial fishery, systematic larval collections were made at the head of tide in all four streams (the main river divides into two 14 miles below the head of tide and each of these divides into two again near the head of tide). Total larval production in each stream was estimated roughly from the area of the mouth of the nets, the cross-sectional area of the streams at the collecting points and the larvae collected during the season in daily 15-minute hauls. Rate of hatching, not stream flow, determines the number of larvae caught per haul in these shallow, turbulent streams.

Rough estimations of larvae production, 1948, in millions

<u>SW Miramichi</u>	<u>Renous</u>	<u>NW Miramichi</u>	<u>Little SW Miramichi</u>
256	1107	409	220

Many eggs were deposited, and no doubt larvae hatched, for a few miles below the head of tide in these branches -- possibly as many as above. Thus the total production in these main branches may have been double the 2 billion estimated above.

R. A. McKenzie

Appendix No. 44

RECOVERY OF MARKED SMELT IN THE 1947-8 FISHERY

It has been shown previously that smelt enter the Miramichi fishing area from outside the estuary irregularly from autumn until late spring and that the fish remaining in the fishing area at the close of fishing at mid-February spawn every year almost entirely in the lower freshwaters of the main NW and SW branches of the Miramichi. The spawners in the tributary brooks enter from outside after the commercial fishery ends in mid-February.

To clarify this picture further about 83,000 smelt were fin-clipped in three spawning brooks in 1947 in addition to the 29,000 marked in the 1946-47 fishery and believed to be still at large. By doing this it was hoped to have distinctive marks on various parts of the total Miramichi stock, both that part which runs early and supports the fishery and that part which runs too late to be of use in the fishery.

Examination of the 1947-48 commercial catch was carried out to see to what degree the residue of the 1946-47 fishery, which spawned in the main NW and SW, had mixed with the later-run 1947 brook-spawning fish by the 1947-48 commercial season. Culling of the catch was conducted throughout the season at all the packing locations in the district and of the 21,422 cwt. of smelt caught in the Miramichi, 2,141 cwt. were actually examined for marks, amounting to 2,966,000 individuals.

To determine the total number of marked fish probably caught during the whole Miramichi season calculations have been made on the basis of the marked fish actually found in the various loads as they arrived at the packing sheds.

Recaptures from smelt marked in:

<u>Miramichi bay,</u>	<u>Wilson brook,</u>	<u>Big brook,</u>	<u>McKnight brk.</u>
<u>winter 1946-47</u>	<u>spring, 1947</u>	<u>spring, 1947</u>	<u>spring, 1947</u>

Actually found	201	34	45	51
Calculated total recaptures	2091	251	401	557

It is seen in the table that the smelt marked in the bay at the end of the 1946-47 fishery turned up in the 1947-48 catch in much greater numbers than did those marked in the brooks, even though it is believed there were about equal numbers of all four markings at large. Statistical analysis indicates that the winter

markings were not thoroughly mixed with the brook markings. Thus, even after spending the summer off the mouth of the Miramichi and being at large almost a year, the residue of the 1946-47 winter fishery seems to have remained somewhat separate from the smelt marked in the brooks. These latter fish in general remained outside the fishing area until the fishery was over not only in 1946-47 but again in 1947-48.

There is thus further suggestion that the various parts of the Miramichi smelt stock remain distinct and enter the estuary in the same order year after year, leaving the same part of the stock unexploited.

R. A. McKenzie

Appendix No. 45

RECOVERY OF MARKED SMELT IN THE 1948 SPAWNING RUN

The survey for marked fish in the spawning run, as in 1946 and 1947, consisted of visiting the principal Miramichi smelt-spawning grounds at least twice a week throughout the season and catching fish and examining and releasing them alive all along the streams.

The marked fish sought were those marked in the 1946-47 fishery and in the three brooks in the spring of 1947, that remained after the 1947-48 fishery. The findings and fish examined are shown in the table:

Where found	Number examined	Where and when marked			
		Miramichi bay, Jan.-Feb., 1947	Wilson Big brook, May, 1947	Big brook, May-June/47	McKnight brook June/47
<u>NW Miramichi</u>					
Above head tide	74,323	0	0	0	0
Tribs. below " "	22,659	0	0	2	0
<u>SW Miramichi</u>					
Above head tide	82,798	6	0	0	0
Tribs. below " "	54,104	0	8	5	2
<u>Main river</u>					
Tributaries	70,574	0	3	31	4
<u>South side bay</u>					
Tributaries	3,110	0	0	0	0
<u>North side bay</u>					
Tributaries	44,373	0	0	4	13
	351,941	6	11	42	19
Recoveries in spawning run x 8.43 to correspond with examinations in 1947-48 fishery					
	2,966,000	50	92	353	160
Recoveries in 1947-48 commercial catch					
	2,966,000	201	34	45	51

The table shows that smelt marked in the 1946-47 fishery were found only in the lower fresh waters of the SW Miramichi, not in any tributaries even of this branch. On the other hand, the smelt marked in the brooks during the 1947 spawning run were re-taken only in brooks and none in the fresh waters of the NW and SW branches.

The marked smelt constituted a higher proportion of those examined in the brooks where they were marked than in any other brooks examined.

It is also seen that there was a complete reversal of the findings in the 1947-48 fishery, for the smelt marked in the 1946-47 fishery dominated the 1947-48 commercial catch, while smelt marked in brooks, especially those marked in Big brook, dominated the spring recaptures. If all parts of the mature Miramichi stock may be assumed to have been on the spawning grounds and examined in almost equal proportions this can only mean that the 1947-48 commercial catch was made up to a very great extent of smelt which would spawn in the main branches while the brook spawners remained generally outside the fishing area. This agrees with the recoveries in the commercial catch in indicating that the smelt marked in the fishery were not thoroughly mixed with those marked in the brooks.

R. A. McKenzie

Appendix No. 46

SOME MINOR ASPECTS OF THE SMELT INVESTIGATION

Predation by cormorants. In the spring of 1947 great flocks of cormorants were on the river for a period of ten days to two weeks while the smelt were moving up to the head of tide. There seems no doubt that these birds preyed on the smelt to a very great extent as this was the only species of fish in quantity in this section of the river at this time. Plans were laid to secure stomachs for analyses in the spring of 1948. However, only three small flocks showed up and these remained only a few days. As a result no specimens were obtained and another attempt will be made.

Predation by mergansers. In contrast, however, to the cormorants which remained in the tidal part of the main river, mergansers appear to prey on smelt chiefly after they reach the head of tide in the larger tributaries. In three or four of these locations flocks of 50 to 100 birds were found in the spring of 1948 when the smelt were actually spawning. In one stream in particular there was a gap of several miles between the head of tide and the lower margin of the spawning school. This is unknown in any other stream and may have been caused by a large flock of mergansers which stayed at the lower edge of this school and presumably fed on them. It is planned to examine merganser stomachs in these situations in 1949.

Fecundity and size. The quantity of eggs deposited during the annual spawning run depends to a great extent on the number and size of females present. To obtain some information

on the effect of different average sizes from year to year the numbers of eggs in females of various sizes have been determined in a few cases. These appear to range from about 8,000 in a female of 12.5 cm. (to the end of the scales on the caudal peduncle) to 70,000 in a female of 21 cm. Material is already preserved with a view to making a series of determinations covering all sizes of ripening females.

R. A. McKenzie

Appendix No. 47

GENERAL SUMMARY OF TROUT INVESTIGATIONS

Until recently a considerable part of this station's trout investigations in the Maritime provinces was concerned with evaluation of the trout production in relation to a variety of associated water conditions. Although this exploratory phase should not be considered complete, it has proceeded sufficiently far to indicate well-defined problems. In 1948, assessment studies were confined to a creel census at Montague pond, P.E.I. (Appendix 48), and to those which formed an integral part of more comprehensive investigations.

Assessment studies have shown a wide variability in the productive capacity of Maritime fresh waters, ranging from the relatively unproductive lakes in the older geological formations of New Brunswick and Nova Scotia to the highly productive streams and ponds of Prince Edward Island, draining soils overlying sedimentary rocks (Appendices 48 and 49).

Investigations are under way to explore the possibilities of increasing the trout production in lakes with infertile waters by the addition of commercial fertilizers. Since such waters usually have a poor supply of young trout, the introduction of hatchery stock is then required to capitalize upon any improved productive capacity. Thus, these investigations also deal with the question of effective utilization of hatchery trout. (Appendix 50).

In the small productive streams of Prince Edward Island and elsewhere in the Maritimes, with large numbers of small trout, the problem is not primarily one of increasing the fertility of the water or the supply of young trout by stocking, but rather one of manipulating the environment, such as by pond formation on the streams, to provide living space for better growth and larger trout, and greater availability of these fish to the anglers. Studies are being made in artificial ponds on P.E.I. streams to determine their maximum carrying capacity for trout of suitable angling size (Appendix 49). Pond formation, however, involves not only the trout in the brooks but also those that run to sea and periodically return to fresh water. At Ellerslie brook, the relationship between these stocks of trout, the effects of a pond upon them, and the utility of a fish-way to overcome restrictions caused by dams of movements of trout are being or will be investigated (Appendices 51 and 52).

In both productive and unproductive waters undesirable species of fish may become dominant. Their control, aside from other factors that may be involved, is necessary before good survival and growth of young native or introduced trout can be realized, with or without fertilization. Experience from past attempts to control unwanted fish by poisoning has shown that a complete kill is necessary to be effective, and that, in stratified waters, derris, which has commonly been employed, does not become well enough distributed to all depths to accomplish this. In co-operation with the Fish Culture Development branch of the Department tests are in progress and will be continued in 1949 with a newly-developed fish poison for which good dispersion in the stratified waters is claimed. (Appendix 53).

M. W. Smith

Appendix No. 48

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

As one of the studies to assess trout production in Maritime fresh waters, a creel census has been maintained since 1943 on a 23-acre pond on the North Montague river, which stream supports an abundant population of small trout. A summary of the results are given in the following table:

Year	1943	1944	1945	1946	1947	1948
No. of trout caught	3731	3801	3533	3819	3061	2403
No. of rod-hours	--	1516	1632	1634	1723	1351
No. per rod-hour	2.5	2.5	2.2	2.3	1.8	1.8
Average total length (in.)	--	8.2	8.5	8.1	8.4	8.0
Average weight (oz.)	--	3.8	4.5	3.6	4.1	3.4
Pounds per acre	--	40.7	44.0	37.2	34.1	22.4

The decidedly lower yield of trout to anglers in 1948 is associated with less fishing effort, lower catch per unit effort, and a smaller average size of fish. The lower catch per unit effort (average for the season) in 1947 and 1948 is tentatively attributed to more adverse angling conditions in these years, rather than to a diminution in stock.

The yields of trout from the Montague pond stand in sharp contrast to those obtained from the relatively infertile lakes of Charlotte county, N.B., where a creel census maintained over a number of years on eight lakes showed that, on the average, between two and three hours were required to capture a trout and the yield was less than one pound per acre.

M. W. Smith

Appendix No. 49

TROUT PRODUCTION IN ARTIFICIAL PONDS ON PRINCE EDWARD ISLAND

Artificial ponds on Prince Edward Island streams usually provide good angling for larger trout than found in the inflowing streams. Pond formation is being investigated as one method of managing the abundant population of small trout in the streams toward a larger size and an increased availability to the anglers. The current investigations are concerned with the determination of the most suitable densities of stock for optimum production of trout of angling size under natural conditions in the ponds. It is planned to investigate the possibility of improving production by supplementary feeding and by fertilization of the waters.

1. Growth and production of trout.

(a) Southport pond (long-established).

Of 1,000 yearling trout planted in 1946, 206 were recovered in 1947 after a 13-month period. The average length and weight had increased from 8.3 to 11.4 in., and from 4.3 to 8.8 oz. - a production for the period of 25 lbs. per acre. Of 2,000 yearlings planted in 1947, 517 were recovered in 1948 after a 12-month period, and the average length and weight had increased from 8.5 to 9.4 in., and from 4.2 to 5.0 oz. - a production of 11 lbs. per acre. In 1947, 453 native trout were found in the pond, giving a standing crop of 50 lbs. per acre, but in 1948 these numbered only 50 and gave a standing crop of 3 lbs. per acre. Since there was such a disparity in the number of native trout present in the two years it is difficult to assess the effects of doubling the introduced stock. Seasonal variations, particularly those between the two winters involved, and some unrecorded angling, undoubtedly had an effect upon the results.

Angling was permitted for eight days in the spring of 1948, and this resulted in the capture of 99% of the surviving introduced stock (7.0 in. average length) and 18% of the native trout (6.1 in. average length). About 90% of the catch was made in the first four days.

(b) Simpson's pond (first flooded in 1946).

On June 15, 1948, 975 yearling trout (420 per acre) were planted. On September 3, 1948, 871 of these were recovered upon draining the pond. (Barriers prevented escapement or entrance of trout.) The average increase in length and weight was from 5.4 to 7.2 in. and from 1.0 to 2.3 oz. The production for the 80-day period was 63 lbs. or 27 lbs. per acre.

It is planned to duplicate the density of stocking in 1949 to determine the effect of the aging of the pond upon trout production.

2. Ecological studies.

These studies are principally concerned with the development of the bottom fauna upon newly-flooded land and the effects of draining ponds upon the various organisms.

The average quantity of bottom organisms at Simpson's pond in 1947 was 1.2 cc. per dredge (81 sq. in.) in August, two months after flooding fallow land.

In June, 1948, the average quantity was 0.9 cc. per dredge. The smaller quantity in 1948 may reflect seasonal variation and/or cropping by fish.

Draining and reflooding the Southport pond in June, 1948, which involved a period of less than a week, resulted in a decrease in the average quantity of bottom organisms from 1.9 to 1.3 cc. per dredge. Chironomid larvae almost disappeared, but Oligochaetes, which were dominant, were largely unaffected. A similar action at Simpson's pond gave the following results, before and after draining the pond.

Stream bed (not drained) - before	0.8 cc. per dredge
after	1.2 cc. " "

Bottom exposed by draining - before	1.1 cc. per dredge
after	0.6 cc. " "

Chironomid larvae were dominant in this pond, but appeared less severely affected than at Southport.

In summary, the bottom fauna studies show a rapid development of fish foods in a new pond and a moderate reduction by the short-term exposures upon drainage necessary for trout assessment.

An additional pond will be available for study in 1949. The investigations are being made in co-operation with the Fish Culture Development branch of the Department of Fisheries and the Province of Prince Edward Island.

R. M. Spence

Appendix No. 50

FERTILIZATION OF NATURAL LAKES

The low yield of speckled trout from eight Charlotte county lakes, N.B., has been attributed to the infertility of the waters. Commercial fertilizers have been added to two of these lakes, Crecy and Gibson, to determine if the production of trout can be increased commensurately with the cost of such a procedure and how long any improvement may last.

Crecy lake, with an area of 50 acres and mean depth of 7.8 ft., was fertilized in June, 1946, with one ton of ammonium phosphate and 500 lbs. of potassium chloride, and in July, 1947, Gibson lake, which has an area of 59 acres and a mean depth of 13.2 ft., received 5,000 lbs. of superphosphate, 700 lbs. of ammonium nitrate, 1,300 lbs. of potassium chloride, and 3 tons of crushed limestone. The amount of P and N per unit volume added to Gibson was one-half that in Crecy lake. Gibson lake was studied for over a year prior to fertilization, and limnological observations have been made in nearby Limeburner lake to serve as a "control".

1. The concentration of fertilizers declined rapidly following fertilization. By late September of the year of fertilization the phosphorus content of the water in both lakes approximated pre-fertilization values. Since little or no water flowed from the lakes during the summer, presumably the fertilizers were removed from the water by organic growths and/or chemical precipitation.

2. In each lake a bloom of blue-green algae developed during the fall following fertilization. Such blooms have not previously been observed in these lakes. In Gibson, but not in Crecy lake a similar, but less dense bloom occurred in the second fall (1948), notwithstanding that Gibson lake had received half the amount of fertilizer per unit volume.

3. Routine sampling has shown no marked general improvement in the quantities of zooplankton. On the contrary, the algal blooms appeared to have an inimical effect upon the microcrustaceans.

4. The number of bottom organisms taken each September from the deeper water of Crecy lake has been greater since fertilization - averages of 32 (1945), 120 (1946), 136 (1947) and 280 (1948) organisms per dredge haul. Sampling at other seasons, however, has not shown a consistent improvement for the deeper water in either lake. As evidence of an increased food supply in the littoral bottom fauna of Crecy lake, it was found that the average volume of food (largely littoral bottom organisms) in the stomachs of trout angled in 1946 (before fertilization) was 0.75 cc. per stomach, while in 1947 the average was 3.6 cc., although the average size of the trout was somewhat smaller.

5. A marked reduction of the dissolved oxygen content of the water in Gibson lake occurred during the winter following fertilization to a mean value of 3.03 cc. per litre in March which approached the limit required by trout. A comparable reduction was not noted in Crecy lake, where in March, following fertilization, the mean value was 7.14 cc. per litre.

Following the fertilization of Crecy lake, introduced fingerling trout grew rapidly, whereby they were of sufficient size to enter the anglers' catches the year after introduction. This favourable growth rate persisted into the second year after fertilization. The growth rate of introduced yearling trout was also improved. Further, the native trout grew at a faster rate after fertilization. The average lengths of 2+ native trout were 9.4 cm. before fertilization as against 10.6 and 11.7 in. in 1947 and 1948, but the numbers angled progressively declined. A similar improvement in the growth rate of introduced trout was not found in Gibson lake after fertilization. Comparative data are presented in the following table. (Each lake was planted with the same hatchery stock at any one time).

Stock		Average length in inches		Growth (ins.)	% Survival to anglers
		when planted	when angled a year later		
<u>Crecy lake</u>					
unfertilized	yearlings	7.5 (1945)	10.1	2.6	10.2
1st. year after fertilized	yearlings fingerlings	8.4 (1946) 3.2 (1946)	11.4 8.5	3.0 5.3	16.7 3.6
2nd. year after fertilized	yearlings fingerlings	8.4 (1947) 2.9 (1947)	12.2 9.3	3.8 6.4	3.9 0.5
<u>Gibson lake</u>					
unfertilized	yearlings fingerlings	8.4 (1946) 3.2 (1946)	10.4 4.5	2.0 1.7	12.0 0.2
1st. year after fertilized	yearlings fingerlings	8.4 (1947) 2.9 (1947)	10.5 5.5 (only two recaptures)	2.1	3.8

In the following tables the yield of trout (and salmon) to the anglers from Crecy and Gibson lakes are set forth. The improvement noted in 1947 for Crecy lake resulted largely from the improved growth rate of the planted fingerlings which entered the anglers' catches the year after being introduced. Although the growth rate of fingerlings and yearlings was somewhat greater even in 1948, the survival of both groups was inexplicably poor, with the result that the yield to the anglers fell to pre-fertilization levels. The yield of trout and land-locked salmon from Gibson lake fell after fertilization, perhaps reflecting some winter kill resulting from low oxygen values.

Crecy lake

	<u>1943</u>	<u>1944</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>
No. caught	167	148	143	425	110
No. per rod-hour	0.4	0.5	0.6	1.0	0.3
lbs. per acre	2.1	1.3	1.5	3.6	1.6

Gibson lake

	<u>1944</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>
No. caught trout	20	5	8	82	50
salmon	44	47	57	21	17
No. per rod-hour (trout and salmon)	0.3	0.4	0.5	0.3	0.2
lbs. per acre (trout and salmon)	0.7	0.5	0.8	1.1	0.8

Observations will continue at both lakes. It is planned to repeat the kind and degree of fertilization in Crecy lake in 1949. G. K. Higgins, Mrs. L. Miller and Miss Mary Holmes assisted in the investigations.

Appendix No. 51

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

Although pond formation upon Prince Edward Island streams may be considered a good method of improving trout angling, it restricts the movements of the sea-run trout into the streams. Restrictions upon their upstream movements may affect the sea-run population (1) by causing them to congregate in areas just below dams, instead of being distributed throughout the streams, and thus become more vulnerable to anglers, and (2) by reducing the stream area available for spawning. The reduction in spawning areas is most serious if sea-run parents are necessary for sea-run progeny, but of much less significance if the sea-run group is recruited indiscriminately from the stock of young trout in the streams, irrespective of parentage. An investigation was begun in 1946 at Ellerslie brook to assess the effect of pond formation upon the trout population of a stream system, to study the relationship between the sea-run and brook populations, and to gain information upon the value of a fish-way as a means of overcoming restrictions imposed by dams upon upstream movements of trout.

A two-way fish trap has been in operation at the mouth of Ellerslie brook, near the head of tide, since June, 1946. Daily trap records are kept of the number of trout moving either way, and of the length of each fish. Since April, 1947, a numbered tag has been attached around the lower jaw of each trout as it moves through either trap for the first time. A creel census (number caught, effort, length, age, record of tags, samples of scales) is maintained upon the stream from April 15 to Sept. 15, and an effort is made to obtain records of tagged trout caught in neighbouring areas. Air and water temperatures, and water levels are recorded for the brook.

In 1948, progeny from (1) sea-run and (2) brook stocks of trout (about 2,000 of each) were planted as fingerlings in Ellerslie brook, after being marked differently by fin-clipping. In 1949, about 500 of each of these stocks will be planted as yearlings. By this procedure, which will be repeated after the pond is formed, it is hoped to determine if any differential movement to sea on the part of those two groups of trout occurs.

The trout population of the Ellerslie system will be studied until 1950 without a pond being formed. It is planned to erect a second counting fence in 1949 at the head of the proposed pond site to contrast the movements of trout within the stream with movements between stream and sea with and without a pond.

Certain of the results may be summarized as follows:

1. The traps have been maintained and operated throughout the year with only four brief interruptions due to freshets in the brook and once to flooding in a reverse direction from an unusually high storm tide.

2. The principal inward movements of trout have occurred in (a) June and early July and (b) in fall and early winter. The dominant downward movements are in fall and early winter, with minor ones in May. A strong inward movement in April, 1947, was not repeated in 1948. An appreciable out-run occurred in mid-February, 1948. There is a fairly general pattern in time to the major movements, but these and the more sporadic ones appear much influenced by changes in water conditions, especially water level.

3. The following data show the number (inclusive of those fish that may have moved through the traps more than once in the designated interval) of trout that have moved into and out of Ellerslie brook. It appears that the population may be declining, perhaps reflecting a greater angling effort as a result of paying a tag reward.

	April - May		June - July		Fall - Winter	
	up	down	up	down	up	down
1946	--	--	902	97	1110	2049
1947	629	197	879	81	1100	1038
1948	78	88	563	15	--	--

Ellerslie brook has a total length of about four miles. The large number of trout associated with this small stream again illustrates the productive character of P.E.I. streams.

4. Angling results for 1947 and 1948 were quite comparable. In both years about one-half of the catch consisted of trout that had not been to sea. They were, however, of somewhat smaller average size than the sea-run fish.

	Number caught		Av. total length (in.)	
	tagged (sea-run)	untagged (brook)	tagged	untagged
1947	501	640	7.5	6.4
1948	548	538	7.1	6.9

As an indication of the cropping by anglers, 32% of the trout that entered the brook between April 15 and September 15, 1947, were captured in 1947, and in 1948, 29%.

5. Only a minor percentage of the trout angled in the brook consists of fish over 2+ years of age. The age composition of angled trout in 1947 was as follows:

	1+	2+	3+
1947	3%	82%	15%
1948	3%	81%	16%

The traps were built and operated by C. R. Hayes. Mrs. L. Miller made the age determinations.

M. W. Smith

Appendix No. 52

ESTIMATION OF THE NUMBER OF YOUNG TROUT IN ELLERSLIE BROOK

Neither the trap nor the creel-census records for Ellerslie brook provide information upon the stock of fingerling trout. Such is largely the case for the yearling trout as well. To evaluate possible effects of pond formation upon the populations of these young trout, it is necessary to estimate their numbers in the stream before and after the pond is created. Work in this direction was begun in 1947, but was confined to one branch of the brook. In 1948 the program was extended to the brook as a whole.

Eleven sections of the brook, each 50 yards in length, except in one tributary where a section of 350 yards was involved, were shut off by net barriers. Within each section the population was sampled by hand-seining, the captured trout marked and released. Sampling was repeated usually on three successive days, with a continuation of marking and releasing. Schnabel's formula was employed for the estimates of population. The sections were selected purposely to represent, as closely as possible, the average conditions in that part of the stream in which they were located. Only one estimate of population was made in each section. The work covered the period from July 7 to August 7.

Estimates of the population are presented in the accompanying table and show about 15,500 fingerling, 4,400 yearling and 950 older trout in the brook. Yearling and older trout were grouped in the estimates of population by Schnabel's method, and then segregated, as in the table, by using the ratio of yearling to older trout found in all the sampling for each division of the brook. The number of older trout in any one section was too small for an independent estimate. For comparison, estimates made in 1947 for the last section in the table (the tributary Hayes brook) gave 939 trout, of which 588 were fingerlings and 351 yearlings or older.

Division of stream	Length (yds.)	Estimates		
		fingerlings	yearlings	older trout
Lower main stream	850	8827	1053	568
Middle main stream	900	2970	1328	85
Upper main stream	1900	2990	1670	256
Tributary (Hayes brook)	350	729	342	45
Totals	4000	15,516	4393	954

Almost 30 per cent (4400) of the estimated fingerling population was in that part of the stream which will be flooded when the pond is formed. Few, if any, fingerling trout were found in the pools, and presumably they will have no greater inclination to inhabit the pond. The data suggest that a considerable portion of the stream will be lost to fingerling production upon pond formation. On the other hand, older trout tend to occupy pools, and may be expected to run into the pond.

The estimates of fingerling trout are considered the more reliable, since these fish were more evenly distributed, were in greater abundance, and more easily captured. Experience showed that the best technique of capturing yearling and older trout, which invariably hid when disturbed, was quite different from that for fingerlings which were readily taken in the open. Estimates of the older fish should be made independently of the fingerlings.

Marked fingerlings appeared to be more easily seined than unmarked individuals if reseining was done during the day of marking. By the next day, however, such a difference in the ease of capture between marked and unmarked fingerlings was not so apparent.

R. V. Scott and M. W. Smith

Appendix No. 53

CONTROL OF UNDESIRABLE FISH BY POISONING

The fish populations of many Maritime lakes are dominated by species unwanted by the anglers. Their control is necessary before stocking with hatchery trout, and fertilization to increase trout production, can be most effective.

Attempts to poison the fish population of Potter's lake, N.B., with derris powder showed that a complete kill was essential, as otherwise the unwanted species soon re-populated the lake, and that in thermally stratified waters a proper distribution of derris to insure a complete kill was not realized.

Under the auspices of the Fish Culture Development branch of the Department of Fisheries, Cassidy lake, near Sussex, N.B., was treated in late September, 1948, with Fishtox, a newly-developed poison, for which ready dispersion in lethal concentration throughout moderately deep stratified waters is claimed. In company with Dr. D. G. Wilder, the writer made observations at Cassidy lake during and after the poisoning.

1. The lake was treated with 3880 lbs. of Fishtox, which was sufficient to give a concentration of 0.5 ppm.
2. The poison was placed in coarse gunny sacks and distributed by towing these through the surface waters. The waters of the lake were almost homothermous at a mean temperature of almost 14.5°C.
3. The following species of fish were observed: gaspereau (fish of the year), common white sucker, golden shiner, common shiner (*Notropis*), brown bullhead, chain pickerel, eel, killifish, white perch, yellow perch, pumpkin seed (*Lepomis*). Predators, notably pickerel and eels, were prominent in the population.

In the surface water, fish were affected by the poison in less than 30 minutes. Three days after the poisoning all gaspereau, pickerel and yellow perch seen were dead. Other species were noted alive, although distressed, with the exception

of some golden shiners which were observed in a seemingly undistressed condition three days after poisoning.

5. Pickerel, killifish and yellow perch held in cages at a depth of 30 ft. were not killed within 24 hours after poisoning.

It is planned by the Fish Culture Development branch to treat the lake in 1949 with 1.0 ppm. of Fishtox to establish the effectiveness of the initial treatment. Also as a co-operative effort with this branch, tests of this poison are to be made under more controlled conditions.

M. W. Smith

Appendix No. 54

DETERMINATION OF THE AGE OF SPECKLED TROUT BY SCALE READING

The determination of the age of speckled trout by scale reading has been viewed with some scepticism since the annuli on the small scales of this species are frequently ill-defined, particularly with increasing age. However, age determinations are necessary for an adequate study of fish populations, and work is in progress to establish the efficacy of the scale-reading method as applied to speckled trout. Features of the results to date are as follows:

1. For those populations that have been studied, there is assurance that age determinations can be made by scale reading. However, it is necessary to read a large number of scales taken from fish of all ages at frequent intervals during the year to establish the pattern of growth. Little confidence is placed upon readings for small samples taken from different waters.

2. A marked difference in scale pattern, particularly with respect to definition of the annulus, has been noted on the scales of trout taken from adjacent waters; e.g. Crecy and Bonaparte lakes, N.B.

L. C. Miller and M. W. Smith

Appendix No. 55

GENERAL SUMMARY OF SALMON INVESTIGATIONS

The investigations on Atlantic salmon by the Station in 1948 have been limited largely to the factors controlling the production of young salmon to the stage at which they leave fresh water for the sea. In this field of "smolt production" lie the principal possibilities for positive action to increase salmon stocks, as contrasted with steps to assure that adult salmon are used to the best advantage. While the relationship between the production of smolts in a river and the number of adult salmon in or near it is not well known and doubtless varies greatly, the latter does depend on the former, and, with food supply or space unlikely to limit the numbers of salmon in the sea, it seems safe to assume that increase of smolt production will usually result in increasing the number of adult salmon.

Investigations have been centred for some years in the Petitcodiac river system, selected for the variety of conditions which its tributaries offer. Many aspects of smolt production have been studied, but recently attention has been concentrated on attempts to improve it by control of bird predators - which in earlier experiments on the utilization of hatchery stock seemed to keep survival to a low level.

Smolt production from planted hatchery stock. From 1942 to 1946 five plantings varying in density and method of distribution were made on an eleven-mile stretch of the Pollett river, a tributary of the Petitcodiac inaccessible to adult salmon. An attempt was made in 1948 to trap the smolt run resulting from plantings in 1945 and 1946 (Appendix 56). Regardless of numbers planted or methods of dispersal, the five plantings produced only from 1,000 to 4,000 smolts, the largest production resulting from a dense planting (about 250,000) and a low survival (1.8%), and the best survival (5%) resulting from a sparse planting. Further experiments on the effect of density of planting were initiated (Appendix 57).

Bird predators and smolt production. As predation by mergansers and kingfishers appeared to be the factor principally responsible for limiting smolt production in the experimental stretch of the Pollett river, experiments in the effects of bird control were initiated in 1947 with experimental dense plantings of hatchery stock in 1947 and 1948 comparable with that of 1945 (Appendix 57). Estimates of fish populations by seining indicated that one year of intensive bird control resulted in a 250% increase, all species being affected, and that, to date, the increase in other species has not prevented a substantial increase in smolt production (Appendix 58). Control of bird predators, therefore, continues to offer some promise in waters with many other species as well as in waters, like the Margaree river, where the fish population consists almost entirely of salmonoids and where its value has already been indicated.

Less intensive bird control on neighbouring streams also resulted in a comparable increase in fish populations (Appendix 59) and, on the Pollett, trout angling was improved (Appendix 60). Activity of mergansers was observed on a wide variety of New Brunswick salmon streams (Appendix 61). These indications of the wide value of bird control and of the effectiveness of a moderate effort emphasize the importance of pressing our experiments in this field.

Evidence was obtained that American Golden-eyes, which frequent our salmon streams in the winter, are not a serious threat to smolt production, but that mergansers may be important at that season (Appendix 62).

Methods of bird control. A review of the techniques of bird control used in these experiments indicates that the summer removal of young birds is the most effective step in reducing mergansers, and that kingfishers are controlled best by trapping adults during the summer and autumn and by destruction of nests. (Appendix 63).

Kingfishers. Banding of young kingfishers indicated movements over a considerable area shortly after the close of the nesting season (Appendix 64). Mr. White continued his study of kingfishers and their food both in the Petitcodiac river system and elsewhere in the Maritime provinces in order to complete for early publication a well-rounded account of his outstanding work in this field (Appendices 65, 66 and 67).

Identification of fish bones. As an aid to the recognition of fish in the food of birds or of other fish, Mr. White is collecting and describing a series of diagnostic bones (Appendix 68).

Improvement of pools for young salmon. A minor experiment has been initiated on the effects of changes in a pool on the Pollett river, in the hope of discovering means of increasing the capacity of the river to maintain young salmon during periods of low water and high temperature (Appendix 69).

Techniques of estimating populations in streams. A review of the effectiveness of smolt trapping emphasizes the need for its improvement (Appendix 70). Tests of seining indicate its reliability as a means of assessing populations of small fish within fairly wide limits of accuracy. Attempts are being made to develop an electrical method using direct current and suitable for use in streams of moderately large size (Appendix 71).

Late spawning of salmon. Trapping of adult salmon on Holmes brook, a Petitcodiac tributary, in 1947 and subsequent observations indicate that spawning occurred after ice formation (Appendix 72).

Staff. Mr. White has turned his chief efforts this year towards completing his work on kingfishers. In addition to banding birds locally and collecting much data on extended field trips he has undertaken to examine stomachs brought in from bird-control operations on the Pollett. A student Research Assistant, Mr. J. A. Aikins, did the special survey of a pool as well as assisting in general population studies and bird control. H. W. Coates, Assistant Technician II, and P. Graves, part-time employee, have proved invaluable in taking over routine field work and incidental labour which formerly took a very large part of the time of the scientific staff. W. W. Yorston also assisted in field work for 2½ months during the summer and autumn.

A. W. H. Needler from
P. F. Elson's notes.

Appendix No. 56

SMOLT PRODUCTION FROM VARIED PLANTINGS OF HATCHERY STOCK

From 1942 to 1946 five plantings of hatchery-produced salmon fingerlings were made in an 11-mile stretch of the Pollett river, a Petitcodiac tributary inaccessible to adult salmon. Sparse plantings with wide distribution and heavy plantings with more restricted distribution were made both in main stream and tributaries, separately and together, to determine the effects of methods of distribution, density of planting and size of stream on

survival and smolt production.

The run in 1948 represented the production of 3-year smolts from the heavy 1945 planting in the main river and 2-year smolts from a planting in 1946 of 50,000 in the tributaries only, as affected by bird control commencing in 1947. At the end of the summer of 1947 sample seining in the main river indicated a population of 500 to 600 parr. On the basis of size frequencies two-thirds of these were judged to be 2-year-old parr, indicating that 400 fish would become 3-year smolts this spring.

Operation of the Pollett river smolt trap commenced on May 5, 10 days earlier than in other years. The season appeared to be about a week later than normal and it was felt that the trap was in early enough to take the entire smolt run. However, despite better construction than ever before, the trap again proved insufficient to withstand the high water and trash to which it was subjected and was out of operation for six days early in the season and for ten days at a time which should have compassed the peak of the smolt run.

A total of 360 smolts was taken in the trap. The mean length of these fish was 15.5 cm. as against a mean of 16.4 in 1947 and still larger sizes in earlier years. In general it appears that smaller smolts are the product of colder streams where growth is slower. Hence, it is assumed for the purposes of rough estimation that the relatively small size this year reflects production of the small, cool tributaries, with the larger fish representing the 3-year-old production from the main river. Since scale samples have not yet been examined the number of 3-year-olds can now only be estimated roughly as being equal to the number of fish exceeding last year's mean size. There were 82 smolts from 16.5 to 20.7 cm. long. Since a population of 400 such fish was deduced for August, 1947, the implication is that trapping was 20% effective. Winter predators were largely removed and earlier observations indicate a negligible loss over winter under such conditions. No changes in size grouping were noted during the smolt run and it is, therefore, assumed that the entire run was trapped at about the same efficiency level as the 3-year-olds. The catch of 360 smolts then suggests a total production of about 1,800, of which about 1,400 could be taken as the product of the 50,000 underyearlings planted in the tributaries (a 3% yield). In numbers this production is roughly comparable to that obtained in the main river with no bird control. Fish reared in the tributaries would have been subject to very little predation from birds since neither mergansers nor kingfishers commonly occur along such small, densely forested streams.

The total production of smolts from the five plantings made in the Pollett between 1942 and 1946, regardless of numbers planted or method of dispersal, was limited to from 1,000 to 4,000. The maximum percentage survival (5%) came from a sparse planting, and the maximum number (4,000) from a heavy planting with only 1.8% survival. The limitation is seen as resulting from the depredations of fish-eating birds in the main stream and the relatively small rearing capacity of tributary streams. Now, after bird control since July, 1947, there is a population of at least 20,000 yearling parr in the main river which is expected to

produce about that number of smolts next spring. Such a production has not been attained in the main stream without bird control, and is judged to exceed by at least 4 times the best capacity of the tributaries.

P. F. Elson

Appendix No. 57

FURTHER EXPERIMENTAL PLANTING OF SALMON FINGERLINGS

When salmon planting was begun on the Petitcodiac system, and especially on the Pollett in 1942, the objective was defined as study of "effective planting". Sparse plantings with wide distribution and heavy plantings with more restricted distribution were tried in both main stream and tributaries, separately and together. The maximum yield based on percentage production came from a sparse planting (5%) and on numbers of smolts from a heavy planting (1.8%). The general level of all yields was from 1,000 to 4,000 smolts. Bird predations then being seen as the principal factor limiting production, experimental plantings were continued to study the effects of bird control on this stream with its potentially large minnow and sucker population. Some further experiments in the effects of density of planting have also been commenced.

Plantings for the experiment in bird control. The heavy 1945 planting without bird control is being used as a basis for comparison. There is already indication that a similar planting made in 1947 with bird control will produce at least five times as many smolts. However, until the populations of other species reach a more or less stable level the ultimate effect of bird control in such a stream will remain unsettled and comparable plantings must be continued.

This year the heavy planting was again repeated, a total of 235,000 underyearlings of River Philip stock being supplied by the Fish Culture Development branch. In other years one-third to one-half were of this stock and the remainder, Miramichi.

Variability in handling resulted in unavoidable variations in numbers released. In 1945 no field check on numbers planted was made but in subsequent years such checks have been applied. The number planted was 249,000 in 1945, 273,000 in 1947 and 235,000 in 1948.

In planting, approximately 40,000 salmon underyearlings averaging about 35 mm. long were liberated at each of 6 stations along the 11-mile experimental stretch. Unplanted stretches do not exceed 2 miles. At each station the fish were spread over 100-400 yards on liberation. Planting was done in the latter part of August each year.

Plantings to determine effective procedures. This year an experiment was commenced which is designed to test further the role of wide distribution in effective planting. Partial, and effective, bird control is also involved.

A 5-mile section of the Pollett river above the present experimental stretch was selected, partly for uniformity of habitat, the separating distance being judged ample to preclude confusion of the two experiments. Three planting densities were used, one at each of three stations spaced evenly and sufficiently far apart to deter mixing. The greatest density corresponds to the greatest density involved in the larger plantings lower in the river. Proceeding upstream, densities were: at Coleman corner 4,000 in 8 yards; at Steeve's clearing 4,000 in 80 yards; and at Sproule bridge 4,000 in 800 yards. These lots were marked by clipping the right pelvic, both pelvic and left pelvic fins respectively.

Final assessment of production will come when the marked smolts are taken in the smolt trap regularly operated below. Sample fish of each marking are being held at the supplying hatchery for a check on possible fin regeneration.

By planting with re-arranged densities in the next two years, data should be secured for Latin-square treatment giving a reliable answer to the problem of effective planting densities.

P. F. Elson

Appendix No. 58

EFFECT OF BIRD CONTROL ON POLLETT FISH POPULATIONS

To test the effects of control of mergansers and kingfishers commenced in July, 1947, the populations of all species of fish in the Pollett river were sampled by seining in July, 1947, and July, 1948, using the same techniques and sampling stations. As the effects of other species, increased by bird control, on salmon production may be important all species were estimated. Results for both years are given in the table.

Population increases. The total fish population has increased by $2\frac{1}{2}$ times and this ratio is generally applicable to all species except those of casual occurrence and salmon. Salmon were thirty times as abundant in 1948 as in 1947, attributable largely to a heavy planting in 1947 as compared with planting in tributaries only in 1946. Parr were taken at the rate of one per yard stream length, giving a minimum estimate of 20,000 for the 11 miles of stream. A series of markings and similar re-seinings indicated the general effectiveness of seining as about 80% (Appendix 71), suggesting a maximum estimate of 25,000. This is roughly twice the greatest number obtained without bird control, 10,000 to 15,000 being estimated in 1946 from a similar planting, though later reduced to about one-third when in late summer an eagle ceased its natural control of mergansers. Parr from this section become smolts as 2-year-olds and, since winter mortality is believed practically nil with bird predators removed, 20,000 to 25,000 smolts should result in 1949.

Distribution. The two most abundant species, Couesius and Catostomus, were progressively more numerous towards the lower end and increase in numbers over last year shows similar order. This may be partly because they are better adapted to lowland types

Number of fish seined in the Pollett river, 1947 and 1948

Place	Elgin		Mapleton		Blakney		Salmon Hole		Forest Glen		Babcock		Sanatorium		Total		Fish per sq. yd.		Ratio
	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'48/'47
Year	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'47	'48	'48/'47
Length of section seined (yds.)	50	60	50	60	50	50	50	50	50	60	50	50	75	50	375	380			
<u>Species</u>																			
Anguilla	1	2	1	-	2	-	-	8	-	5	1	4	-	3	5	22	0.0005	0.002	4.0
Catostomus	20	16	54	7	14	7	-	70	43	82	36	67	75	319	242	568	0.025	0.060	2.4
Couesius	512	315	82	96	22	60	2	396	184	477	150	610	349	685	1301	2639	0.134	0.278	2.1
Semotilus	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	0.0005	-
Rhinichthys	67	136	58	67	6	26	1	93	18	92	2	60	8	12	160	486	0.016	0.051	3.2
Notropis	-	-	-	-	-	-	-	-	-	-	-	-	3	2	3	2	0.0003	0.0002	0.7
Gasterosteus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	0.0001	-	-
Fundulus	-	-	-	-	-	-	-	-	-	-	-	-	4	11	4	11	0.0004	0.001	2.5
Salvelinus	1	-	-	-	-	-	-	1	-	2	1	1	-	-	2	4	0.0002	0.0004	2.0
Salmo	-	87	7	72	1	53	-	75	-	66	2	41	-	2	10	396	0.0013	0.042	32.3
<u>Totals</u>	601	561	202	242	45	146	4	643	245	724	192	783	439	1034	1728	4133			
Numbers per square yd.	.48	.37	.16	.16	.04	.12	.003	.51	.20	.48	.15	.63	.23	.83	.18	.44			
Ratio 1948:1947	0.8	1.0	3.0	170.0	2.4	4.2	3.6	2.4											

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of habitat and partly because merganser pressure was relatively more severe as the growing broods moved downstream.

A tendency towards greater abundance of salmon upstream is of questionable significance but could result from salmon being adapted to rougher types of water. At the extreme lower end a pronounced scarcity of parr is seen as related to distance from planting site (nearest - 2 miles upstream).

Parasitism. As a by-product of bird control the incidence of "black-spot" infection, for which kingfishers are reported intermediate hosts, on all species has become negligible where it was formerly not uncommon.

P. F. Elson

Appendix No. 59

EFFECTS OF LIMITED BIRD CONTROL ON NEIGHBOURING STREAMS

Once annually in 1947 and 1948 mergansers were removed from the neighbouring Coverdale river and Turtle creek to facilitate fall and winter control of these birds on the Pollett. Population sampling for fish was done to assess results of this partial bird control. Two places were selected to represent the upper and lower reaches of salmon habitat. The same places and techniques were used in 1948 as in 1947 except for the addition of barrier nets to delimit areas during seining. This does not materially affect the results (Appendix 71) but adds some confidence in data obtained. Data for the two years are compared in tables 1 and 2.

The greatest increase for both streams is at the lower end, the part most subject to merganser pressure and having least bottom cover for fish, especially on the Coverdale where the greatest increase occurs. On the upper Turtle, which is too small and forested for much merganser predation, the increase shown is of questionable significance.

Comparison of these streams and the Pollett (Appendix 58) shows increases of the same order despite differences in control procedures, actual densities being greatest in the Coverdale and least in the Turtle. Release from bird pressure has been greatest on the Pollett and least on the Turtle, where only adult mergansers have been found.

The much greater increase in salmon on the Pollett is attributable to hatchery planting there and to low natural fry production in 1947 on the other two streams.

Table 1. Coverdale river

Fish seined per sq. yd. in same areas both years.
Seined July 30-31, 1947, and August 10, 1948.

Species	Lower		Upper		Overall		148/147
	147	148	147	148	147	148	
Catostomus	.011	.199	.266	.266	.087	.220	2.5
Couesius	.015	.103	.437	1.274	.151	.475	3.1
Semotilus	.006	-	.026	.069	.012	.030	2.5
Rhinichthys	.019	.060	.126	.474	.052	.192	3.7
Chrosomus	-	-	.003	-	.001	-	-
Fundulus	.006	.081	-	-	.004	.055	13.8
Salvelinus	-	-	-	.006	-	.002	-
Salmo (parr)	.003	.013	.069	.029	.021	.018	0.9
Overall	.057	.549	.906	2.351	.319	1.131	
148/147	9.6		2.6		3.6		

Table 2. Turtle creek

Fish seined per sq. yd. in same areas both years.
Seined July 31, 1947, and August 11, 1948.

Species	Lower		Upper		Overall		148/147
	147	148	147	148	147	148	
Catostomus	.052	.027	-	.003	.037	.020	0.5
Couesius	.040	.140	.013	.040	.032	.111	3.1
Semotilus	-	.001	-	-	-	.001	-
Rhinichthys	.029	.120	.037	.047	.031	.099	3.2
Salvelinus	-	-	-	.020	-	.006	-
Salmo (parr)	.003	.003	.057	.027	.018	.010	0.6
Overall	.124	.295	.107	.147	.119	.254	
148/147	2.4		1.4		2.1		

P. F. Elson

Appendix No. 60

BIRD CONTROL AND TROUT ANGLING

Control of fish-eating birds on the Pollett and adjacent streams has increased the numbers of all species of fish. The increase in trout populations has been of particular interest to a portion of the local angling public. Emphatic favourable comment has been volunteered.

While there is considerable spring and early summer angling in these streams, it has been shown by marking of trout caught in smolt traps that they move into small spring-fed tributaries with the onset of summer and are, consequently, seldom recorded in mid-summer seining operations. Records obtained,

however, suggest an increase in trout from 1947 to 1948 (Appendices 58 and 59).

On the Pollett several schools of 30 or more trout, 6 inches or more in length, were observed frequently this summer where formerly it was unusual to see two or three. These fish were in spring-fed areas of the main stream with little cover and would normally be extremely vulnerable to predators. Interviews with anglers indicate "the best fishing in 20 years" for this part, and "good catches of 8- to 10-inch fish" where formerly it was "not worth while fishing".

These results suggest that bird control may be efficacious for increasing trout as well as salmon production.

P. F. Elson

Appendix No. 61

MERGANSERS ON NEW BRUNSWICK SALMON STREAMS

During our kingfisher work this past summer we have been impressed by the evidence that mergansers have greatly decreased the populations of salmon and other fishes in most of the larger salmon streams of New Brunswick. The streams where observations were made were: lower Kennebecasis, Canaan, Cocagne, Richibucto, Salmon river above Chipman, Nashwaak, N.W. Miramichi, S.W. Miramichi, Bartibog, Tobique below Plaster Rock, Salmon river near New Denmark, lower Upsalquitch and lower Restigouche. Of the above streams the Cocagne seemed to be little affected, while the Canaan has few parr but a good population of large fall-fish, Leucosomus corporalis, a few small minnows and suckers as well as pickerel, Esox niger and yellow perch, which might account in part for the scarcity of the smaller minnows.

The observations from which we deduce depletion by mergansers are (1) a general scarcity of all fishes of the sizes taken by mergansers in the open stretches of the river while such fishes are plentiful in tributary streams and in parts of the river where mergansers would be frightened away by traffic or by proximity of human habitation, and (2) the finding of no parr in the open but with a few to be found hiding under stones along shore or in side waters. Such conditions exist where many mergansers are seen or where their dung splashes on roosting rocks indicate their presence on the stream.

We found this evidence of depletion by mergansers on all the streams except the two mentioned above. The two areas most severely depleted and with the largest populations of mergansers were the lower Tobique and the N.W. Miramichi. On the Tobique we drove along the road as far as Plaster Rock and visited the main stream at frequent intervals and also the tributaries. On the main river flocks of from 7 to 15 mergansers were seen all along the river. We believe that this concentration was caused by a downstream migration from the headwaters such as we have observed on the lower Margaree river after the ducks had depleted the upper waters.

On the N.W. Miramichi above the head of settlement we examined long stretches of excellent parr water but did not see a single salmon parr or other fish suitable for mergansers. Here we saw a single flock of 30 or more mergansers.

During the smelt run on the Bartibog river we made a canoe trip down the lower eight miles of the stream. We encountered a flock of about fifty mergansers close behind a relatively small school of surviving smelts. Apparently these ducks were mostly males, many being in their immature plumage. In the lower mile the big boulders in and along the stream were white with merganser dung. Three mergansers, two adult males and one immature which we shot, contained a total of eighteen smelts. On August 22, we again visited this stream and there was every evidence of depletion of salmon parr and other fishes.

Nearly all residents along the streams, wardens and fishermen, when questioned answer that mergansers have increased in numbers.

H. C. White

Appendix No. 62

WINTER FOOD OF DUCKS ON THE POLLETT RIVER

The winter food of the American Golden-eye (Glaucionetta clangula americana) and the American Merganser (Mergus americanus) which winter in New Brunswick and feed in the open sections of our streams, was studied.

Golden-eyes are not generally considered to be fish-eating birds but on the Margaree river they are said to feed upon salmon parr, and stomachs of two Golden-eyes taken in the winter of 1927 and 1928 on Forest Glen brook contained a salmon parr and other salmonid bones. During the winter of 1947 and 1948 small flocks visited the Pollett river and fed in the open rapids and pools, at times diving for food beneath the ice along the sides of the open water. Between December 19 and March 22 some twenty-five Golden-eyes were shot and nineteen recovered and analyses have been completed on fifteen of the stomachs.

Their food consisted almost entirely of aquatic insects. Most of the insects taken were Tricoptera of several genera with Brachycentrus predominating. Ephemoptera of rapids-inhabiting species were second in abundance and bulk. A few Plecoptera, mostly large Perla, were eaten. Fish remains occurred in four of these ducks but one contained only a few eroded bone fragments. Each of the other three contained one minnow (Rhinichthys), while one contained also otoliths and bones of a gadoid fish, probably Lota maculosa, from the upper Kennebecasis, from which stream the ducks fly to the Pollett river.

During the winter fewer Mergansers than Golden-eyes visited the Pollett and only five stomachs of Mergansers were available for food analyses. With the exception of two stoneflies, (Pteronarcys) all their food was fish. They contained bones of the following fishes: one salmonid (unidentified), 2 salmon parr, 15 suckers, 6 eels, 1 larval lamprey, 2 sticklebacks,

2 minnows.

The data to date indicate that many mergansers feeding on the stream during the winter might greatly reduce the number of parr, but that it is unlikely that the Golden-eyes would take many parr on this stream, although their feeding might affect the fish food in certain parts of the stream.

H. C. White

Appendix No. 63

METHODS OF BIRD CONTROL ON THE PETITCODIAC

Mergansers: Control of mergansers can be divided into four seasonal phases based on the habits of the birds. Operations on the Pollett for the past year are summarized:

	September to <u>November</u>	December to <u>March</u>	April to <u>June</u>	July and <u>August</u>	September and <u>October</u>
Sight records	15	26	95	13	0
Birds killed	3	5	10	11	0

Summer campaigning against newly-hatched broods has been relatively most productive considering investment of effort. As demonstrated on the Coverdale river (Appendix 59) such procedure produced results comparable to the more thorough control on the Pollett. Whether this will apply over a period of years remains to be seen.

Spring control, which involves destruction of breeding birds, could be very valuable in assisting or even supplanting summer operations, but has not yet been brought to the stage where confidence can be placed in its effectiveness. Spring sight records given involve repeated observations on particular individuals. Greater expenditure of time and more use of decoys may improve present techniques.

Fall and winter operations involve either the residue from earlier efforts or invading birds. Efficient operation at these times of year requires either great effort or a generous supply of "good luck". Such effort, while important for experimental work, is of questionable use as a practical procedure.

A possibility of obtaining cumulative benefits is suggested by kills in comparable periods in the past two years.

Mergansers killed on Petitcodiac tributaries

	<u>Pollett</u>		<u>Coverdale</u>	<u>Turtle</u>	<u>Total</u>
	<u>entire</u>	<u>exptl. area</u>			
1947	58	45	21	6	85
1948	11	0	10	1	22

These kills account for 85% to 100% of sight records for summer operations.

As a result of spring operations no broods were brought out on the experimental stretch of the Pollett this year, although a brood removed up river would probably have invaded later in the year.

While summer removal of young broods seems demonstrated to be effective, further investigation of the possibilities of spring control to facilitate, or even supplant, the former is desirable.

Kingfishers. Control can be divided into three phases: removal of spring migrants, of breeders, and of fall migrants.

Kingfishers killed on the Pollett river

	<u>April to</u> <u>June</u>	<u>July</u>	<u>Aug.to</u> <u>Oct.</u>	<u>Total</u>	<u>Trapped</u>	<u>No.of</u> <u>traps</u>	<u>Shot</u>	<u>No.of</u> <u>guns</u>
1947	no control	11	131	142	130	16	12	1
1948	27	10	221	258	215	39	43	2

The spring take of birds represents nesting migrants and is a small part of the total pressure. The July take is composed of birds nesting on the stream and, while few in numbers, depredations may be large because of time and brood-rearing activities. These birds are readily eliminated when nesting sites are located. Greatest possibilities of harm to small fish come with the late summer invasion by young birds (Appendix 66). Many of these are birds not reared on the system (Appendix 64) so that control over a small area will not be cumulative but will require constant annual effort.

Shooting, very effective for ducks, is much less satisfactory as a method of kingfisher control than trapping. Records are being kept of successful types of sets. To be effective traps should be attended at least weekly.

Comparative results on the Pollett (merganser and kingfisher control) and the Coverdale (limited merganser control only) indicate that where both species are present kingfisher control is less important than merganser control. Nonetheless, kingfishers have been shown capable of removing considerable numbers of fish.

P. F. Elson

Appendix No. 64

MOVEMENTS OF YOUNG KINGFISHERS

In 1947, during bird control on the experimental area of the Pollett river, all discovered nesting kingfishers and their young were killed, but after the close of the nesting season 136 had to be killed on the section in order to keep it free of kingfishers. We had thought that this number was probably about the number which would be reared on other branches of the Petitcodiac system and that a good way to protect the experimental area would be to destroy the young in their nests over the entire system.

However, it was decided that instead of attempting this it would first be well to find out whether or not these kingfishers were all coming from the Petitcodiac system. This required the tagging of young birds.

On June 30 this year we started tagging young kingfishers on the Kennebecasis river, the river system nearest the Petitcodiac. In four days we tagged there 55 young kingfishers, using standard tags of the U. S. Fish and Wildlife Service supplied by the Dominion Wildlife Service. On July 7 to 9 we tagged 39 on the Coverdale river, a large branch of the Petitcodiac system emptying into tidal water. Only two were tagged on Turtle creek, a branch below the Coverdale. Three were tagged on the main Petitcodiac near Petitcodiac village and eleven on the Canaan river of the St. John system ten to fifteen miles from Petitcodiac. In all, 110 kingfishers were tagged.

In tagging young kingfishers care was taken lest the tagging operations might jeopardize their survival. When the nesting burrow was found and the nest chamber located by measurements, a vertical pit was made down to the level of, but to one side of the nest chamber. Then a small tunnel was made into the nest. By working in this manner the nest chamber was scarcely molested as after tagging the young the pit was filled and generally packed with stones to prevent predators from digging into the nest. Since the young birds left the burrows were visited and none had been molested. Moreover, in the recaptures of birds on the Pollett, young from seven different tagged broods were taken.

Between July 26 and August 23 thirteen of the tagged birds were trapped or shot in the experimental section of the Pollett river. Returns came from the Kennebecasis as well as from the Petitcodiac system. Although the young birds must have flown overland from the Kennebecasis, the recaptures indicate that the tendency was for them to follow the water courses, a common observation on kingfishers. The taggings have shown that destruction of the nests on the Petitcodiac system would undoubtedly reduce the number of kingfishers visiting the experimental area but patrols and trapping would still be necessary for complete control of these birds.

H. C. White

Appendix No. 65

SOME ADDITIONAL FACTS ON THE LIFE OF THE KINGFISHER

A knowledge of the habits and life histories of our fish-eating birds is desirable so that we may know in what way and to what extent they are influencing our fisheries and how best to control them if desirable.

We have stated that the brood of kingfishers, after leaving the nest, migrate in a loose flock along the streams. This year such a small flock was observed on the Pollett river and three of them were shot. One of them was a tagged young. Since we had tagged all the brood in the nest from which the one had

come this small flock was not from a single brood. Our returns of tagged birds indicate a general dispersal of the birds of the broods, even to the extent of going overland to other watersheds.

We have stated that young birds take fish of much smaller size than those taken by the adult birds. Stomach contents of tagged birds this year have confirmed this.

To catch enough small fish the young birds make many dives, some without success, from low perches into water so shallow that their bills strike the bottom and some young collected this year had as much as a quarter of an inch worn from the tip of the bill. Adult kingfishers, too, will wear the tips of their bills when constructing a burrow in hard soil. A female taken in a newly-constructed nest in hard soil had a quarter of an inch of its bill worn off.

Statements have been made that man is detrimental to the kingfisher. Our observations this past summer showed that for most of the Maritime provinces man has been responsible for great increases in the kingfisher population. The abundance of kingfishers in any locality is largely limited by the availability of suitable nesting banks near fishing grounds. Throughout most of Nova Scotia and a large part of New Brunswick there would be far fewer nesting banks for kingfishers were it not for the works of man. In areas where there are no flood-swept streams with sand or alluvial banks the only sites for kingfisher burrows are the sand and gravel pits, railway and road cuttings, banks of drainage ditches and sawdust piles.

Young kingfishers digest the bones of the fishes fed to them and do not disgorge pellets until a few days before leaving the nest. Previous workers, not knowing this, have reported the number of fish remains found in a nest to be the number required to rear a brood. These remains, however, were but the pellets disgorged by the parent birds while brooding.

Young kingfishers in the nest eat at least their weight in fish every day and the faeces from this quantity of fish is passed in the nesting chamber and none is removed. Yet when a nest of young kingfishers is opened it is clean and without offensive odour. The young use their bills to dislodge sand which falls and covers their faeces and even the earth in the bottom of the nest has generally only a loam-like odour.

H. C. White

Appendix No. 66

THE FEEDING OF KINGFISHERS ON THE MIDDLE POLLETT IN 1948

In 1946 we made a collection of 32 kingfisher pellets on the middle Pollett river and these pellets contained the bones of 87 fishes, 14 (or 16.1%) of which were of yearling salmon parr ranging in length from 9 to 12 cm. In 1947 bird control was started on the Pollett and the nesting population of kingfishers was destroyed early in the year. After the nesting period this year kingfishers from other areas began migrating into the experimental area and these were trapped or shot, but not before many

of them had already fed on fishes of the stream.

At this writing 20 stomachs containing the remains of 97 fishes have been analyzed. Although the stream this year contains several times more yearling salmon parr than it had in 1946, not a single yearling parr was found in the kingfishers' stomachs. However, they had taken four salmon fry which had been planted in late August.

In 1946 the three common fishes of the stream, Couesius plumbeus, Catostomus commersonii and Rhinichthys atratulus, and salmon parr were taken in numbers in the following order: 33, 27, 4 and 14. In the 1948 analyses the numbers of these fishes were 61, 19, 8 and 0. This year in place of the 9- to 12-cm. parr four recently-planted salmon fry less than 40 mm. long were taken.

Young kingfishers capture much smaller fishes than adult birds, usually taking fish from 3 to 6 cm. in length, while fish under 7 cm. are rarely found in the pellets or stomachs of adult kingfishers. Nearly all the kingfishers taken on the Pollett this year were young birds and the yearling parr were much too large to be taken by them. On the other hand, although most of the 1946 pellets were collected in late September, only a few of them were of the type from young birds.

These apparently discrepant findings for the two years are rationalized if it is supposed that after the nesting season the adult birds continue patrolling and defending their breeding territory even against their own self-supporting young.

H. C. White

Appendix No. 67

SURVEY OF KINGFISHER FOOD IN THE MARITIME PROVINCES

Many birds do not digest the hard parts of their foods but disgorge them in the form of stomach pellets and thus the pellets are useful in the study of their food. Kingfishers disgorge the bones, scales and chitinous parts of their prey, and pellets containing these may be found beneath the perches favoured by kingfishers if such perches do not overhang the water. For the purpose of food studies the kingfisher's pellet, which generally represents a full meal, is superior to the stomach of a dead kingfisher, as the latter is often empty or contains only part of a meal.

During many years we have at various places made studies of the kingfisher and its food but these studies have not covered a wide variety of habitats. In order to make a more comprehensive study of the kingfisher and its food, pellets were collected this past summer from parts of Nova Scotia and New Brunswick, and from Prince Edward Island where we had not previously collected pellets. When collecting pellets this year we endeavoured to cover a wide variety of habitats from southwestern Nova Scotia to northern New Brunswick. As a result of these collections the content of an additional 600 pellets is now available for a detailed study of the food of the kingfisher in a variety of habitats. In making these collections we have learned facts new

to us regarding the kingfisher and have made observations on fish populations and on mergansers.

We have made analyses of only a few of the pellets but, being familiar with the bones of the various fishes, we have had, while collecting the pellets, a preview of the results.

At nesting time the kingfishers feed upon whatever fishes are available within their range, but when not nesting they tend to congregate in areas where small fishes are most abundant. They seem to prefer certain fishes and crustaceans. In areas where crayfish are abundant kingfishers may feed largely upon crayfish. They seem to show a preference for sticklebacks and fresh-water sculpins. Along the seashore they feed largely upon sticklebacks and Fundulus. Salmon parr appear to be more readily available than some of the minnows and young suckers. In the smaller trout waters they feed largely upon trout and sculpins.

When the analyses and study of these pellets have been completed the status of the kingfisher in relation to our fisheries in the Maritime provinces should be fairly well established.

H. C. White

Appendix No. 68

REFERENCE COLLECTION OF FISH BONES

For the purpose of stomach analyses of fish-eating birds it is necessary to have a reference collection of bones from identified specimens of the fishes occurring in the habitat where the birds have been feeding.

During our previous studies of the fish-eating birds in rather localized areas we have prepared the reference bones from the fishes of each locality. This year with our area for study covering the entire Maritime provinces it has been necessary to add new species to our collection. We now have available a reference collection of 29 anadromous and fresh-water fishes of the Maritime provinces as well as the common brackish water and shore fishes which might be taken by kingfishers. Our collection lacks specimens of ten species known or reported as occurring in the fresh waters of the Maritimes. These species are rather rare and occur in restricted habitats.

To facilitate the work of identification we have prepared a set of drawings of the diagnostic bones used in the identification of each species.

H. C. White

Appendix No. 69

RELATION OF FISH POPULATION TO PHYSICAL
CHARACTERISTICS OF A POOL

There is evidence that pools, of which there is a dearth on all branches of the Petitcodiac, may add to the smolt-producing capacity of the stream by providing better cover during low-water periods and respite from severely high summer temperatures. They also can provide habitat for adult salmon and trout. One of the numerous prospects for pool improvement along the Pollett occurs near the site of the smolt-counting fence. Installations desirable here to improve trapping facilities are being arranged to serve the additional purpose of providing material for an experiment in pool improvement. In order to assess the value of any changes, a study was made of the morphology of the pool and the distribution of the fish population under existing conditions.

The pool is at a bend of the stream. There was a maximum low-water depth of 3 ft. and an average depth of $1\frac{1}{2}$ to 2 ft. The pool is about 120 ft. long by 20 to 40 ft. wide. On the outside curve the bottom is sandstone and broken rock, and on the inside, gravel. Because of the wide, shallow rapids above there was no riffle at the head of the pool, which with the relatively smooth bottom presented little shelter for fish. Since the main current flows across to the inside bank near the head of the pool there is a dead-water area at the outside corner, which is the deepest part; as a result this becomes relatively warm on hot days and is little utilized by fish. Cool water from entering springs is dissipated over sand-and-gravel bars before it reaches the deep pockets.

Study of fish distributions was based on observation under undisturbed conditions. Counts were made of salmon parr but other species were too numerous for more than rough estimates to be made. Suckers (Catostomus) were dominant, with an estimated population of 300 to 400 over 5" long and 10 to 20 over 10". These fish were mostly observed lying in fairly deep water with moderate current and close to broken rock cover or, especially, near and under a log boom crossing the lower end of the deep water. Smaller suckers occurred throughout the pool and adjacent rapids. There were an estimated 500 to 1000 Couesius throughout the area, principally in the stiller and deeper parts of the pool but present in small numbers everywhere. The 500 to 1000 Rhinichthys were most in evidence in the rapids above and below the pool proper but with some individuals in the pool. Eleven salmon parr were counted on one day, on other days fewer. These invariably occupied the lower half of the pool where there was most current and, consequently, coolest water, and some rubble cover. The parr were well strung along the lower 60 ft. of the pool with none of the tendency to school which was evidenced by other species.

Pool improvement procedures already instituted include narrowing and turning the upper rapids from an initial angle of 150° to concentrate the entering flow and construction of a stone-filled crib to further accelerate and divert the current to a final angle of about 100° . Changes in the current alone have already resulted in a shifting of the fish towards the upper and

deeper part which now has good riffle, while the crib provides some solid cover. Next summer it is proposed to divert the cold water of a spring into the deep part of the pool for holding parr in summer.

J. A. Aikins and P. F. Elson

Appendix No. 70

SMOLT TRAP CONSTRUCTION

Trapping descending smolts, if it can be satisfactorily accomplished, gives unequivocal information on smolt-producing capacity. An assessment in itself, it can also provide a check for population studies made earlier in the life history. Smolt counting has long been a regular procedure of the Atlantic Salmon investigation, but has not always been satisfactory because as traps have been improved more difficult conditions have been encountered. The problems have been ones of engineering and cost.

Traps used on Petitcodiac streams have been capable of straining higher freshets than those used earlier but have still proved insufficient, with consequent loss of important data.

History of smolt trapping on the Pollett. The first fence was operated near the mouth of the river in 1942. With no rises of more than 2 ft. over normal summer level good results were obtained. In 1944 the trap site was moved up to the Sanatorium dam, the lower end of the section used for experimental salmon plantings. With consistently higher water levels and relatively deeper and swifter water at the new site, difficulty was experienced in each of the next four years in getting the trap installed sufficiently early to get the entire run, or sometimes even most of the run. In 1945 and 1947 (said to be "the highest in 20 years") the trap was broken by excessively high water. In 1948 the trap was moved to a site one-half mile upstream, the loss of territory being accepted in view of better prospects for early installation and more efficient operation at a wider, shallower and less swift place. This year the trap had one-third more straining surface (about 400 ft. long) and was made stronger. It was installed sufficiently early to take the run. However, while it would probably have functioned under conditions previously experienced it was made inoperative at a critical time by still higher spates (69 inches over normal summer level).

Weaknesses of traps and recommendations. The 6-foot racks used have been insufficient. It is proposed to substitute 8-foot racks, allowing a safety margin of about 1 foot vertical depth over any contingency so far experienced.

The length of fence required to give sufficient straining space with 1" slats and $\frac{1}{2}$ " spaces is too great for satisfactory cleaning by a crew of three. It is proposed to substitute $\frac{1}{4}$ " steel rods for the slats. This will permit reduction of the total length to one half and two men should be able to keep it clean. A small trial installation of steel rod has proved effective in straining the water. The shorter length will permit earlier installation also.

Undercutting of the gravel substratum occurs when the racks become clogged with drift in high water. A solid floor for the fence would prevent this. Considering availability of materials, labour costs and efficiency, a concrete floor would be most satisfactory. With neither time nor funds available this year a floor of heavy stones placed in a shallow trench has been built, with the line of the fence altered to incorporate as much bed rock as possible.

Heavy drift (tree trunks, saw logs, etc.) accumulates on the fence in very high water, its weight and the pressure of water against it preventing removal. This in turn prevents cleaning the straining surface, with consequent breakdown in trap operation. Booms having been demonstrated insufficient, a trash screen is proposed above the regular counting fence, with provision for by-passing heavy drift at the upper end of the fence. Materials for the screen are available from the old trap. A stone-and-timber crib has been installed to divert the current so that heavy drift can be most easily handled.

A weak point of former traps was the box for holding fish, which being at the downstream apex was subject to maximum pressure. A new design of box will incorporate two staggered funnels and allow the box to be placed behind the lowest part of the fence. The new box should trap fish even more effectively than the old type.

P. F. Elson

Appendix No. 71

TECHNIQUES FOR STUDYING STREAM POPULATIONS

Seining. Seining during summer low water and trapping descending smolts have been the methods used for studying stream populations in the Petitcodiac. Until recently one-man nets have been used for seining but, while good in small streams, they are less satisfactory in large waters. Since 1946 a two-man net has been found more effective (30' x 8', of $\frac{1}{2}$ -inch netting, cuprinol-treated, mounted 20' x 5'), particularly when one or two men drive the fish a short distance into the net by beating water and bottom with sticks. By working a given set until no more fish are taken, fairly consistent results are obtained. This year the addition of barrier nets to delimit the area being seined adds confidence to data obtained. Since in 1947 such barriers were not used, two samplings were done this year in order to have both a comparison with last year and results in which more confidence could be placed.

Total numbers of fish taken from seven sample plots.
Total stream length - 380 yds.

	<u>no barriers</u>	<u>barriers</u>
Anguilla	22	16
Catostomus	568	635
Couesius	2,639	2,802
Rhinichthys	486	621
Fundulus	11	8
Salvelinus	4	0
Salmo	396	389
Total	4,126	4,471

Overall catches are seen to be very similar. At individual stations the number of fish of each species was also of the same general order both times. There was an interval of seven days between the two seining. All parr taken in the first seining were marked and released. In the second seining, 25% to 70% of these were taken at individual stations with an overall take of 40%. Movement of the fish was not restricted during the interval, hence the summer population seems fairly stable.

In September a 45-yard stretch of the Pollett was closed off with barrier nets and an attempt was made to estimate the population by marking and releasing the fish caught in successive seinings. Seinings made one and three days after those listed gave similar population estimates but with proof that by this time fish were moving in and out of the area, the additional data were discarded.

Estimated fish population in 45-yard stretch of Pollett,
seined September 9 and 10, 1948.

	<u>Number seined</u>	<u>No. of marked fish caught</u>	<u>Total no. marked previously</u>	<u>Population estimate</u>
<u>Catostomus</u>				
1st seining	18	0	0	-
2nd "	14	0	18	-
3rd "	27	13	32	66
<u>Couesius</u>				
1st seining	134	0	0	-
2nd "	28	19	134	198
3rd "	25	22	143	163
<u>Semotilus</u>				
1st seining	4	0	0	0
2nd "	3	1	4	12
3rd "	2	1	6	12
<u>Rhinichthys</u>				
1st seining	86	0	0	-
2nd "	30	6	86	430
3rd "	150	15	110	1100
<u>Salmo</u>				
1st seining	49	0	0	-
2nd "	42	36	49	57
3rd "	49	48	55	56

Consistent estimates were obtained for salmon parr, Semotilus and Couesius. Rhinichthys and Catostomus, because of size and habits, are both more difficult to capture and to retain within the barriers, and less consistent results were obtained for these two species. Further development of this technique seems desirable.

Electrical methods of assessment may prove particularly useful in accessible situations where water and bottom conditions make seining techniques insufficient. A beginning has been made towards combining the D.C. principles described by Ph. Wolf with the large field system advocated by Prevost. Apparatus assembled produces 1000 volts D.C. When used in a tank the current produced causes all fish to show a pronounced tendency to swim towards the positive pole. However, if the voltage gradient is higher than about 1 volt per inch the fish become narcotized in a few seconds and may even be injured. They respond progressively less well after the initial shock.

The apparatus was tried in the Pollett river but current capacity proved insufficient to satisfy the demands of the electrical field.

Professional advice was sought from an electrical engineer, Prof. J. O. Dineen of U.N.B. It was learned that the present apparatus should be usable in a stream having a cross-sectional area no greater than 7 sq. ft. A similar outfit for streams the size of the Pollett would require a capacity of 5 amps., with voltage sufficient to supply the volt per inch gradient indicated, preferably for at least 50 to 75 feet. An A.C. generator employing a vacuum tube rectifier to produce D.C. has been recommended as economical and relatively portable. It would still be of such size as to be movable only by motor vehicle. The estimated cost of such an outfit is \$1,000. Further field experiments with the present small outfit should be undertaken as the next step.

P. F. Elson

Appendix No. 72

LATE SPAWNING OF SALMON IN HOLMES BROOK IN 1947

In the summer of 1947 there was a drought similar to that of the previous year, with the streams even lower until late in the fall. Holmes brook was a trickle too small for the ascent of salmon and this condition continued until November 24. On that date there was a fairly heavy rain and the water level rose twelve inches in the pool where the trap was situated. This gave a depth of six inches or more on the rapids and during the night of November 24 two male and one female salmon entered the trap. By the evening of the 25th three more females had entered. During the nights of the 25th and 26th four females and one male were taken in the upstream trap, while one male, number 8207 which had ascended on the 25th, was in the downstream trap and was released below that trap. On the morning of the 27th the brook was frozen over with only the central parts of the rapids open and this ice remained into the winter. No more salmon were taken in the trap. With one male descending there was a total of eight females and

three males left above the traps. Of these, one female was about half spent and all the males were partly spent.

Seining in the brook in the early fall of 1948 indicated that there was a good stocking of under-yearlings from these spawners although they had spawned with the water temperature at or close to zero centigrade.

All the salmon ascending in 1947 were tagged with double red tags - the only time we have used double tags on this river. Early in December a trapper reported that he had seen through an opening in the ice a salmon bearing two red tags at a spawning pit on the Anagance river just below the first beaver dam which is about two miles above the junction of Holmes and the Anagance. This fish could have been no other than number 8207. We visited this redd and found it covered. This spawning had taken place at a temperature near zero. At the end of April, 1948, another trapper brought in a dried salmon skin bearing tag number 8207 which he had found on the bank near the place where this fish had been seen the previous fall.

Two of the twelve salmon ascending Holmes brook were recaptures of salmon tagged in that brook in 1945. Scale readings show that one of these, an 81-cm. female, had not spawned since the fall of 1945. The other, an 88-cm. male which had spawned in 1945, shows a spawning mark for 1946 although it did not spawn in Holmes brook that year but had returned to Holmes brook for its third spawning.

H. C. White

Appendix No. 73

GENERAL SUMMARY OF EEL-GRASS INVESTIGATION

Eel-grass (Zostera marina L.) is an aquatic flowering plant which grows in the warm, shallow, salt and brackish waters of our coasts. As a result of the importance of this plant to the biology and commercial exploitation of marine life in the waters around the Maritimes, and in particular because of its immediate concern to the oyster fisheries, an investigation into the biology and possible methods of control of eel-grass was commenced for the Fisheries Research Board during the summer season of 1948. This was carried out mainly at the P.E.I. Biological Station at Ellerslie, P.E.I., with additional observation or experimentation at Shippigan, Tracadie and Shediac Bridge in New Brunswick, and Orangedale and other parts of the Bras d'Or lakes in Nova Scotia.

There are two distinctly opposed viewpoints on the desirability of having this plant in abundance in our coastal waters. To some it has always been a definite nuisance or even an apparent enemy. In this group are included those engaged in fishing who found it either a hindrance to the passage of their boats through channels which it sometimes filled or even a direct impediment to their operations as, for example, when it has overgrown oyster beds. These people regarded with favour its almost complete disappearance from our Atlantic coast in the 1931-1932

period as a result of the attack of the epidemic "wasting disease". The progressive recovery of the eel-grass, particularly within most recent years, has resulted in increasing difficulty in the fishing of oysters in some shallow-water leases, especially in P.E.I. and northeastern N.B. waters. As yet it has scarcely returned to the point of impeding shallow-water navigation.

A larger and more varied group regarded eel-grass favourably and were adversely affected when it disappeared. Among these are the hunters and others interested in the provision and conservation of adequate stocks of game birds, for eel-grass was the principal food of the sea brant, Canada goose and perhaps also black duck. Also there are those who benefited from its exploitation, both commercial and private, particularly for manufacture of insulation, its present principal use, but also for farm use as fertilizer and for winter banking of houses. At the present time, there is one firm producing insulation building "blankets" from eel-grass in Nova Scotia and the owner of another in New Glasgow has made enquiry about present stocks of eel-grass returning along our coasts. To the favourable group we must also add those who are directly or indirectly concerned through the part eel-grass plays in the life of numerous aquatic organisms, either in providing a habitat for part or all of their lives, or through its influence on local currents and wave action by which it exercises a measure of control of shore erosion and of alteration of the bottom conditions through erosion or sedimentation.

To gain insight into local conditions in many areas which could not be reached, a questionnaire was distributed to all fisheries inspectors in areas concerned by which gaps in the over-all picture may perhaps be filled in.

The phases of research initiated are dealt with in the succeeding appendices.

A. R. A. Taylor

Appendix No. 74

THE BIOLOGY OF EEL-GRASS

Several phases of the biology of eel-grass have had considerable investigation devoted to them in the past and this work has been reviewed. It is important to find out more about the nature of its growth and the limitations on its growth and range, as well as its general biology in the waters concerned.

Life cycle. It is a perennial plant with numerous branching rhizomes. In our areas almost all foliage seems to be lost from these rhizomes over the winter period to be replaced by new leaves from the renewed growth of the rhizomes as the water temperature rises above 10°C. on departure of the ice. At this time also terminal flowering branches commence to grow from many of the rhizomes and flowering seems to occur shortly after the water temperature reaches 15°C. In the waters of Malpeque bay flowering proceeded vigorously through June and early July, but occasional flowering shoots were found as late as the end of

August. Seed production is considerable; a normal upright flowering branch producing approximately 12 spadices each with perhaps up to 15 pistillate flowers, giving a possibility of about 180 fruits, each with a single seed. This is rarely realized in fact as the spadices usually break off as the whole plant, weighed down by the growing seeds and epiphytes, bends over. A disintegration of the fruiting shoots usually follows seed production. The seeds when finally released may germinate to give rise to new plants. Very few seedlings were found in the areas examined and it would seem that reproduction, in these areas at least, is mainly from extension and fragmentation of rhizomes, and that dispersal occurs in similar fashion.

Growth and density. Studies of the extent of growth of the plants as expressed in size of leafy shoots, leaf production and leaf size were carried out weekly at Bideford from May 18 and are still in progress. Similar weekly observations were made at stations in New Brunswick from early June until the beginning of September by seasonal junior research assistants of the oyster investigation - M. V. MacInnis (Shippigan and Tracadie), J. H. Neil (Hardwicke, on the Miramichi), and J. A. Delahunt (Shediac Bridge). Extent and size of the plants is indicative of activity and also of the ability of the plants to cause any concerted influence on ecological conditions. When data are complete and analysed it should be possible to see a more complete and definite picture of the activity of the plant through the seasons.

Accompanying this work, a study was made at Bideford of the density of growth of upright shoots (the apparent plants of eel-grass) both in respect to seasonal change and distance from shore, and thus depth of water in a shore area. In this experimental area the plant occupies the shallow water from a point just covered at mean low tide but sometimes exposed at spring tides, to the deeper water which is covered by approximately 5' to 6' at mean low tide with a normal tidal rise of approximately 4'. Its densest growth occurred at a point 2-3 metres beyond its shallowest occurrence, the density decreasing shoreward and towards deeper water. This area of densest growth is covered at mean low tide by from 1'-1½' of water. The plants in deeper water showed increasingly larger and longer leaves: this would seem to be an effect of decreased light intensity, but has not been demonstrated such as yet.

The density of growth of upright shoots showed a gradual increase over all the experimental area from the inception of observation at the beginning of June until after flowering and fruit formation had been accomplished for most of the plants in mid-July, and gradually decreased as the summer progressed and the flowering branches disappeared.

Relationship to sedimentation. One would expect the plant to have considerable effect on sedimentation where it grows. It has been observed by some of the oyster fishermen that their beds appeared to become shallower since the return of the eel-grass. This is perhaps due in part to the formation of a matted sod of rhizomes and roots but also would be due in large part to a possible increased sedimentation among the leaves of eel-grass where the currents would be slowed down and their carrying power

decreased. Samples of bottom soil representative of different depths, currents and exposures, and the various localities mentioned above were collected where the eel-grass grows, together with samples from areas of bottom devoid of eel-grass. It is hoped to show the effect that eel-grass has on sedimentation and also to determine if soil bottom conditions impose a limit on growth of eel-grass. Observations and mechanical analyses conducted so far have shown that eel-grass grows in soils as different as a soft mud with 37% of its material of particle size less than 62 μ and a coarse gravel with 95% of particle sizes greater than 125 μ . Actual mechanical analysis has been completed on only some 20 samples out of over 80 taken so far, so that conclusions will have to await completion of analyses and further sampling.

Presence of disease. The symptoms of the wasting disease were observed to be present at Bideford, Shippigan, Tracadie Lagoon, Hardwicke, Shediac Bridge and the Bras d'Or at various times during the summer. External symptoms were first noticed in late June and continued present in older leaves throughout July, were less apparent in mid-August, but could be seen increasingly towards the end of August. Almost every plant appeared affected when the Bideford area was visited again on October 9. At no time were the plants attacked to the extent of complete defoliation, but when observed the symptoms were accompanied by a continual loss of the older leaves to be replaced by new ones. On at least two occasions the writer was able to make preparations from fresh leaves of the labyrinthulan parasite described by Renn and Young. These were not checked by experts, but seemed so like photographs of the organism in the "air spaces" of the plant as to be unmistakable.

A. R. A. Taylor

Appendix No. 75

EFFECT OF EEL-GRASS ON OYSTER GROWTH

It has previously been reported by Medcof that eel-grass caused a decrease in the rate of growth of oysters growing in its midst. An experiment has been initiated to test this further.

Oysters of a definite year- and size-class, each measuring 58 mm. in length on July 22 at the inception of the experiment, were set out in four groups of 50 each, and left to grow until October 23, when they were taken up and measured again. Average growth in length appeared as follows: it was least (4.0mm.) for the group which was left on the bottom among eel-grass plants, and increasingly greater for the ones on stakes (which held the oysters about 3"-4" above the surface of the soil) amongst eel-grass (6.0 mm.), those on the bottom free of eel-grass (6.4 mm.) and the remaining 50 on stakes but away from eel-grass (6.5 mm.). This seems to substantiate Medcof's results. After measurement this autumn, the oysters will be over-wintered at the bottom and set out anew in the spring.

Measurements at the beginning of the experiment were made by A. J. Wilson; measurements at the end of the season's

growth were made by Alice J. L. Wyman.

A. R. A. Taylor

Appendix No. 76

METHODS OF CONTROLLING EEL-GRASS ON OYSTER GROUNDS

Chemical methods. While chemical control methods have not been explored extensively, the two which were tried met with no success. By very nature of the plant and also because it grows in sea-water control by 2,4-D would be expected to fail. This was substantiated in a series of dilution tests: concentrations of 2,4-D (expressed as acid equivalent) in sea-water of 1/100 and 1/1000 by weight maintained for 36 hours caused bleaching and death of the plants, but lesser concentrations seemed to have little or no effect. (The source of the 2,4-D was a commercial preparation, "Weedanol", of 2,4-D in Carbowax). This would seem to indicate that the cost and difficulty of maintaining a sufficient concentration of 2,4-D over the plants in the sea would prevent its use.

Unslaked lime proved also to be not sufficiently effective to recommend for use. It would kill leaves of plants with which it came in contact, but beyond this seemed ineffective.

Other chemicals have yet to be tried.

Mechanical methods. Past attempts at control have included cutting the eel-grass, mechanically or manually, uprooting incidental to tonging, and smothering or covering of the plants by various means. A certain measure of control is afforded by oyster fishermen who regularly and actively fish their beds, thereby pulling up quantities of the eel-grass. This is only partially effective and involves considerable labour. Cutting has been ineffective in eradication when tried in the past periods of heavy eel-grass growth. Complete smothering of the eel-grass by means of wooden platforms loaded with gravel and mussel-mud was successful when tried by Sharp and Burleigh some thirty years ago. The area so treated is still relatively free of eel-grass.

An attempt was made by Joseph Landry at Basse bay (Shippigan, N.B.) to eradicate the plant over a small area of his lease by covering it with small, thin concrete slabs. He was aided by M. V. MacInnis and men employed by the Department in oyster culture work at Shippigan. The effect of other materials in smothering eel-grass was tested on two other plots on Landry's lease and two at Tracadie lagoon. In each case shells of soft-shelled clams were used on one, and coarse gravel on the other. Spat was planted on these plots (each 20' x 20') in definite, well-separated rows with a density of approximately 170 of year 1945, 300 of year 1946, and 3900 of year 1947 spat per plot.

All these materials resulted in the smothering and death of the eel-grass. Mr. MacInnis reports that the spat seemed to survive, and remained in place on all three types of material even though the bay was subjected to a severe storm in late August. The rather coarse gravel sank considerably into the muddy

bottom and probably would be least permanent and satisfactory. The shell formed a very resilient and satisfactory covering. The concrete, of course, offered a bottom on which the spat could be seen very readily and from which cysters could be removed easily at a later date. The cost of forming such artificial bottoms is very considerable and might be prohibitive.

Some method of dragging to uproot the plants, thus greatly reducing the density of the eel-grass, probably would be within the economic means of the larger and smaller Canadian operators alike. An experiment was started to test this in which an area of dense eel-grass was chosen, the density of growth was determined and then the area was dragged using a lever-harrow towed behind the station motor boat. The density of growth was again measured after a few days had elapsed to allow settling back or uprooting and dispersal of partially dislodged plants. Harrowing cleared some areas almost completely, but owing to difficulty in handling the boat in the shallow, confined area of the plot some parts were missed, thus the average reduction in density from 176 to 98 plants per square metre does not give a true picture of the apparent success in areas harrowed well. Viewed on October 11, the actively harrowed areas were still relatively clear with a little growth from rhizomes not dislodged, while areas partly or completely missed had become heavily overgrown. The cost is very low. The method seems to have real possibility and it is proposed to find the best time for treatment as well as to determine the effect of other drags and harrows.

A. R. A. Taylor

Appendix No. 77

IRISH MOSS INVESTIGATIONS - 1948

The purpose of this investigation was to determine the presence of any improvement in the quality of dried, or dried and bleached, Irish Moss ready for shipment from Prince Edward Island. In addition an effort was made to detect improvement in the producers' methods of handling the product. In conjunction with this an educational campaign is being carried on by the Department of Fisheries in this region with the aim of driving home the need of drastic change in the treatment of the primary product and marked reduction in the foreign material content. Inspection of moss voluntarily submitted by dealers is being instituted by the Department of Fisheries, and the inspecting officers were given some instruction and guidance in applying the standards set. The education of producers and buyers alike was in the hands of these officers.

Foreign material present in Irish Moss has been put in three classes: (1) relatively harmless (sand, stones, wood and shells - not considered harmful to the extract); (2) foreign seaweeds (rockweed, kelp, etc. - which affect the properties of the extract); (3) filth (animal faeces of the various kinds - particularly dangerous due to the use of Irish Moss in food products). In addition, estimates of the amount of moisture present were made, because moisture affects the keeping quality as well as being useless weight to the buyer.

The present standards, as set by the Department of Fisheries in co-operation with the people in the Irish Moss industry and with the results of a similar survey of 1947 as a guide, are as follows:

Grade "A" Moss - less than $2\frac{1}{2}\%$ of relatively harmless material
 - less than 5% of foreign seaweeds
 - no filth
 - moss must be dry to the touch

Grade "B" Moss - over $2\frac{1}{2}\%$ harmless materials
 - over 5% foreign seaweeds
 - no filth
 - moss must be dry to touch

The method of sampling used was to draw small portions of moss by hand at random from several points in each lot - this constituting a single sample. In some instances where baled moss was being sampled a core was drawn by an apparatus designed to get a better picture of the content, especially in regard to relatively harmless material which shakes most readily from the surface of the bales. The weight of the samples varied from 100 to 1,000 grams, depending on the size of the lot being sampled. These were carefully examined for foreign materials which were classified as above and the percentage weights of each class determined. Results are summarized in the table:

	<u>1947</u>	<u>1948</u>
Number of samples	52	66
Foreign seaweeds:		
Average percentage by weight	5.19	3.38
Percentage of samples having more than 5%	46	14
Harmless foreign materials:		
Average percentage by weight	2.43	1.25
Percentage of samples having more than $2\frac{1}{2}\%$	30	10
Percentage of samples with filth	80	36

The survey in 1948 showed an improvement in freedom from all three classes of foreign materials. Visits to curing operations indicated, however, that many producers are still exposing Irish Moss to contamination by farm animals and poultry. The need for a continuation of the educational campaign is indicated.

A. E. C. MacRae

Appendix No. 78

ATLANTIC OCEANOGRAPHIC GROUP
 GENERAL SUMMARY FOR THE YEAR 1948

1. The oceanographic activities of the Atlantic Oceanographic Group, under the Canadian Joint Committee, initiated in 1947, were continued during the past year.

Oceanographical Activities

2. The oceanographical vessel, H.M.C.S. "Lloyd George", assigned to the Group by R.C.N., after some heavy weather during

a late winter cruise, was declared unseaworthy and the oceanographical activities were entirely dependent upon the temporary assignment of other R.C.N. ships as required.

3. In gulf of St. Lawrence activities, the Group had the co-operation of the Atlantic Herring Investigation Committee and also the Naval Research Establishment. Two extensive cruises of the gulf of St. Lawrence were made, one in late May and the second in October, totalling 620 hydrographic stations.

4. An observer and equipment were assigned to the R.C.N. cruise to Hudson bay in September and 84 hydrographic stations were occupied.

5. Through activities of R.C.N. in the Great Lakes, records from 208 hydrographic stations were obtained.

6. Hydrographic activities on the Scotian shelf resulted in observations from 170 stations. In particular, a winter cruise was made of the Cape Sable Island Triangle, a transition zone between bay of Fundy waters and those of the Scotian shelf.

7. Including miscellaneous observations, and those of 1947 and 1948, over 3,000 records were processed and added to our hydrographic files during the past year.

Oceanographic Vessel

8. C.N.A.V. "Whitethroat" has been assigned to A.O.G. to replace "Lloyd George". She is presently being fitted and is expected to be ready for sea by February 1, 1949. The "Whitethroat" is a modern steel vessel, 150 feet long, with a crew of 25, and capable of cruising in any weather for twenty-five days.

S. T. D. Recorder

9. A long-term loan of an S.T.D. Recorder has been arranged through R.C.N.-U.S.N. for use on the Atlantic coast. This instrument gives a continual recording of salinity, temperature and depth as the unit is lowered or towed through a body of water.

Liaison Meteorological Services

10. Sea surface-water temperatures, obtained twice daily at coastal points, are now being transmitted daily to the Meteorological Service, and are being used in a study of fog predictions.

Underwater Photography

11. Progress was made in the design and construction of equipment of an underwater camera. The equipment was perfected mechanically and the unit is ready for field tests. For the present the project has been shelved due to shortage of personnel.

Staff

12. The present organization is as follows:

Atlantic Oceanographic Group

Oceanographer-in-Charge	H. B. Hachey, M.Sc.
Assistant Oceanographer	H. J. McLellan, M.Sc.
"	Wm. Bailey, RCN(R) Attached for the summer months.
Technical Secretary	Helen E. Rigby
Technician	E. L. Graham
"	Audrey L. Mooers, B. Sc.

13. Recommendations for further additions to the staff include:

- (a) Assistant oceanographer
- (b) Field technician Grade II

For position (b) an attempt is being made to contact Mr. Graham Clark.

14. Mr. H. J. McLellan is on leave of absence, as of October 1, pursuing studies in oceanography at the University of California.

Appendix "A"

TRENDS AND CYCLES IN SURFACE TEMPERATURES
OF THE CANADIAN ATLANTIC

Surface-water-temperature data, collected over a period of twenty-seven years at St. Andrews, N. B., have been analysed, and it has been shown that the temperature variations are cyclic in character, the mathematical treatment indicating that cycles of 3.3, 9 and 15 years are involved.

It has been shown, too, that the temperature variations as observed at St. Andrews, N. B., are typical for the main Atlantic coast of North America.

On the basis of the analysis general forecast of surface-water temperatures can now be made. It will be of interest to check these general forecasts during the next few years.

H. B. Hachey and H. J. McLellan

Appendix "B"

HYDROGRAPHIC CONDITIONS IN THE CAPE SABLE ISLAND TRIANGLE

Cape Sable island is the apex of a triangular area extending to the southwest of Nova Scotia which forms a transition zone between waters of the Scotian shelf and those of the bay of Fundy.

Two cruises of this area were planned for 1948, but a March cruise only was completed. The area is of interest from

both its physical and biological aspects.

The shallower coastal waters of the Scotian shelf mix with the waters of the bay of Fundy to produce a characteristic water of comparatively low salinity and stability, while another characteristic water is formed through comparatively high-salinity water entering into the mixture from offshore. The resulting distribution of these two waters, both horizontally and vertically, presents a very unstable and complicated hydrodynamical picture, which in this area is of considerable biological significance.

The investigation of this area will be given further attention.

H. B. Hachey and H. J. McLellan

Appendix "C"

GENERAL HYDROGRAPHIC CONDITIONS CANADIAN ATLANTIC COAST

The contribution of Arctic waters, through the agency of the Labrador current, was seemingly heavy throughout the 1948 season, with one of the heaviest ice seasons over the Canadian Atlantic coast in years. As a result sea-water temperatures tended to be depressed, but recovered to normal by mid-summer, due probably to the considerable heat budget carried over from the 1947 season.

A full assessment was not possible due to the disruption of planned cruises through the loss of the "Lloyd George".

H. B. Hachey

Appendix "D"

HYDROGRAPHIC CONDITIONS IN THE GULF OF ST. LAWRENCE

Two hydrographic cruises were made in the gulf of St. Lawrence, one in late May and the other in October. In both cases these cruises involved the co-operation of the Atlantic Herring Investigation Committee and the Naval Research Establishment. Two ships were involved in each cruise.

A.O.G. interest lay firstly in filling in gaps of our knowledge of these waters, and secondly in co-operating with the Atlantic Herring Investigation Committee in dealing with the general hydrographic problems of the area.

Final analysis of the data will be a co-operative effort between personnel of A.O.G. and A.H.I.C. At present Dr. Lauzier is reporting on the general hydrographic picture.

H. B. Hachey, H. J. McLellan and Wm. Bailey

Appendix No. 79

HYDROGRAPHIC INVESTIGATIONS IN THE GULF OF ST. LAWRENCE

The co-operative effort between the Atlantic Oceanographic Group and the Atlantic Herring Investigation Committee which began in 1947 has been continued during the present year. The Committee has contributed the services of its hydrographer, Dr. Lauzier, and part-time use of its boats, the "Harengus" and the "Gulf Explorer". The Atlantic Oceanographic Group has covered a much wider area by the use of H.M.C.S. "New Liskeard" which was available to it for limited periods in June and October. Dr. Lauzier accompanied the "New Liskeard" on the October cruise.

The following cruises have been carried out by the Committee: (a) "Harengus" and "Gulf Explorer" - May 20 to June 8. Thirty-one stations in the southern Gulf, Northumberland strait, off Gaspé and across the Laurentian channel from Gaspé to Anticosti; (b) "Harengus" - July 9-13. Eighteen stations in four sections in the southern Gulf; (c) "Harengus" - August 18-20. Fifteen stations in three sections in the southern Gulf; (d) "Harengus" - October 16-24. Twenty-three stations in five sections in the southern Gulf and Northumberland strait.

In addition, approximately weekly observations were made at four "shore" stations off North Rustico, P.E.I., Cheticamp, N.S., Grand River, P.Q., and Richibucto, N.B. The observers at North Rustico and Cheticamp were employed by the Committee. The Committee is indebted to Dr. J. L. Tremblay, Director, Station biologique du St. Laurent, for the Grand River data, to the Fisheries Research Board of Canada for the Richibucto data and to Dr. L. P. Chiasson of St. Francis Xavier University for assistance in setting up the Cheticamp station.

Sixteen hydrographic stations were established in Fortune Bay and these were occupied at intervals during the period from March 15 to April 16. Representative ones were occupied weekly.

While the 1948 data are not worked up as yet, it is apparent that the waters of the south-western Gulf tended to be cooler during the May and August cruises in 1948 as compared to former years. The data from the October cruise show that the temperature conditions in the early autumn of 1948 were generally similar to those of 1947 in the surface layers but the depth of the isothermal layer was greater in 1948 than in 1947.

The 1947 data for the southern part of the Gulf have been organized and the cross sections and horizontal sections show a consistent pattern of temperature and salinity distribution. This pattern consisted of low-salinity and high-temperature waters spread along the Prince Edward Island and Cape Breton coasts, which was somewhat counter-balanced by high-salinity and low-temperature waters in the Bradelle Bank and Magdalen Islands areas. In general, the maximum surface temperature was recorded in either the Miramichi area, Northumberland strait or George bay. The minimum surface salinity was observed in the Miramichi area during the spring cruise, off North Rustico during the summer

cruise, and in Northumberland strait during the early fall cruise. The main body of low-salinity water was always located in the Miramichi area. It was also encountered in Northumberland strait during the spring and early fall cruises and along the Prince Edward Island coast during the summer cruise. As in previous years the minimum water temperature was always observed in the Bradelle Bank area.

In comparing the 1946 and 1947 spring cruises there was a general tendency toward cooler waters at the surface and warmer water in the lower layers in 1947. The salinity was higher in 1947 in the surface layers but there was no appreciable difference within the deeper layers. During the summer cruises the temperature was generally lower in 1947 than in 1945 and 1946. Salinities were lowest in 1947 except in the Bradelle Bank and Magdalen Island areas where the salinity of the bottom layer was at a minimum in 1945. In general, for the three-year period, 1945-47, the temperatures during the early fall cruises were lowest in 1947. The salinities were least in the upper layers and greatest in the lower layers during the October, 1947, cruise.

From the shore station observations it was noted that there was a lag of approximately five to six weeks in the time of occurrence of minimum surface salinity from Grand River to Cheticamp. A lag of three weeks occurred in the time of maximum surface temperature at the same stations. There is evidence of a movement of the water masses from Gaspé to Cape Breton with mixing occurring along the way.

L. Lauzier and A. H. Leim